



Heavy vehicle driver fatigue data
Final report
May 2016



National Transport Commission

Report outline

Title	Heavy vehicle driver fatigue data
Type of report	Final report
Purpose	For publication
Abstract	<p>The purpose of the report is to establish a national framework to collect and analyse fatigue data to better inform future policy. An improved evidence base is needed to demonstrate the impact of any reforms to the fatigue regulations in the Heavy Vehicle National Law. The report identifies regulatory fatigue issues that should be addressed in the national framework. The report endorses framework activities. These include: scientific research in partnership with the Alertness CRC, analysis of de-identified commercial data, national harmonisation of fatigue reporting and coding, and linking data to evaluate the safety of BFM and AFM.</p>
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Foreword

The Heavy Vehicle Driver Fatigue reforms of 2008 have resulted in a reduction 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, driver fatigue remains a policy challenge, with many contributing factors. A driver's alertness is 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 the causes of driver fatigue.

In 2014, the Transport and Infrastructure Council considered the fatigue impact of heavy vehicle driver regulations, in particular the ability for drivers to work two long work shifts around a major rest break. Ministers recognised that more data is needed to better understand the link between specific work and rest hours and fatigue.

The purpose of this framework is therefore to ensure that we have sufficient data to underpin any future reforms of the fatigue regulations in the Heavy Vehicle National Law, including but not limited to the counting time rules.

I would like to thank staff at the National Transport Commission, the National Heavy Vehicle Regulator and the Alertness Safety and Productivity Cooperative Research Centre (CRC) for their strong collaboration in the development of the national heavy vehicle fatigue data framework.



David Anderson PSM
Chairman, National Transport Commission

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1 A national framework

Key points

The objective of the framework is to collect real-life operational data to better inform future fatigue policy. A program of four projects will address the priority fatigue issues identified in this report:

- new research to evaluate the fatigue impact of current laws
- harmonised definitions, fatigue scales and coding
- analysis of commercial data to evaluate the frequency and impact of fatigue regulations
- a feasibility review of road agency capabilities to link crash data to driver accreditation.

1.1 Objective

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 (the 'counting time rule'). Governments and industry agreed that amendments to the fatigue rules were not warranted without further data demonstrating the case for change.

In November 2014, the Transport and Infrastructure Council requested that the National Transport Commission (NTC) and the National Heavy Vehicle Regulator (NHVR) develop a national framework to collect real-life operational data to better inform fatigue policy directions, including (but not limited to) the counting time rule.

Council endorsement: that the NTC and NHVR collaborate with industry and governments to develop a national framework to facilitate collecting real-life operational data to better inform future fatigue policy.

1.2 Program of four projects

The National Heavy Vehicle Fatigue Data Framework is a program of four projects that will generate data for research and policy development. The projects are grounded in real-life operational data and designed to address one or more of the prioritised fatigue issues:

1. Scientific research to evaluate impact of current fatigue laws

The Alertness Safety and Productivity Cooperative Research Centre (Alertness CRC), in collaboration with the NTC, will seek partnership resources to conduct comparative research in laboratory and field environments. This research will scientifically evaluate the fatigue impact of current regulations in the context of operational work schedules and validate the accuracy of alertness monitoring technology (**Recommendation 3**).

The research will use a combination of alertness monitoring devices, event recorders, work schedules and actigraphy devices to link measurable fatigue indices of long distance and local work drivers against incidents, near misses and work schedule data.

2. Analysis of de-identified commercial data

The NTC will facilitate analysis of de-identified commercial telematics and alertness monitoring data to be incorporated into Alertness CRC research activities. The data will support evaluation of the impact of regulations on driver fatigue, including nose-to-tail schedules (for definition see section 1.7, p. 8), Basic Fatigue Management (BFM) work patterns (for definition see section 4.4, p. 27), night driving and local work (**Recommendation 4**).

A range of companies in Australia hold fleet scheduling data and written work diary data that can be linked to fatigue events or incidents (such as lane swerving or near misses). This data can reveal large scale workforce patterns, such as when fatigue-related incidents occur at the beginning, middle or end of a driver's shift, time of day and the frequency of nose-to-tail schedules.

3. National harmonisation of fatigue reporting and coding

Data on driver fatigue is collected in each jurisdiction, usually based on police data. Across the country, methods of recording fatigue crash data differ, leading to limitations in national and comprehensive analysis. Comparable data would support improved road safety research and policy development.

Austrroads is therefore being asked to consider a National Road Safety Strategy project to review and agree national harmonised fatigue crash data (**Recommendation 5**).

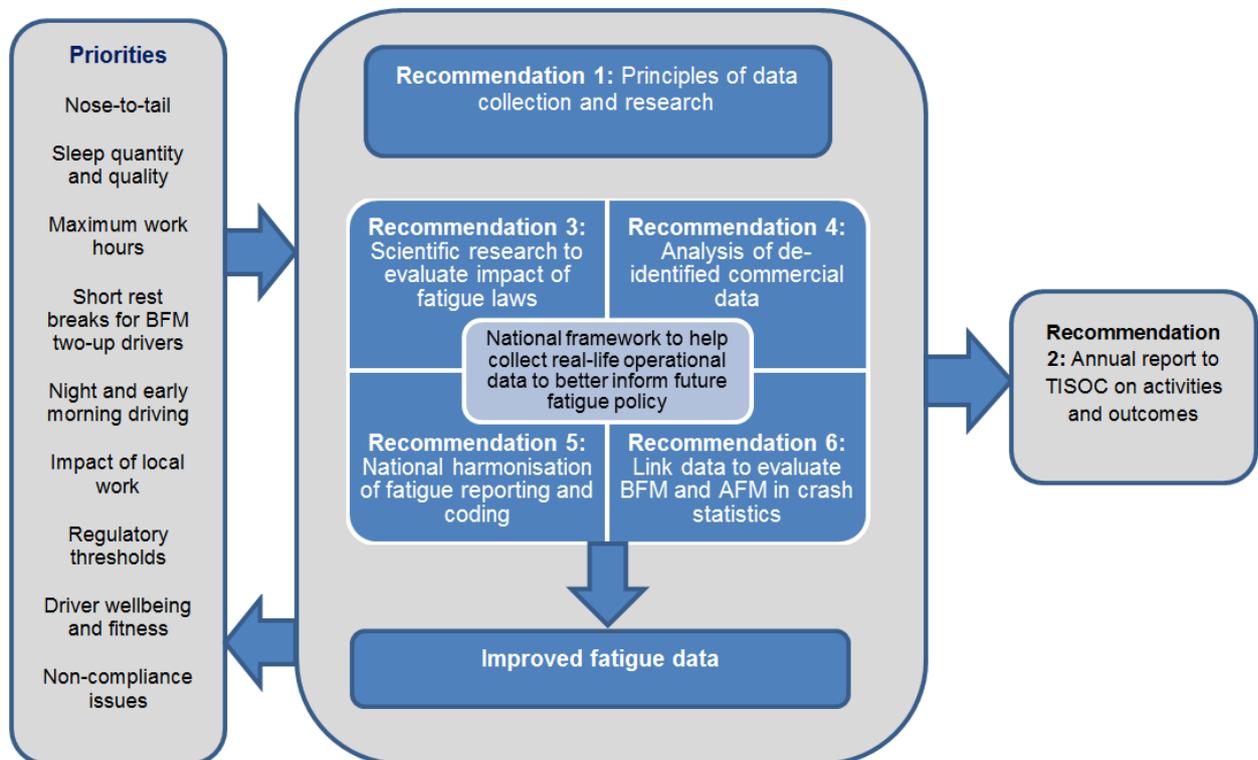
4. Link data to evaluate Basic Fatigue Management and Advanced Fatigue Management representation in crash statistics

The NHVR (through relevant road agencies in HVNL-participating jurisdictions), and road agencies in Western Australia (WA) and the Northern Territory (NT), will seek to evaluate the proportion of BFM and Advanced Fatigue Management (AFM) drivers involved in heavy vehicle crashes (**Recommendation 6**). This includes agreement to:

- undertake a feasibility review of linking crash, licensing and accreditation data, having regard to licensing laws, privacy protections and data systems in each road agency
- subject to outcomes of the feasibility review, develop capability to link crash data to National Heavy Vehicle Accreditation Scheme (NHVAS) data, supplied by the NHVR; and to report outcomes to the Transport and Infrastructure Senior Officials' Committee (TISOC).

Figure 1 illustrates the framework. Each project will be guided by framework objectives and principles, functioning within the governance arrangements of each lead organisation. Data outputs will be reflected in future reports that will be published for research and policy development purposes. The data framework will commence in 2016.

Figure 1: How the Heavy Vehicle Fatigue Data Framework will operate



1.3 What the framework will achieve

The data framework will help us to build an ongoing evidence base to better understand and address the following issues and challenges.

1. Clarifying the contribution of heavy vehicle driver fatigue to road crashes

Fatigue is widely acknowledged as a core safety issue in the transport industry (House of Representatives 2000, p. xxix). The Bureau of Infrastructure, Transport and Regional Economics (BITRE) reported that heavy vehicles were involved in 220 road fatalities in 2014 (BITRE 2015, p. 2) and yet the impact of fatigue on these fatalities remains unknown. For example, the BITRE annual reports on heavy vehicle crash data identify fatal crashes by vehicle type, jurisdiction, area and alcohol – but not fatigue or driver distraction (BITRE 2015). 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 largest contribution to crashes since 2007, with WA having the highest proportion of major crashes attributed to fatigue (NTARC, p. 7).

2. HVNL fatigue provisions have not been evaluated since their introduction in 2008

Current work and rest hour regulations are based on the assumption that the longer drivers work, the more fatigued they become. Yet there is extensive scientific evidence that fatigue, as understood as the propensity to fall asleep or drowsiness, is more accurately related to the amount of sleep obtained and the circadian phase, as they dynamically interact over time and impact driver performance and therefore road safety outcomes.

Other factors include a driver's health and wellbeing, external stressors and drug taking.

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

3. There is insufficient data to support future reforms

Sufficient data is required to underpin any future reforms of the fatigue regulations in the HVNL. This includes the safety impact of the counting time rule. Methods of recording fatigue data differ across states and territories, limiting national, comprehensive analysis. Comparable and available data would support improved policy settings, ensuring that regulations mitigate the safety risks while providing the flexibility that drivers and operators require.

4. Alertness monitoring technology and existing commercial data can be better harnessed to support evidence-based policy and regulatory reform

Commercial technology and data sources are already available to support evidence-based reform. 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.

1.4 Policy findings

Based on consultation on our discussion paper of August 2015, our recommendations to TISOC are underpinned by these findings:

- **Fatigue is a complex policy issue** and data collected for research and policy development needs to have clear objectives and address specific regulatory questions related to identified priority fatigue issues.
- **More comparable data** is required to support further reform of the fatigue laws. Fatigue data should be accessible to governments, industry and researchers.

- **Personal information** should be treated ethically and protected in accordance with the Australian Privacy Principles. Only de-identified data should be shared between organisations and for research purposes.
- **Collecting sleep and work diary data during roadside enforcement activity** is operationally impractical and clouds the distinction between enforcement and research aims: given that priority fatigue issues can be addressed through new research and commercial data sources, the framework should not use enforcement intercepts for research purposes.
- **Data collection should be voluntary** and clearly distinct from enforcement: additional legislative protections to collect data under the framework are not required as framework principles will regulate use of the data.
- **Recording accreditation and sleep data at all heavy vehicle crashes** would require intensive officer training and process change – drivers self-reporting sleep patterns to police may not generate robust or validated data and outcomes from a Victorian trial should be assessed before this option is further considered.
- **Longitudinal industry surveys** monitor driver interaction with fatigue regulations and the NHVR and road agencies are encouraged to undertake surveys using terminology and industry segmentation consistent with previous NTC surveys. However, industry surveys do not provide substantive evidence required to measure the fatigue risks of current regulations and therefore do not form a core project within the program of works.
- **The Australian Transport Safety Bureau (ATSB) operational definition of relative fatigue**, used for statistical purposes to measure the contribution of fatigue to crashes, could be further refined; however, stakeholders agree that operational definitions of relative fatigue would only support the framework objectives to a limited extent and should not be prioritised at this time.

1.5 Recommendations and next steps

In April 2016, TISOC approved the following recommendations and next steps.

Recommendation 1: that TISOC approves the framework principles outlined in **Table 2** (p. 16 of this report), and that the principles are implemented as part of fatigue data collection, research and analysis activities.

Responsibility: all parties involved in implementing the framework.

Timeframe: early 2016.

Recommendation 2: that the NTC provides TISOC an annual Heavy Vehicle Fatigue Data Framework Report summarising framework activity and outcomes.

Responsibility: the NTC.

Timeframe: from September 2016.

Recommendation 3: that the Alertness CRC, in collaboration with the NTC, seek partnership resources to conduct comparative research in laboratory and field environments. This research will scientifically evaluate the impact of HVNL fatigue regulations on road safety risks. The project will undertake:

1. Meta-analysis of existing research to:
 - a. validate alertness monitoring tools and to identify research gaps
 - b. establish a link between alertness measures and actual safety risk (i.e. crash incidents and/ or near misses).

2. A comparative analysis of the impact of nose-to-tail and conventional schedules on heavy vehicle driver fatigue
3. An assessment of heavy vehicle driver sleep quantity and quality in rest periods
4. An assessment of heavy vehicle driver alertness measured against work schedules and in-vehicle event data.

Responsibility: the Alertness CRC in collaboration with the NTC.

Timeframe: research to commence from 2016 — with an update to TISOC in September 2017 and a final report to TISOC by September 2018.

Recommendation 4: that the Alertness CRC in collaboration with the NTC will assess de-identified commercial data to evaluate the impact of regulations on driver fatigue, including nose-to-tail schedules, BFM work patterns, night driving and local work.

Responsibility: the Alertness CRC in collaboration with the NTC.

Timeframe: commercial data analysis from 2016 — with an update to TISOC in September 2017 and a final report to TISOC by September 2018.

Recommendation 5: that Austroads considers a safety taskforce project, established in partnership with NTC, NHVR, road agency and police representatives, to review and agree the following harmonisation outcomes:

1. Definition and interpretation of driver fatigue for reporting and statistical purposes
2. Fatigue likelihood scale and fatigue impact scale for inclusion in crash reports
3. Coding fatigue as a contributory factor in vehicle crashes and HVNL breaches.

Responsibility: Austroads.

Timeframe: commencement subject to Austroads' business planning cycle.

Recommendation 6: that road agencies and the NHVR co-operate to evaluate the proportion of BFM and AFM drivers involved in heavy vehicle crashes. This includes agreement to:

1. Undertake a feasibility review of linking crash, licensing and accreditation data, having regard to licensing laws, privacy protections and data systems in each road agency.
2. Subject to outcomes of the feasibility review, develop data linkage capability to link crash data to NHVAS accreditation information supplied by the NHVR; and for road agencies to provide de-identified data to the NHVR for research and policy development purposes.

Responsibility: the NHVR and road agencies in each jurisdiction participating in the HVNL.

Timeframe: commence feasibility reviews in 2016 – with a final report to TISOC by September 2017 (subject to outcomes of the feasibility reviews).

1.6 Priority fatigue issues the framework will address

Chapter 5 details the priority fatigue issues the data framework will seek to address. They are based on direction from ministers at the Transport and Infrastructure Council of November 2014, consultation feedback and fatigue expert advice.

In summary, the framework will provide data to better evaluate the fatigue impact of:

1. Nose-to-tail schedules (the 'counting time rule')

2. Quantity and quality of sleep attained in major rest breaks
3. Maximum hours of work, with a focus on BFM
4. Short rest breaks, particularly in relation to BFM two-up drivers
5. Night time driving and ending shifts in the early morning
6. Impact of local work
7. Threshold application of fatigue laws and work diary record-keeping
8. Driver wellbeing and fitness to work.

1.7 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 supported an overarching duty not to drive while impaired by fatigue and 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, BFM and AFM. This approach was replicated in the HVNL.

The NTC's *Developing a heavy vehicle fatigue data framework: discussion paper*¹ (NTC 2015) provides a concise summary of current fatigue regulations in the HVNL and other Australian jurisdictions.

Counting time rule – nose-to-tail schedules

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.²

Consequently, drivers can work nose-to-tail schedules. *Nose-to-tail* is the term used to describe the scheduling of two longer work periods in a 24 hour period, with a long rest period of at least seven hours between them. A driver can have up to four nose-to-tail combinations in an eight-day period. A driver can have up to 16.25 hours of work in a nose-to-tail combination, but in doing so restricts the amount of work that can be undertaken in the 24 hour periods before and after that combination.

Victoria's and South Australia's (SA) agreement to the ATC decision was based on the NTC reviews 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.

Council's recommendation in 2014

In 2014, the NTC published *Counting Time and Residual Fatigue Risk: final report* (NTC 2014).³ The report recognised the challenge of measuring the fatigue impact of nose-to-tail schedules:

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:

¹ *Developing a heavy vehicle fatigue data framework: discussion paper* can be accessed on the NTC website at <http://www.ntc.gov.au/current-projects/heavy-vehicle-driver-fatigue-data/>.

² For more information about nose-to-tail schedules see NTC, *Developing a heavy vehicle fatigue data framework: Discussion paper*, 2015; and NTC *Counting Time and Residual Risk Final Report*, 2014.

³ *Counting Time and Residual Fatigue Risk: final report* can be accessed on the NTC website at [http://www.ntc.gov.au/Media/Reports/\(159F4D5E-FCF2-4C1E-8C9E-3318AEFF9116\).pdf](http://www.ntc.gov.au/Media/Reports/(159F4D5E-FCF2-4C1E-8C9E-3318AEFF9116).pdf).

- 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.

There is a lack of data on the frequency and safety impact of nose-to-tail schedules. Without this data, it is difficult to make informed judgements about the nature and extent of the risk and what steps might best mitigate the risks (NTC 2014, p. 8).

Ministers agreed that there should be no policy changes until a framework is developed to collect real-life operational data to better inform future fatigue policy, including nose-to-tail schedules.

Alertness Summit – June 2015

In 2015, the Alertness CRC and the NTC 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, industry peak bodies and heavy vehicle operators. The aim of the summit was to identify factors that contribute to increased fatigue risk, including the data required to assess the effectiveness of current fatigue rules.

A major theme explored in the summit was consistent and accurate terminology. This encompassed a review of how the term *fatigue* is applied in different ways and with different meanings. Stakeholders also recognised that 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 the definition covers 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 who is feeling sleepy is to sleep. Data analysis needs to be clear about which characteristic is being considered and terminology 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 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 data collection and research activities.

NTC discussion paper – August 2015

Developing a heavy vehicle fatigue data framework: discussion paper identified how governments can work together and with industry to develop a data framework to collect and analyse fatigue data to better inform future policy. The discussion paper identified regulatory fatigue issues that could be addressed through the development of the data framework, and proposed framework activities. Activities canvassed in the discussion paper included: standardisation of crash investigation recording, improved data collection, industry surveys and new scientific research in partnership with the Alertness CRC.

This report makes recommendations based on stakeholder feedback on the discussion paper.

2 Consultation

Key points

Stakeholders broadly agree with the framework objectives and the need to improve data collection to support future fatigue reforms. Feedback on specific issues and options are detailed in subsequent chapters.

We received 17 submissions to *Developing a fatigue data framework discussion paper* from road and rail regulators, enforcement agencies, industry peak bodies, heavy vehicle operators and drivers, technology providers and academics.

Stakeholders were encouraged to comment on any aspect of the discussion paper. The following consultation questions were provided to assist with responses:

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 method 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.

Appendix B lists the individuals and organisations that made a submission. Submissions are available at <http://www.ntc.gov.au/submissions/history/?rid=88414&pid=7866>.

We previously surveyed industry and government agencies in December 2014 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 commissioned further advice from fatigue experts to identify which issues 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.

2.1 Government agency feedback

Government agencies in general welcomed the development of a data framework. The framework objectives to measure the impact of regulations on driver fatigue to support future reforms are clearly understood and valued:

The heavy vehicle fatigue data framework is a positive step to improve the data collection and evidence of the effects of heavy vehicle driver fatigue for both worker and public safety. This is a necessary first step to implement evidence based reform of the fatigue regulations in Heavy Vehicle National Law (Safe Work Australia, submission, p. 1).

Transport for New South Wales (TfNSW) agreed that comparable and available data across jurisdictions will support improved policy-making and ensure that regulations mitigate the safety risks while providing flexibility for industry. In TfNSW's view, collaborative data collection can provide the evidence 'to review and reform fatigue legislation', and TfNSW further notes that there has not been a comprehensive review or evaluation of the fatigue reforms since they were introduced in 2008.

In TfNSW's view, the collection of fatigue data, particularly in relation to crashes, should be consistent for both light and heavy vehicles, given that police undertake the same investigation processes for both. To build a comprehensive picture, information will need to be collected from a wide range of sources (TfNSW submission, p. 5).

VicRoads viewed the development of the framework as essential to support the effective regulation of fatigue in the heavy vehicle industry, while also noting that the framework is a critical step in understanding fatigue issues in the industry more generally. VicRoads welcomed a framework that takes a practical approach to data collection and leverages existing information and data sources, and centralises the data storage.

However, VicRoads recommended that data collection should be supported by *legislated privacy protections* – particularly in relation to data collected through enforcement intercepts. The implementation of the framework will also have unknown resource implications. For these reasons, while VicRoads provided in-principle support for the framework, it requested:

- the development of a high level project plan which includes timeframes and provides sufficient information to determine establishment and ongoing costs
- further work to specify technical standards and legislative controls to ensure the integrity, security and privacy protections related to ongoing data collection, storage and analysis.

Queensland Department of Transport and Main Roads (TMR) supported the objective to develop a data framework to inform future policy through the collection and analysis of records and data, research and periodic industry surveys. TMR agreed that a principal contributing factor of fatigue is insufficient sleep, and that an *increase to the minimum major rest period* would provide increased sleep opportunity as well as help to minimise the potential fatigue impacts of nose-to-tail schedules. However, the impact of extending the sleep opportunity on productivity and efficiency, and industry's ability to effectively manage the available spread of work hours in a 24 hour period, needs to be understood (TMR, submission, p. 1).

The NHVR stated that the framework 'will contribute to more effective and appropriate regulation and will improve the NHVR's management of heavy vehicle driver fatigue' (NHVR submission, p. 1). The NHVR suggested that the framework would be most useful if it draws on multiple data sources, including industry data, compliance data, consumer complaints and fatigue-related incidents and insurance claims data.

However, the NHVR noted that if there are administrative changes to the HVNL that have no obvious safety impacts, those changes could be progressed ahead of the framework.

The NHVR was also concerned that any requirements for de-identified data could create parallel data systems. The NHVR would prefer to operate one data management system and noted that, in addition to compliance with the *Privacy Act 1988* (Cwth), the NHVR has statutory protections for personal information to properly manage identified data.

Police agency feedback was focused on those elements of the data framework related to enforcement intercepts and crash recording. Police agencies seek a practical and appropriate data framework. They have questioned the research value of subjective information requested from heavy vehicle drivers in an enforcement context, in addition to resource costs associated with changing police investigation procedures.

Victoria Police and South Australia (SA) Police stated that there is already sufficient evidence to support amendments to the counting time rule and to address the nose-to-tail issue which it views as a safety critical matter (ANZPAA submission, p. 4). SA Police express concern that nose-to-tail schedules are becoming more commonplace.

SA Police stated that recording additional data about vehicle crashes may be problematic as it would require costly changes to information technology systems, and the vehicle collision reporting system is not linked solely to fatigue-regulated heavy vehicles.

Queensland Police Service (QPS) supported the proposed data collection and research activities, and highlights the strong linkages QPS maintains with researchers, such as the Queensland Centre for Accident Research and Road Safety, which could be included in research activities. QPS also suggested that the data framework should be delivered in conjunction with the NHVR's National Data Sharing Protocol and the implementation of EWDs.

NSW Police acknowledged insufficient sleep is an issue, but stated that the ability to determine sleep patterns or quality of sleep is outside the field of on-road enforcement (ANZPAA submission, p. 10). Likewise, NSW Police did not believe that the wellbeing of a driver is a policing issue: 'on-road enforcement is not a medical check, it is to ensure drivers are compliant with current with current work time permitted by regulation' (ANZPAA submission, p. 12).

NSW Police had concerns in relation to introducing standardised questions for a heavy vehicle driver, as drivers are not required to provide this information by law (ANZPAA, submission, p. 13).

2.2 Industry feedback

Industry broadly supports the collection, analysis and publication of data to assess the impact of fatigue reforms. Like the police, industry seek to ensure that research and data collection is undertaken distinctly from enforcement activities. Data should be de-identified.

The Australian Trucking Association (ATA) made eight recommendations in relation to the proposed data framework. These are summarised below:

1. data should be de-identified and not used for enforcement purposes
2. the framework should be managed by a federal statistical agency or evaluation-oriented agency such as the BITRE or the ATSB
3. the framework should nationally harmonise terminology, collection and analysis
4. coronial hearings and findings should be included, where appropriate
5. the framework should collect de-identified minor work and rest hour breaches to support EWD policy development
6. the framework should collect data about the seven hour major rest break
7. data should be publicly accessible, including for industry groups that require access to data to underpin submissions and policy development
8. the framework should be reviewed after two years to evaluate its strength as an evidence base and its capacity to improve heavy vehicle fatigue policy.

The National Road Transport Association endorsed the ATA's recommendations. The National Road Transport Association supported evidence-based policy to manage driver fatigue and recognised that without improvements in data collection, further improvements of fatigue laws will be impeded. The National Road Transport Association stated that the development of a data framework is an important step in addressing known information gaps, and ensuring both a consistent and robust evidence base to best inform future fatigue policy.

Mr Russ Martin, national vice president of the National Road Freighters' Association, suggested a greater role for the ATSB to investigate heavy vehicle crashes. Mr Martin questioned whether there will be appropriate resourcing to train police and the subsequent reliability of information obtained from enforcement intercepts. In Mr Martin's view, research should be based on a wide selection of transport industry participation.

Toll Group recognised the need for credible data to undertake a 'policy overhaul in the fatigue space' to simplify and standardise a national regulatory regime.

Toll Group suggested that governments should be mindful that the HVNL is one of many legislative regimes the industry may be subject to, including WA's and the NT's fatigue management approach and work health and safety laws. Furthermore, there are industry-specific fatigue regulations such as the *Guidance Note for Fatigue Risk Management* imposed by the *Mining and Quarrying Safety and Health Act 1999* and *Coal Mining Safety and Health Act 1999* (Qld).

There are also other government and industry sponsored data collection and research activities to consider, including Austroads' recent report on fatigue data coding issues (*Road Crash Injuries Cost and Prevention*), the National Road Safety Partnership Program's benchmarking project and EWDs.

Toll Group is reviewing its fatigue management practices and its own preliminary findings support the discussion paper focus on fitness for duty, regulatory thresholds (especially around why fatigue laws apply at 12 tonne but not at 4.5 tonne vehicles), and nose-to-tail schedules.

Optalert is an Australia company that has developed technology for continuous, real-time monitoring of driver alertness.⁴ Optalert agreed with the problem statement that the regulations are based on hours of work and not sleep and the circadian rhythm:

Heavy vehicle drivers are likely to suffer injuries or death because of drowsy-driving accidents. Like other shift-workers, they often work overnight, when their body-clock says they should be resting or asleep. Current regulations about the hours of work for drivers do not adequately address this issue. A solution to this problem requires information that is currently not available to most drivers or their managers i.e. their levels of alertness/drowsiness while driving at any time (Optalert submission, p. 4).

Optalert noted that current legislation is based mainly on hours of duty, with log books and subjective reports. And while speed, alcohol testing and seatbelts have all been tackled by policy and legislation, measuring a person's level of alertness or drowsiness has not been possible to date. Optalert stated that technology for monitoring a person's drowsiness in real time is now available and being used in many countries.

Bus operator, Transdev Australasia, considered that all relevant legislation, policy, enforcement, medical standards, data capturing and reporting needs to be standardised, and views the data framework a step in the right direction for industry. Transdev's view is that quantity and quality of sleep and fitness for work are the most important issues to address. The data framework should not be restricted to 100+km work, as many metropolitan and regional bus drivers have journeys that fluctuate around the 100km radius.

⁴ A concise description of Optalert's technology and methodology to measure alertness is contained in **Appendix C** of the discussion paper.

3 Framework governance

Key points

Fatigue data generated by projects will be subject to the research ethics and governance arrangements, including project boards, of lead organisations. Data collection and handling will be consistent with the framework principles.

The data framework requires projects with clearly defined roles, resources and clear principles for data collection.

The NTC discussion paper canvassed a framework manager role. The key function of such a role would have been to oversee and facilitate accessible and comparable data through the maintenance of a data warehouse. Based on stakeholder feedback, there are a number of challenges with this approach:

- the cost and complexity of maintaining a data warehouse, including the standardisation of different data formats
- the potential misuse of data that is taken out of context or used for purposes not envisaged by the researcher or research subject
- the potential to re-identify drivers or commercial operators based on large-scale data capture
- the potential to duplicate data handling and analysis
- a framework manager would be required to have defined research objectives that are clearly separated from compliance and enforcement functions.

For these reasons, this report recommends that each project within the framework is subject to its own governance, resourcing and data management, and that each project generates separate outputs (such as research reports) that are not reliant on a framework manager role or data warehouse capability.

In the longer term, as more research generates data, the development of a database could support accessible, comparable and open data. This approach is reflected in framework principle 6, below, which recognises that the framework should support open data when it is practical to do so.

3.1 Resourcing

Data collection and research costs will be borne at the project level. **Table 1** sets out the organisations responsible for each project. TISOC was not asked for additional funding to resource the data framework.

Reporting on the progress of the framework project activities will be resourced from within the NTC's ongoing budget.

Table 1: Funding responsibilities for data collection and research projects

Project	Funding responsibility
Project 1 – scientific research to evaluate the impact of fatigue laws	Alertness CRC in collaboration with the NTC
Project 2 – analysis of de-identified commercial data	Alertness CRC in collaboration with the NTC
Project 3 – national harmonisation of fatigue reporting	Austrroads
Project 4 – feasibility review	Road agencies

3.2 Principles of data collection and research

The discussion paper recognised that many participants in the data framework projects will be employed or engaged by organisations that have comprehensive human research ethics guidelines. Most organisations are also bound by the Australian Privacy Principles or equivalent state-based Information Privacy Principles.

However, data collection principles relating to ethics and privacy protection should capture the relationships between entities and overarching governance and data-handling responsibilities.

The discussion paper therefore proposed that the framework should adopt principles that:

- establish the ethical collection, analysis and distribution of data and research findings that are consistent with the:
 - Australian Privacy Principles
 - applicable standards for the ethical conduct of research in Australia
 - responsibilities of research institutions to establish good governance and management practices
- support and facilitate comparable and accessible data, and be consistent with the underlying principles of the Productivity Commission’s *Report on Government Services*
- always explain to participants why particular data is being collected
- demonstrate how data collection and research meet project objectives.

Consultation feedback supported the need for framework principles but a number of agencies expressed concern with an open data approach.

VicRoads raised concerns that the inclusion of commercial or enforcement information, such as EWDs, in an open data arrangement may exceed the consent of participants. Data that is ‘freely available to everyone to use for any purpose and without restrictions or gate keeping’ could mean that the use of the data would not be covered by existing ethical research guidelines. VicRoads suggested that legislative protections should be considered, particularly in relation to data collection through enforcement activities.

TfNSW agreed with the general approach, but would like the framework principles to provide explicit guidance on how to manage data sharing and linking possibilities and limitations between different data collection agencies. TfNSW noted that agency collection of personal information collected by agencies across different jurisdictions are protected by various laws and regulations, but cautioned that the required ethics and data custodian approvals may be challenging to establish.

NSW Police suggested that practical approaches to resolving issues with an open data approach, such as any potential interface with police systems, will have to be explored.

The ATA supported the principles and that data collected should be de-identified and not used for enforcement purposes. The ATA recommended that the principles include ethics approval and access arrangements that recognise that industry groups require access to data on a timely basis to underpin submissions and policy development.

Recommendation

In response to VicRoads’ feedback, we suggest that legislative protections are not required given that the projects will not be reliant on enforcement activities or enforcement powers, and data will be de-identified and therefore not personal information. The NTC agrees with TfNSW that the framework would benefit from guidance on how to manage data sharing and limitations between different data collection agencies. This has been included in the framework principles.

As discussed in **section 3.1**, we recognise the challenges of providing open data for research purposes. Principle 6 recognises that open data is an aspirational goal of the framework.

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, we propose 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 rather than non-compliance or illicit activities.

The NTC recommends the principles of data collection and research for the data framework set out below in **Table 2** are endorsed as the National Heavy Vehicle Driver Fatigue Data Framework Principles.

Table 2: National Heavy Vehicle Driver Fatigue Data Framework Principles

Principle	The data framework will –
Principle 1	support data collection, research and evaluation of heavy vehicle driver fatigue
Principle 2	have clear governance and data sharing protocols that govern the collection and transfer of data between organisations
Principle 3	ensure that the purpose of any data collection is clearly articulated and reflects relevant project objectives
Principle 4	collect, use, share and destroy personal information consistent with the Australian Privacy Principles – information will be de-identified as soon as practicable
Principle 5	support research consistent with Australian standards for the ethical conduct of research
Principle 6	support and facilitate comparable and accessible data, including access by industry – the framework will facilitate open data where it is practical to do so and consent is attained (where relevant),

4 Data collection and research projects

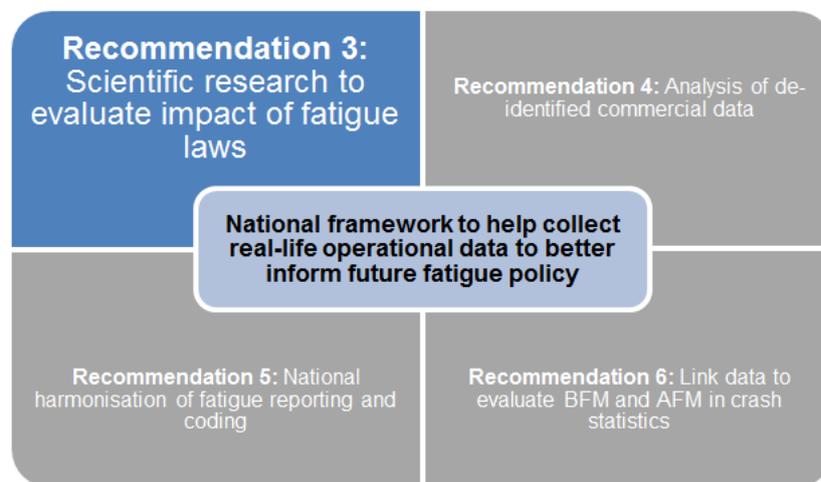
Key points

The framework will consist of a program of four projects:

1. Scientific research to evaluate impact of fatigue laws
2. Analysis of de-identified commercial data
3. National harmonisation of fatigue reporting and coding
4. Link data to evaluate BFM and AFM representation in crash statistics.

New and existing data sources (including longitudinal industry surveys, standard information recorded in every crash report and EWD data analysis) can further enrich the framework.

4.1 Scientific research to evaluate impact of fatigue laws



The objective of the project is to measure the impact of fatigue and the current fatigue laws on road safety risks. Targeted scientific research to evaluate the impact of current heavy vehicle fatigue laws is a core project of the data framework and should generate comprehensive evidence to support future reforms.

This is a major research initiative led by the Alertness CRC in collaboration with the NTC and government and industry partners. Key research tasks are:

1. Field-based validation of alertness monitoring technologies for heavy vehicles.
2. Comparative analysis of nose-to-tail and conventional schedules on heavy vehicle driver fatigue.
3. An assessment of driver sleep quantity and quality during long rest breaks.
4. An assessment of alertness monitoring data against driver work schedules, telematics, in-vehicle cameras, event data and actigraphy devices to measure the impact of fatigue and the current fatigue laws on safety risks.

Research funding will be sourced through the Alertness CRC framework.

Subject to funding, **phase 1** will be a laboratory-based comparison of nose-to-tail and conventional schedules. It is important that nose-to-tail analysis is conducted in laboratory settings so that all variables can be controlled and the research can provide a scientific evaluation of the fatigue impact of nose-to-tail schedules, taking into account the length of the major rest break and sleep quality and quantity.

Phase 2 involves field-based research, including validation of alertness monitoring technologies and an assessment of driver sleep quantity and quality in major rest breaks. Field research will:

- measure heavy vehicle driver fatigue in real-life operational settings, capturing:
 - long-distance and local work
 - drivers operating under standard hours and BFM (including drivers who work maximum hours in BFM)
- compare driver fatigue at the beginning and end of a week's work cycle
- compare night driving with daytime driving (including drivers who finish a long shift between midnight and 6am)
- compare the fatigue impact of nose-to-tail and conventional schedules to validate phase 1 research findings (where available)
- assess fatigue impacts of regional and remote heavy vehicle operations (where available).

In combination with actigraphy devices to measure sleep quantity and quality, alertness technology can measure the comparative fatigue impact of different regulations and drivers schedules. Laboratory and field research using alertness monitoring and actigraphy devices can be correlated with scheduling data and event recording based on telematics and in-vehicle camera data to build a comprehensive evidence base of heavy vehicle driver fatigue.

Appendix C provides information about the Alertness CRC and alertness monitoring technologies.

Stakeholder feedback

Stakeholders supported CRC research to measure the fatigue impact of current laws.

VicRoads agreed that the Alertness CRC role should be to collect, produce and use specific types of data (VicRoads submission, p. 6).

The NHVR supported the development of technology for detecting and predicting driver drowsiness. Importantly, the NHVR stated that research must aim at validating predictive models and to 'provide specific insights into the development of drowsiness and its impact on driving performance and indicators of drowsiness that can be used by drivers to prevent any impaired performance' (NHVR submission, p. 12).

SafeWork Australia stated that the research must ensure data is representative of the heavy vehicle driver cohort and include representative random sampling of drivers who have been made aware the data will be de-identified. SafeWork Australia also observed that data quality will be depend on how it is collected.

The ATA recommended that the framework should specifically enable the collection of fatigue data relating to regional and remote operations (ATA submission, p. 8).

Optalert recommended that drowsiness monitoring technology be used to help determine regulations and conditions for AFM accreditation.

Recommendation

The development of a CRC research project addresses many of the issues raised by stakeholders. CRC research:

- can be tailored to address specific research
- can evaluate fatigue laws in both controlled and field environments
- has clear funding and governance arrangements and partnership agreements
- does **not** take place in the context of enforcement and can be de-identified data
- does **not** rely on subjective data, such as industry surveys or crash interview questions
- does **not** involve changes to police or crash investigation processes.

The Alertness CRC, in collaboration with the NTC, will seek partnership funding to conduct comparative research in laboratory and field environments to scientifically evaluate the fatigue impact of current regulations in the context of operational work schedules and a validation of alertness monitoring technologies. Specifically the project will undertake:

1. Meta-analysis of existing research to:
 - a. validate alertness monitoring tools and to identify research gaps
 - b. establish a link between alertness measures and actual safety risk (i.e. crash incidents and/ or near misses).
2. A comparative analysis of the impact of nose-to-tail and conventional schedules on heavy vehicle driver fatigue.
3. An assessment of heavy vehicle driver sleep quantity and quality in rest periods
4. An assessment of heavy vehicle driver alertness measured against work schedules and in-vehicle event data (**Recommendation 3**).

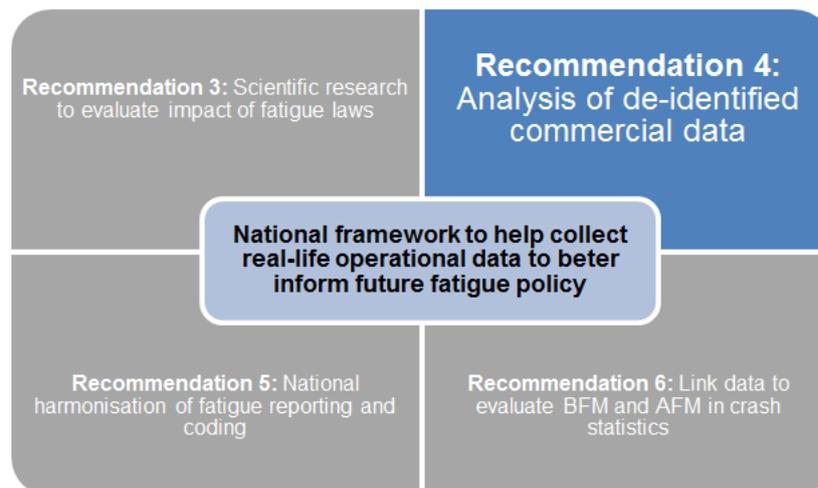
Project objective: to measure how fatigue and the current fatigue laws impact on safety risks.

Method: laboratory and field research that correlates data from alertness monitoring, schedules, telematics, in-vehicle cameras, event data and actigraphy devices to: validate alertness monitoring technologies and measure the impact of the identified priority fatigue issues.

Priority fatigue issues addressed: nose-to-tail schedules, quantity and quality of sleep on major rest breaks, impacts of BFM on fatigue, BFM two-up short rest breaks, night driving, local work, significance of current legal thresholds and driver well-being.

Project lead: the Alertness CRC in collaboration with the NTC.

4.2 Analysis of de-identified commercial data



Existing commercial data provides a rich source of real-life operational data to supplement new research and data collection activities. Led by the Alertness CRC in collaboration with the NTC, the project will analyse commercial data to measure the frequency and impact of priority fatigue issues.

The Alertness CRC and the NTC will source data from commercial providers of scheduling information and work and rest hour records, and where feasible combine this data with incident and driver fatigue reporting.

The **analysis of de-identified commercial data** will seek to identify and address:

1. Frequency of specific work schedules (such as nose-to-tail schedules where a driver has a long work period followed by a long rest period followed by a long work period).
2. Frequency of BFM two-up driving and periods of rest taken by drivers in two-up driving arrangements.

3. Event data (such as lane swerving, crashes and near misses) correlated with:
 - a. driver work schedules
 - b. time of day
 - c. 100km and 100km+ work
 - d. driver fatigue accreditation (BFM or AFM).
4. HVNL fatigue breach data that identifies the rules most frequently breached, including the distribution and scale of the breaches (e.g. by how much time drivers worked in excess of the legal hours).
5. The extent to which heavy vehicle drivers only take the minimum rest required by the fatigue regulations.

Data collection and analysis will be consistent with the data framework principles and subject to commercial arrangements.

Potential commercial providers include operators, insurers, fatigue management companies, telematics service providers and electronic record keeping service providers.

Stakeholder feedback

The discussion paper canvassed the collection of work diary records through enforcement intercepts. Roadside enforcement activities provide an opportunity to identify patterns of behaviour – such as nose-to-tail schedules – and to extract 28 days of records to analyse the issue in further detail. However, police, road agencies and industry peak bodies clearly signalled in submission feedback a preference for research and enforcement activities to be separated.

There was a general view from police that data collection that requires changes to police procedures would be resource-intensive and have significant process and officer training implications. This perspective was summarised in the NSW Police response to the discussion paper:

The NTC has to accept there will be significant limitations of what data and how this data may be collated. Notwithstanding, if this is conducted within the jurisdictions this may involve an entirely different operating process and collection ability, whilst not knowing what costs will be incurred (ANZPAA submission, p. 13).

Road agencies also expressed concerns about the potential blurring of responsibilities and obligations to co-operate with authorised officers, if authorised officers analyse work diary records for both enforcement and research purposes. Further, there is no legislative power for authorising officers to access work diaries for research purposes (except for EWDs). These data collection issues relating to work diary records obtained during roadside enforcement intercepts were summarised by VicRoads, which noted that:

- information collected from written work diaries is always going to be extremely labour intensive hence the use of this process needs to be well considered and targeted
- legislative changes may be required to use data in the framework collected from compliance and enforcement activities
- requests for more detailed information will need to consider the practicalities of collecting the data, including who is going to collect it and how much it will cost (VicRoads submission, p. 6).

TMR supported the use of work diary records as part of the data framework, but noted that it would require appropriate confidentiality assurances to encourage participation (TMR submission, p. 4).

TMR raised an option for the data framework to analyse filled-up work diary pages returned to the road agencies. However filled-up work diaries are not returned to road agencies in most jurisdictions.

Industry were highly supportive of using existing de-identified commercial data to support future fatigue reforms. The National Road Transport Association noted that its members already collect rich data sets to manage driver fatigue within their operations on a daily basis (National Road Transport Association submission, p. 2).

For these reasons, **Recommendation 4** relates to the analysis of de-identified *commercial* data. However, the potential collection of enforcement data is discussed in section 4.5 under Other Issues.

Recommendation

A range of companies hold commercial data that can be linked to fatigue events or incidents, such as lane swerving or near misses. This data can reveal large scale workforce patterns, such as when fatigue-related incidents occur at the beginning, middle or end of a driver's shift, time of day and the frequency of nose-to-tail schedules.

The Alertness CRC and the NTC will facilitate analysis of de-identified commercial telematics and alertness monitoring data to be incorporated into Alertness CRC research activities. The data will support evaluation of the impact of regulations on driver fatigue, including nose-to-tail schedules (for definition see section 1.7, p. 8), BFM work patterns (for definition see section 4.4, p. 27), night driving and local work (**Recommendation 4**).

There are a range of benefits associated with undertaking a project to analyse de-identified commercial data. This approach:

- accesses a rich source of real-life operational data to supplement new research and data collection activities
- is cost effective
- is less likely to be able to identify drivers than using written work diary records
- can be undertaken in a timely manner
- does **not** rely on enforcement powers and is clearly separate to enforcement actions
- does **not** involve changes to police and road agency processes and training.

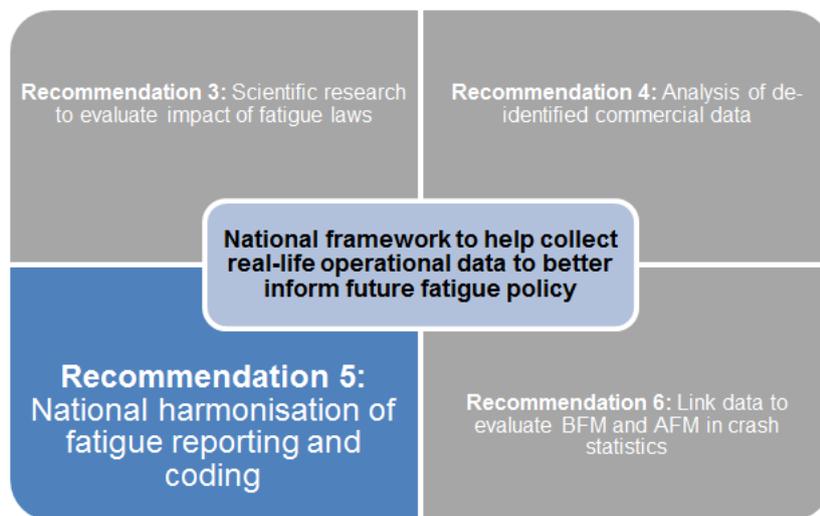
Project objective: to use commercial data to measure the frequency and impact of nose-to-tail schedules and other practices (including short rest breaks for BFM two-up drivers) on driver fatigue; and to correlate a high volume of scheduling data against fatigue incidents to identify the impact of current regulations on driver fatigue.

Method: the NTC will source data from commercial providers of scheduling information and work and rest hour records, and combine this data with incident and driver fatigue reporting when this is also available. The data will be provided in de-identified form but, where possible, data sources will be linked to specific (anonymous) drivers to identify and evaluate priority fatigue issues.

Priority fatigue issues addressed: nose-to-tail schedules, impacts of BFM on fatigue, BFM two-up short rest breaks, night driving, local work, significance of current legal thresholds.

Project lead: the Alertness CRC in collaboration with the NTC.

4.3 National harmonisation of fatigue reporting and coding



The discussion paper identified the importance of data comparability. The meaningfulness of fatigue data increases if common terms, definitions and measures are used. One of the key areas where data collection and comparability can be improved is crash investigation and crash recording.

Project purpose

Crash data on driver fatigue is collected in each jurisdiction and is usually based on police data. Methods of recording fatigue crash data differ across jurisdictions, which limits national and comprehensive analysis. Comparable and available data would improve decision-making and the evidence base for future road safety research.

Austrroads is therefore being asked to consider managing a National Road Safety Strategy project, established with NTC, road agency and police representatives, to review and agree national harmonised processes.

The project would aim to harmonise fatigue crash reporting in each jurisdiction. The project would benchmark current fatigue reporting and coding practices, identify inconsistencies and recommend standard fatigue crash reporting processes in relation to:

- definition and interpretation of driver fatigue for reporting and statistical purposes
- fatigue likelihood scale and fatigue impact scale for inclusion in crash reports
- coding fatigue as a contributory factor in vehicle crashes and reporting heavy vehicle driver breaches of fatigue law.

While project outcomes will support heavy vehicle fatigue policy, the harmonisation of fatigue crash reporting extends to, and will benefit, all road vehicles and road users.

Tasks

The most important task is to standardise the criteria and method 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 method, 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, crash investigation processes must be reformed so that police and crash investigators can consistently and more accurately establish that (1) the driver was fatigued, and (2) the nature of the errors that contributed 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, these two principles could 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.

Fatigue scales

Professor Dawson, in advice commissioned by the NTC and published in the discussion paper, has proposed a fatigue likelihood scale. That is, police and investigators would be required to identify how likely it was that the driver was impacted by fatigue (from highly unlikely to highly likely) and to identify the extent to which fatigue contributed to the crash. This approach is inconsistently adopted in major crash investigations and rarely adopted for less serious crashes, where police only record that a crash occurred and other basic information.

Austrroads would review proposed fatigue likelihood and fatigue impact scales in light of international best practice and recommend a preferred approach to be adopted by jurisdictions. The scales should be adopted for both major crash investigations and crash recording and should replace current *yes/no* categorisations of fatigue.

Improved identification of fatigue as a contributing crash factor will be supported by fatigue coding, so that crash reports across jurisdictions are consistent and comparable.

Project outputs

- a review of current research on current fatigue reporting and coding in Australia and overseas
- workshops with jurisdictions to discuss and agree definition/interpretation of fatigue, fatigue scales and coding – supported by fatigue expert advice
- final report with recommendations.

Post-implementation, when crash investigation and reporting processes are harmonised, road agencies will be able to produce more accurate and comparative data on the likelihood and impact of fatigue on road safety.

Stakeholder feedback

Road agencies, the NHVR and SafeWork Australia supported the development of fatigue scales in principle. TfNSW noted, however, that further supporting evidence would be required to develop a valid and reliable fatigue likelihood scale. It also queried the usefulness of terms such as *possibly fatigued*, asking whether such an assessment would in fact be recorded as a fatigue crash. TfNSW suggested that a scale should be:

- framed to complement the definition of fatigue outlined in section 223 of the HVNL
- capable of recording fatigue as a contributory cause of a crash even when other causes are demonstrated and corroborated.

VicRoads noted that:

The usefulness of a fatigue likelihood scale will be contingent on development of additional detail around how the indicators would be applied, who would apply them, and appropriate scales and controls [...] The fatigue likelihood scale appears to call for a significant level of judgement on the part of the assessing officer. It would be useful to have examples of similar scales from other safety studies (perhaps in aviation) (VicRoads' submission, p. 5).

Feedback from road and police agencies and SafeWork Australia concerning fatigue scales was extensive. In summary, the project should take into consideration the following views:

- experienced crash investigators should be consulted to determine how practical the use of such a scale might actually be in the field
- fatigue scales should be crafted to minimise subjectivity, recognising that fatigue reporting is subjective today
- consider the impacts on resourcing and officer training, e.g. instructing investigators how to differentiate similar causes such as distraction and fatigue
- clarify whether the scales would be used for research purposes only, or include operational, compliance and enforcement purposes
- the validity of the scale should be tested widely against an external measure of fatigue, such as alertness data or work diary records, to gauge the scale's reliability and validity.

The NHVR suggested that the use of a likelihood scale might duplicate its Risk Classification System, 'which also provides a composite measure of fatigue likelihood'. Nonetheless, the NHVR supports the concept of a scale in principle, 'if it can be used to assist in the identification and management of driver fatigue/drowsiness' (NHVR submission, p. 16).

SA Police recommended that any scale incorporate 'faculty impairments such as slurred speech and other indicators [of] drowsiness' (ANZPAA submission, p. 8). Like TfNSW, SA Police emphasised that other factors that may contribute to both fatigue likelihood and poor decision making, such as drug use, would need to be incorporated into any useful scale.

NSW Police did not support a fatigue likelihood scale used within an enforcement context, citing concerns that any fatigued driver should not be driving and that the only method of checking this is to compel drivers to provide certain information through work diaries. NSW Police also did not agree that fatigue scales should be used for crash investigation purposes and suggested that police officers attending a crash must focus on ensuring that 'drivers are compliant with current work time permitted by regulation' (ANZPAA submission, p. 12).

In relation to coding, Victoria Police noted that any changes would have to be fully costed and align with other projects, including the NHVR's data sharing protocols. The NHVR stated that 'the long term benefits of data governance outweigh the short term impositions of changing any single organisation's coding definitions and practices' (NHVR submission, p. 16).

In relation to consistently interpreting fatigue, TfNSW cautioned that any proposal must be carefully considered and not adversely affect the ability of agencies to manage heavy vehicle driver fatigue and enforce the general duty not to drive while impaired by fatigue. NSW Police noted that there is no simple method of introducing a uniform definition of fatigue, given that it is a subjective issue that will vary between jurisdictions.

The ATA and the National Road Transport Association stated that regardless of what definition is used, the framework should harmonise fatigue terminology nationwide, in addition to harmonised data collection and analysis.

ATSB definition of relative fatigue

The discussion paper sought views on a potential project to review the ATSB operational definition of fatigue. The purpose of the operational definition is to identify for statistical purposes those crashes that are likely to have been caused by fatigue (based primarily on time of crash and head-on collisions where neither vehicle was overtaking at the time) but were not identified as fatigue-related in crash reports. This enables fatigue trends at a high level to be monitored in those jurisdictions that have adopted the mechanism, but there are concerns that the approach is unsophisticated and excludes too many fatigue-related crashes.⁵

The submissions did not consider a review of the ATSB definition as a high priority or directly relevant to addressing the priority fatigue issues. TfNSW stated that refinements to the ATSB definition are less important than improving the collection and categorisation of data.

Recommendation

National harmonisation of the definition and interpretation of fatigue – including the harmonisation of crash coding of fatigue (and the parameters of the codes) would be a major enabler of an Australian dataset of comparable fatigue data. The national harmonisation of crash reporting fatigue is also an opportunity to introduce a more sophisticated level of capturing the likelihood and impact of fatigue as a cause of crashes and the *practical feasibility* of fatigue scales should be considered as part of the proposed project.

The stakeholder feedback has confirmed that any introduction of fatigue likelihood and fatigue impact scales should **not** be introduced as part of roadside enforcement processes.

The ATSB operational definition of relative fatigue, used for statistical purposes to measure the contribution of fatigue to crashes in some jurisdictions, could be further refined. However, stakeholders agree that operational definitions of relative fatigue would only support the framework objectives to a limited extent and should not be prioritised at this time.

⁵ Section 4.2 of the discussion paper provides further information about the ATSB operational definition of fatigue.

Recommendation 5 provides that Austroads considers managing a safety taskforce project, established with the NTC, the NHVR, road agency and police representatives, to review and agree a national harmonised definition and interpretation of driver fatigue, fatigue likelihood and impact scales for inclusion in crash reports, and coding fatigue as a contributory factor in vehicle crashes.

Project timeframes will be dependent on Austroads' work program and project governance arrangements. **Recommendation 5** suggests that a final report recommending actions to harmonise fatigue report could be submitted to TISOC by early 2018.

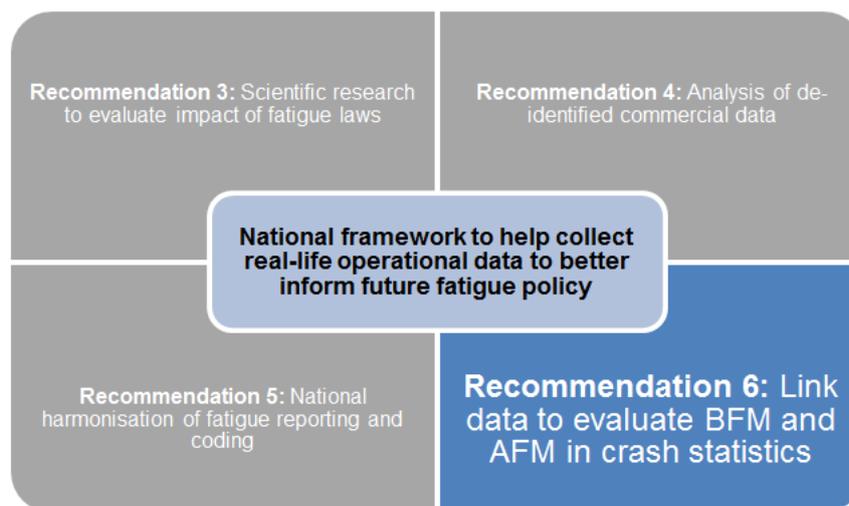
Project objective: for each jurisdiction to generate comparable fatigue data for future research and statistical purposes, through road agencies and police agencies agreeing and implementing a national harmonised definition and interpretation of driver fatigue, scales to record fatigue likelihood and fatigue impact, and harmonised crash coding.

Method: 1) conduct a literature review to identify current and best practice in each area of harmonisation, 2) establish a working group to review and agree nationally-harmonised outcomes, and 3) report recommending an implementation pathway for consideration by TISOC.

Priority fatigue issues addressed: insufficient sleep, impacts of BFM on fatigue, night driving, local work and significance of current legal thresholds.

Project lead: Austroads.

4.4 Evaluate BFM and AFM in crash statistics



The HVNL has a three-tier fatigue management structure comprising standard hours, BFM and AFM.

BFM and AFM are accreditation modules. BFM-accredited drivers have more flexible work and rest hours than drivers who work standard hours. While BFM allows drivers to work up to 14 hours in a 24-hour period, operators using BFM must demonstrate that they are properly managing the risks of driver fatigue. AFM accreditation is a safety risk management approach to managing driver fatigue. AFM operators must demonstrate how the fatigue risks of the schedules will be offset by sleep, rest and other management practices in a compliant fatigue management system.

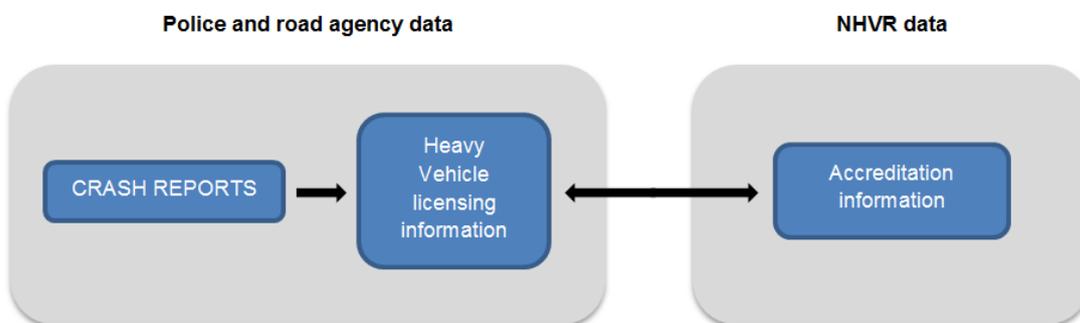
The number of BFM and AFM heavy vehicle drivers involved in fatigue-related crashes is a significant missing link in our data collection capabilities. The aim of this project is to improve data to evaluate the relative safety impacts of BFM and AFM comparative to standard hours drivers.

VicRoads is funding a research project for Victoria Police to collect fatigue accreditation data in crash investigations. However, police and crash investigators do not generally record a heavy vehicle driver's accreditation details in a crash report and we do not know the extent to which BFM and AFM heavy vehicle drivers are under- or over-represented in fatigue-related crashes. This highly valuable data could validate the current risk offsets that permit longer working hours, particularly under BFM.

The discussion paper suggested changes to police and crash investigation processes to collect BFM and AFM information at every heavy vehicle crash, in addition to asking questions related to driver sleep patterns. Stakeholder feedback indicated that this would be significantly resource-intensive in terms of both process and software changes and officer training. As noted above Victoria is also currently trialling the collection of this data and is due to report findings in 2016.

An alternative approach based on linking current data sources is therefore proposed. **Figure 2** illustrates the proposed linkage of data between crash reports (which includes heavy vehicle driver licensing information) and accreditation information.

Figure 2: Data to evaluate BFM and AFM in crash statistics



Road agencies have access to the relevant licensing information but to link the data would require permission from NHVR as owner of the accreditation information.

Linking crash and licensing data with accreditation information does have limitations: some operators and drivers have BFM or AFM accreditation for contingency and do not necessarily work longer hours regularly. Drivers would not necessarily be working longer hours at the time of a crash. The classification of the crash as fatigue-related is also imperfect, although it will hopefully be improved if the national harmonisation project proceeds. Further, it may not have been determined that the accredited driver was at fault.

Nonetheless, linking crash and licensing data with accreditation information provides a high-level, cost effective trend analysis which – in the absence of a wide-scale national collection of accreditation information during crash investigations – provides longitudinal insight into the representation of BFM and AFM drivers in fatigue-related crashes and all crashes.

Critically, the data linkage should be de-identified and compliant with road agency data sharing guidelines, the Australian Privacy Principles and data framework principles.

Stakeholder feedback

TMR supported the three standard questions proposed to have crash investigators ask drivers, including their accreditation. Police agencies, on the other hand, stated that the challenges of significant crash investigation and reporting processes would make this proposal impractical.

Victoria Police stated that enforcement officers attending the scene of a heavy vehicle incident will not generally have the time, resources or specialised knowledge to collate and verify information (ANZPAA submission, p. 3). SA Police held similar views. It stated that recording accreditation details 'makes sense and is a reasonable question but does pose some problems, as some police who attend a crash scene may not be aware of exactly what AFM/BFM/standard options are' (ANZPAA submission, p. 8).

In relation to the alternative approach of linking crash and licensing data with accreditation information, TfNSW suggested the data linkage project and does not see any system, legal or policy barriers to the project.

VicRoads noted that resources would be required to extract relevant crash data from the Victorian Crash Statistics database. VicRoads noted that it would require identification of the operator's accreditation number and that the NHVR accreditation data would have to be current.

Recommendation

Road agencies should undertake a feasibility review on implementing a process to link crash and licensing data with accreditation information. The review should consider:

- the capability of current systems to link data, de-identify results and provide to the data framework
- any privacy or data sharing legislation or policy that would limit or prevent linkages
- cost estimates to implement and undertake an annual data linkage process
- the feasibility of linking drug and alcohol offences to BFM and AFM drivers.

The NHVR would have to share accreditation information with each road agency for this purpose. As part of the project feasibility assessment, the NHVR would review policies and systems to facilitate data use for this project.

Road agencies will report on progress of the feasibility review to TISOC in September 2016 (**Recommendation 6**). Resourcing the data linkage project will be subject to the outcomes of the feasibility review.

This approach:

- will provide high-level trend data over longer timeframes
- is more cost effective than collecting data at crash investigations
- will enable road agencies to de-identify information before using it as part of the framework
- will be resource efficient and not require officers to re-train in collecting data at roadside intercepts or crash investigations.

Project objective: to identify on an annual basis the number of BFM and AFM heavy vehicle drivers involved in fatigue-related crashes.

Priority fatigue issues addressed: impacts of BFM and AFM on fatigue

Method: feasibility review of linking crash and licensing data with accreditation information

Project lead: road agencies in each jurisdiction participating in the HVNL and the NHVR.

4.5 Other data collection and research opportunities

Based on discussion paper analysis and consultation feedback, in the longer-term the data framework can support a range of other data collection and research opportunities. These include:

1. Longitudinal industry surveys.
2. Standard information recorded in every crash report.
3. EWD data collection.

A fourth activity canvassed in the discussion paper, **collection and analysis of work diary records through enforcement activities**, is not recommended based on consultation feedback. Collecting work diary records data during enforcement intercepts is operationally impractical and clouds the distinction between enforcement and research aims. Given that priority fatigue issues can be addressed through new research and commercial data sources, the framework should not use enforcement intercepts for research purposes

Longitudinal industry surveys

Longitudinal industry surveys are a valuable research tool to evaluate changes in driver and operator attitudes to sleep, fatigue management and effectiveness of the law. However, industry surveys are not a core project within the data framework because industry perceptions are not necessarily reflective of current practices, nor do they substantively evaluate the fatigue impact of current laws.

However, the NHVR and road agencies are encouraged to develop and implement longitudinal heavy vehicle industry surveys to periodically evaluate attitudes and practices related to fatigue management and compliance with fatigue regulations. Where possible, surveys data should be included in the data framework and available for general research and policy making.

To assist with establishing comparative data, the NHVR and road agencies are encouraged to undertake surveys using terminology and industry segmentation consistent with previous surveys.⁶

Standard information recorded in every crash report

In addition to asking heavy vehicle drivers if they are accredited under BFM or AFM, the discussion paper identified opportunities to introduce crash recording questions relating to when the driver last woke up and how much sleep the driver had in the last 24 and 48 hours.

Police feedback indicated that recording accreditation and sleep data at all heavy vehicle crashes would require intensive officer training and process change. Police further stated that drivers self-reporting sleep patterns to police is unlikely to generate robust or valid data.

Questions about sleep patterns need to be asked for clearly-defined reasons. It is unlikely that an authorised officer can ask fatigue-related questions and only use that information for research purposes. In addition, the obligations of a driver to co-operate with authorised officers is a matter of law, whereas a decision to provide information for research purposes should be a voluntary decision without consequences for the driver.

Road agencies were more supportive of the proposal. TfNSW noted that drivers may not be prepared to answer the questions if it could result in admissions of breaches, but suggested that these concerns could be addressed through depersonalised data and guaranteed anonymity.

VicRoads suggested that the harmonised three questions should also be supported with standard alcohol and drug testing. TMR agreed with the three questions but suggested that they should be reviewed by fatigue experts and broadened to include time of crash and time since started driving.

Current heavy vehicle research in Victoria

Since March 2015, VicRoads has funded a Victoria Police heavy vehicle research project to pilot the collection of crash data to better evaluate heavy vehicle driver fatigue patterns. During the 12 month project, Victoria Police's Heavy Vehicle Unit is interviewing heavy vehicle drivers involved in serious crashes to identify sleep patterns, health status and hours' option. Heavy vehicle drivers are being asked how much sleep they had in the previous 24 hours, medications they were currently taking and the HVNL hours option they were working under. This information, together with copies of work diary records, are being collected and provided to VicRoads for analysis.

On balance, standard information about sleep patterns recorded in every crash report has significant challenges related to the subjectivity and reliability of the responses. It is therefore appropriate that outcomes from the Victorian trial should be assessed before a national project is further considered.

EWD data collection

The discussion paper suggested that the introduction of EWDs will improve our research capability to analyse work patterns and measure the frequency of priority fatigue issues, such as nose-to-tail schedules.

⁶ The 2012 Reform Evaluation Survey of Driver Fatigue can be found at: [http://www.ntc.gov.au/Media/Reports/\(7A1EF335-ACF2-6F1A-7445-6F72466013D9\).pdf](http://www.ntc.gov.au/Media/Reports/(7A1EF335-ACF2-6F1A-7445-6F72466013D9).pdf).

Police and road agencies agreed that the data framework should incorporate EWD data. VicRoads supported the use of EWD data in principle, provided the data can be effectively de-identified. VicRoads noted that the difficulties of achieving de-identification should not be underestimated, given EWD data has accurate location information.

The ATA recommended that the framework should support the analysis of data to reveal whether persistent multiple minor breaches of both work and rest periods arise through the use of EWDs. This will support the development of future EWD policy. This recommendation was supported by the National Road Transport Association.

SafeWork Australia suggested that real-life operational data be collected from EWDs, IAP and other satellite navigation technology to track vehicle location, speed and time spent at stops.

The research value of EWDs is potentially very high, and the HVNL permits the use of de-identified EWD data for research purposes. Post-implementation of EWDs in the heavy vehicle industry, there is strong support for including de-identified and relevant EWD data in the framework. The NHVR will be responsible for this data and it is important that any processes for accessing the data are consistent with the NHVR's national data sharing protocol.

5 Priority issues with current laws

Key points

- Evaluating the fatigue impact of nose-to-tail schedules is the priority task of the data framework. We also need to better understand how much sleep drivers are having in their major rest breaks and the impact of longer hours.
- Where possible, data collection and research activities should be leveraged to address the remaining priority fatigue issues: short rest breaks (particularly for BFM two-up drivers), night-time driving, the impact of local work, the impact of vehicle and record-keeping thresholds, health and wellbeing, and non-compliance with fatigue laws.

5.1 Prioritising fatigue issues

The discussion paper proposed a prioritisation of issues to be addressed by the data framework. Criteria for prioritisation were developed, which stakeholders largely agreed with.

TfNSW suggested that criterion 5 for prioritising fatigue issues be re-framed:

We suggest Criteria 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” be reframed to note that the data collection and research is to provide an evidence basis to understand the level of impairment and develop controls and countermeasures as part of fatigue management, especially for BFM, AFM and Chain of Responsibility. The level of impairment to be expressed and analysed in terms of fatigue alertness (TfNSW submission, p. 2).

The sixth criterion, detailed below, reflects TfNSW’s feedback.

The NHVR suggested that the criteria should factor in the existing body of fatigue knowledge and capture risks to safety, benefits to industry and national harmonisation of regulations. This suggestion has been reflected in a new second criterion.

Criteria for prioritisation of the fatigue issues

Based on consultation feedback, the fatigue issues have been prioritised based on the following criteria:

1. The issue relates to a **current** fatigue provision or regulation in the HVNL.
2. Resolution of the issue would benefit industry, road safety outcomes and national standardisation of regulations.
3. The provision or regulation is complex and/or difficult to comply with.
4. The issue could be addressed in a future review of fatigue regulations.
5. The benefit of addressing the issue is greater than the cost to industry and regulators to collect the data to address the issue.
6. Data collection and research can provide an evidence base to understand the level of impairment and develop controls and countermeasures as part of fatigue management, with the level of impairment to be expressed and analysed in terms of fatigue alertness.

Prioritisation of the fatigue issues

Based on consultation feedback, priority fatigue issues are outlined in **Table 3**. Data collection and research objectives will be prioritised according to this hierarchy of fatigue issues.

Table 3: 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	Maximum hours of work, with a focus on BFM
Priority 4	Short rest breaks, particularly in relation to BFM two-up drivers
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, we propose 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.

Other issues identified in submissions include:

- regulating the private use of fatigue-regulated heavy vehicles during a driver's rest break
- regulating the treatment of a driver who occupies the driver's seat with the engine running while resting
- the relationship between fatigue and driver distraction
- instances where dangerous goods rules may conflict with rest requirements in the HVNL.

These issues are primarily related to enforcement or are broader in scope than the data framework criteria. They are out of scope for inclusion in the data framework at this time but can be project proposals in the NTC's forward work plan.

5.2 Nose-to-tail schedules

The fatigue impact of nose-to-tail schedules is related to how much sleep drivers have in their major rest break. Fatigue issues 1 and 2 are therefore closely linked.

Road agencies, police and fatigue experts strongly supported the proposal to evaluate the residual risks that may arise from working nose-to-tail schedules.

Three of four fatigue experts consulted by the NTC in the development of the discussion paper also agreed that the fatigue effects of nose-to-tail schedules should be a priority subject for investigation, because they may create similar risks to those associated with sequential night shifts and rotating shifts, which can reduce the amount of regular sleep and create a compounding fatigue impact.

Industry recognise the importance of addressing the issue but noted that many operators do not use nose- to-tail schedules because they are inefficient.

Stakeholder feedback

The NTC's recommendation that the fatigue effects of nose-to-tail schedules be considered the first priority for evaluation in the data framework was endorsed by a majority of the submissions.

VicRoads, TfNSW and SA Police agreed with the NTC's categorisation of the issue as the first in a list of ten priority issues in current fatigue laws and regulations to investigate through a data framework. TMR rated the issue the third most important.

SA Police raised concerns about the impact of nose-to-tail scheduling and stated that the practice is becoming more common.

More qualified support for researching the effects of nose-to-tail scheduling was offered by the NHVR. While the NHVR agrees that the performance of more work in a prescribed period of time will make a driver 'more likely ... to be at risk of fatigue impairment', it contends that this increased risk 'should not be overstated'. Citing advice Professor Ann Williamson provided for the NTC discussion paper, the NHVR emphasises that the fatigue risk associated with nose-to-tail scheduling is more strongly associated with poor quality sleep and rest between, rather than during work shifts.

The NHVR stated that the 'mandatory maximum work and minimum rest limits stipulated by the law' actually provide drivers working a nose-to-tail schedule 'with an opportunity for adequate sleep in the seven hour break and for recovery from any sleep debt on the following day', after their second long shift is completed. And the NHVR's own analyses of the nose-to-tail data shows that drivers working in this arrangement have a minimum seven hour sleep opportunity on one day followed by a shorter work opportunity and longer sleep opportunity on the following day. The NHVR cautioned that any changes to regulations disallowing nose-to-tail scheduling must first demonstrate a net safety benefit, including analysis of the potential safety and fatigue risks associated with alternative counting regimes.

Industry views on the importance of nose-to-tail scheduling varied. The ATA suggested that it is not representative of industry practice but agreed that better data will confirm or confound this view.

Toll Group supported the prioritisation of nose-to-tail schedules as a primary focus for data collection and research and suggested that research could be informed by the NHVR's current EWD project.

Mr Hannifey would like more flexibility in the regulation of work and rest hours, to allow drivers to better manage when they take small and major rest breaks. Mr Hannifey does not advocate giving drivers more total hours than current regulations permit, but does believe they should 'allow split rest up to three times a week' and at times to suit the driver, who should be able to choose their own work and rest combinations so that drivers could exceed the standard hours that can be worked in a 24 hour period, provided they take 'a major rest break within those hours' and do this only twice a week. This will allow drivers to 'move [their] seven hour continuous break into a better time, for example from day to night'.

Recommendation

A majority of stakeholders support prioritising the investigation of the fatigue impact of nose-to-tail scheduling. The NTC recommends that the fatigue impact of nose-to-tail schedules is a priority issue for consideration in a fatigue data framework. Research should assess whether drivers on a nose-to-tail schedule are having sufficient sleep, compared with other drivers, as well as the safety risks of alternative practices. Data collection and research should make use of all available data and technology, including EWD and de-identified commercial data.

5.3 Quantity and quality of sleep

A majority of stakeholders, including road agencies, police and transport operators, agreed that sleep quantity and quality should be a high priority. The key questions are:

1. To what extent are drivers restricting their rest periods to the legal minimum?
2. Do minimum regulatory rest periods provide sufficient quantity and quality of sleep to manage driver fatigue?

Evaluating the optimum amount of sleep is not a simple process, as it varies somewhat by individual. NTC guidelines to industry in 2007 advised that 'the average daily sleep required for an adult generally varies between six to eight hours' and that anyone who has 'less sleep than necessary will build up a sleep debt' (NTC 2007, 7). The American Academy of Sleep Medicine and Sleep Research Society states that optimal sleep in normal conditions is seven continuous hours, or nine hours continuous sleep to allow a person to recover from a sleep debt.

Many fatigue experts advise that the sleep opportunity in current regulations is insufficient, and that a minimum of seven hours' *sleep* every 24 hours is required to provide sufficient rest and recovery from work.⁷ Dr Mark Howard 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. Accordingly the discussion paper suggested that there is a strong case for investigating the effects of the length and timing of different-length major rest breaks on driver fatigue.

The impact of smaller rest breaks and split rest breaks also needs to be considered. While smaller rest breaks help reduce some of the effects of fatigue, only sleep can reduce sleep debt. Further research could indicate the optimal placement and duration of breaks and sleep in operational settings.

Stakeholder feedback

Sleep quantity and quality as a significant issue was endorsed by a majority of the respondents.

The ATA agreed the quantity and quality of sleep attained in major rest breaks was an issue for further investigation, and could be considered in conjunction with driver health and wellbeing issues. The ATA further recommended that the framework enable collection of data about long rest breaks of seven hours or more to support long rest break flexibility (ATA submission, p. 8).

Mr Hannifey stated that drivers have little control over their schedules and the facilities that they have to use to wash and sleep in. It is not easy to cease driving and take some rest, or obtain quality sleep, when schedules are binding and inflexible, customers are demanding and rest facilities are either unavailable or inadequate.

Mr Hannifey suggested that if drivers are to be encouraged to obtain more sleep and quality sleep, then more flexibility will have to be built into their schedule, to increase their control of how they work their permitted hours.

'It is all well and good to say that fatigue causes crashes, but what role did the current lack of rest areas have? What role does forcing a driver to stop and have a break when he is not tired, or to force him to sleep in the heat when he can't, have on his fatigue and if this is the problem, then what is being done to alleviate these issues?' – *driver and safety advocate, Rod Hannifey*

Toll Group also noted the shortage of suitable rest areas for long-haul drivers. Toll Group recommended an analysis of sleeper berth design rules to assess whether they provide sufficient restorative rest for drivers. The fact that such berths do not currently need to be air-conditioned was one inadequacy cited by Toll Group.

Mr Allen stated that in his experience drivers were forced to spend as much as six hours of unpaid time at waiting at terminals in situations where they are unable either to rest or to work. They cannot leave the queue for fear of losing their spot or go and eat or sleep somewhere because they are confined to their rig.

SafeWork Australia queried any assumption that drivers are provided with adequate opportunity to obtain the necessary quantity of quality sleep in their long rest break.

Transdev encouraged the examination of quantity and quality of sleep, and fitness to work together as a whole. In addition, Transdev believes it is currently 'impossible to obtain any knowledge of sleep patterns, sleep insufficiency and medical issues' from employees such as bus drivers, 'which

⁷ The HVNL requires a major rest period for a driver on standard hours of seven hours and a major rest period for a driver on BFM of six hours.

limits the effectiveness of early intervention strategies and the prevention of fatigue in the driver network', as it is currently the legal 'responsibility of the driver to notify of medical issues or sleep fatigue issues'.

The NHVR suggested that the adequacy of sleep in the major rest break had been prioritised too highly. It proposed that 'drowsiness and education on driver's identifying/managing fatigue' be considered in future project work connected with the data framework. It also urged that research 'focus on aspects of the regulatory framework that directly inhibit drivers from taking adequate rest. These include two-up driving (in both standard hours and BFM) and the split rest defence'.

The NHVR is concerned that the two-up driver rest rules do not allow an opportunity for drivers to have seven continuous hours of sleep. The NHVR has also suggested that this *split rest break defence* currently available to drivers may need to be examined.⁸

Recommendation

The NTC recommends that an evaluation of sleep quality and quantity in major rest break periods is a priority issue. Where possible, data collection and research should take into consideration the following linked themes:

- the impacts of different schedules on work and rest patterns
- sleep that drivers obtain while working in two-up arrangements
- the difficulty monitoring work and rest of drivers who work both solo and two-up
- different impacts on the work environment (including availability and quality of rest areas, the condition of sleeping berths and queuing delays)
- availability of the split rest defence.

Where possible, research should involve road agencies, the NHVR, industry, telematics providers and a mix of long-distance and local drivers working standard hours and BFM.

5.4 Maximum work hours, with a focus on BFM

Fatigue experts advise that safety issues associated with prolonged continuous work, particularly with the additional work hours options permitted under BFM, need to be better understood and correlated with crash data.

Dr Howard and Professor Haworth identified the prolonged periods of continuous work permitted by current law, as well as the incidence of lengthy work periods that are interspersed with insufficient sleep and rest, as issues for further evaluation through a fatigue data framework.

BFM allows fatigue-regulated drivers to work an additional two hours more each day than drivers working standard hours. This greater work opportunity affects the length of continuous work periods (six hours rather than five hours in standard hours) and the length of the overall work period in each 24 hours (14 hours rather than 12), which are not compensated for with increased stationary rest time. Over a seven day period, BFM drivers may work a maximum of 84 hours compared with standard hours drivers' maximum of 72 hours.

These additional hours of work may increase fatigue risk. While BFM provides more night time sleep opportunities than standard hours, there is insufficient evidence that the night work limits of BFM offset the fatigue risk created by the additional work hours. There is also insufficient evidence that the additional training and health checks required for BFM accreditation sufficiently offset this fatigue risk.

The discussion paper therefore suggested that the fatigue effects of BFM be comprehensively assessed. We further suggested that the number of fatigue-related crashes involving both BFM and AFM drivers be analysed, and the fatigue counter-measures used in each system evaluated.

⁸ When a BFM solo driver does not have at least seven continuous hours of stationary rest in a 24 hour period, an offence is committed, but that driver may invoke *the split rest break defence* in a court proceeding, if they can show they took six continuous hours of stationary rest time and two continuous hours of stationary rest time instead and had seven consecutive hours of stationary rest in the previous 24 hour period.

Stakeholder feedback

The importance of continuous hours of work as an issue impacting fatigue in heavy drivers varied across submissions. Road agencies rated the issue as being of high importance.

The NHVR stated that framework activities should not be focused on validating AFM. Data collected on the implementation of AFM schedules 'suggests that the risk is infrequently used by AFM participants and is safely managed when it is used' and 'there is sufficient evidence available for [it] to be satisfied that there are no unmanaged safety risks associated with AFM' (NHVR submission, p. 8).

The ATA regards the issue of continuous hours of work as significant, but from the perspective of flexibility for operators and drivers so that they can design flexible and safe schedules. Furthermore, 'technology can be used in a smart way to create flexibility at the driver's discretion'.

Recommendation

The fatigue effects of additional work being performed by drivers working BFM should be assessed in the data framework, particularly as long hours of continuous work, when combined with poor quality sleep (and night driving schedules) can have increased effects on driver fatigue.

The data framework should not duplicate NHVR's evaluation and validation of the refreshed AFM and risk classification system. Data outputs and research conclusions of AFM evaluation and validation should feed into the data framework for comparative analysis.

5.5 Short rest breaks, particularly for BFM two-up drivers

In two-up driving arrangements, two people share the driving of a heavy vehicle with a sleeper berth. Two-up drivers operating under BFM do not have minimum rest time requirements but a two-up driver must not work more than 14 hours in a 24-hour period. The safety impact of not having regulated short rest breaks – and the potential for one driver to undertake most or all of the driving task – needs to be further measured and understood.

In the development of model fatigue laws, the NTC's position was that regulating rest breaks for two-up driving could result in drivers taking over the driving task while still fatigued. Further, two-up drivers were thought to have reduced pressures or incentives to keep driving if impaired by fatigue and were more likely to manage their fatigue by sharing the driving task, and that the safety benefits of this approach are reduced by regulating short rest breaks.

However, uptake of two-up driving is comparatively low in Australia, and these assumptions have not been validated. The discussion paper therefore suggested that better evidence is required to understand the safety risk the current rules.

Stakeholder feedback

Road agencies regarded the rest periods of BFM two-up drivers an important issue. TMR had particular concerns about sleep quantity and quality of BFM two-up drivers, as well as the difficulty of proving that drivers in these arrangements have breached fatigue regulations.

Police are similarly concerned that sufficient and timely rest breaks are not being taken by two-up drivers, and most critically that if a BFM two-up driver is driving while fatigued, a breach of the HVNL becomes more difficult to prove. SA Police further noted an additional issue – that some drivers may be missing a stationary rest break when changing from solo to two-up arrangements.

The NHVR agreed that further investigation of short rest breaks for BFM two-up drivers was warranted, given that the current arrangements 'allow uncontrolled, unaddressed high fatigue risks which could be simply prevented by the introduction of short rest break requirements'. The NHVR cited its own analysis of operational data collected during the development of the Livestock Transport Fatigue Management Scheme, which showed that the average sleep opportunity over the three month period for BFM two-up drivers was shorter than that of the other solo drivers. However, this was based on the data of just one pair of BFM two-up drivers.

NHVR also recommended that BFM drivers be advised and educated about best practice two-up work and rest arrangements.

TfNSW suggested that while it is important to assess the fatigue risk of short rest breaks in BFM two-up driving, the investigation could be broadened to include short rest breaks for other fatigue-regulated heavy vehicle drivers. This would help stakeholders determine if short rest breaks in general aid in keeping drivers alert.

The ATA did not regard BFM two-up driving as a significant issue, although it agreed with the inclusion of BFM two-up driving in the framework to support better analysis of the issue.

Recommendation

The rest and sleep patterns of drivers, in particular BFM two-up drivers, needs to be better evaluated and should be included as a research objective in framework projects.

Data collection and research should evaluate the:

- extent to which short rest breaks mitigate driver fatigue and drowsiness
- current rest and sleep patterns of BFM two-up drivers
- fatigue risk of current sleep and rest patterns of, compared with solo BFM rest requirements.

Alertness CRC research and commercial scheduling data that includes work diary information can be leveraged to address these research issues. Additional or separate research is not envisaged at this time.

The low level of two-up driving will be a data collection challenge. For example, one telematics service provider in discussions with the NTC stated that it collects data on over 3,000 drivers, of whom *less than 20* are BFM two-up drivers.

5.6 Night-time driving and ending shifts in the early morning

The human body is regulated by natural rhythms that are repeated approximately every 24 hours. This body clock or circadian rhythm regulates sleeping patterns, body temperature, hormone levels, digestion and many other functions. Our body temperature drops during the night resulting in sleepiness, and increases during the day to help us stay alert.

This means that night-time driving (during the circadian low point) not only increases the safety risk because of a driver's fatigue impairment, but also because a sleep debt can accumulate that requires significantly more sleep in later days. Research indicates that night driving risks are exacerbated when a long shift ends between midnight and 6 am.

The discussion paper therefore suggested that the effects of night work be evaluated through a data framework.

Stakeholder feedback

Night-time driving and the ending of long work shifts during the night was partially endorsed in submissions.

The NHVR supported regular analysis of data to assess the relative frequency of night sleep among heavy vehicle drivers. The NHVR recognised that night work carries a higher risk of being impaired by fatigue, and that all current work and rest modules in the HVNL 'try to specifically address the issue of night work, though there has been no systematic investigation of the effectiveness of these countermeasures since they were introduced in 2008'.

Optalert recommended that drivers who work overnight be given real-time 'information about [their own] alertness and drowsiness levels in order to properly determine when breaks should be taken' and their shifts begun and concluded. They agreed that this is essential data for effective fatigue management policy.

The ATA agreed with the inclusion of night-time driving in the data framework to support better analysis of the issue, noting that it could be incorporated into a wider analysis of driver well-being and fitness to work.

Recommendation

The impact of night-time driving and sleep debt recovery in the heavy vehicle industry needs to be better evaluated and should be included as a research objective in framework projects.

Data collection and research should evaluate:

- frequency of night time driving and ending long shifts between Midnight and 6am
- impacts of regular night-time driving and accumulated fatigue
- assessment of sleep debt recovery opportunity after finishing a long shift between Midnight and 6am or after repeated night-time driving.

Commercial scheduling data and Alertness CRC field research to evaluate sleep quantity and quality can be leveraged to address these research issues. Additional or separate research is not envisaged at this time.

5.7 Impact of local work

All fatigue-regulated heavy vehicle drivers must comply with fatigue regulations, but drivers performing local work (within a 100 km radius of a driver's base) do 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 a local driver has worked. This information does not have to be kept in the vehicle.

Industry stakeholders suggested that fatigue associated with working in congested traffic and meeting tight delivery deadlines needs to be better understood. Enforcement agencies are concerned about lack of record-keeping transparency.

Stakeholder feedback

There was agreement across road agencies, police and industry that knowledge about the fatigue impact of local work could be improved.

The NHVR noted that it is aware of commercial data suggesting that there has been an increase in the crash rates for local work, but is not clear about what is causing this increase. The NHVR has received reports from industry 'that operators who work only local area work, are more likely to disregard the work and rest limits in the HVNL and the general duty to not drive while impaired by fatigue'. The NHVR therefore supports further research into the work and rest patterns of local area drivers, their fatigue management practices and safety performance.

Transdev commented that more resources need to be directed towards monitoring and analysis of the fatigue effects of local work.

The ATA supported the proposal to investigate the fatigue impact of local work, and commented that 'different freight tasks are fatiguing in different ways', so distance travelled should not be regarded as the only sound measure of fatigue likelihood and severity.

Recommendation

The majority of heavy vehicle driving in Australia is local work. Measuring the effects of local work on driver fatigue will help governments and industry better understand the safety value of record keeping and the impacts of fatigue in the context of pressurised urban driving.

An evaluation of local work should capture the impacts of urban driving and the impacts of less stringent record-keeping requirements on driver fatigue. Where relevant, local work should be included as a research objective in framework projects.

Data collection and research should evaluate the:

- work and rest patterns of local work drivers
- fatigue impact of driving in congested urban areas and the stress of meeting deadlines
- fatigue impact of not requiring in-vehicle written work diary records for local work
- frequency of incidents and near misses during local work compared to long-distance driving (excluding events that occur in urban areas by long-distance drivers).

Commercial scheduling data, longitudinal surveys and Alertness CRC field research can be leveraged to address these research issues. We do not envisage additional or separate research at this time.

5.8 Thresholds for fatigue regulations in the HVNL

There are two key threshold requirements in the fatigue regulations that warrant further evaluation:

- what gross vehicle mass (GVM) or people capacity of a vehicle requires a driver to be fatigue-regulated under the HVNL (noting the greater crash impact of heavier vehicles)
- at what distance from base should a fatigue-regulated driver be required to keep and use the national work diary.

We have insufficient knowledge of the impact of regulatory thresholds on driver fatigue.

First, we do not know the risk profile of drivers using vehicles with a GVM of less than 12 tonnes and if these drivers regularly work in patterns that have a high level of fatigue risk that would justify greater regulatory scrutiny.

Second, we do not have substantive evidence of the impact work and rest hour record keeping has on managing driver fatigue, and we do not know if record keeping improves road safety.

The evaluation of regulatory thresholds could be informed by identifying substantive links between record keeping and road safety outcomes, and the impact of any exemptions and changes to record keeping thresholds that are currently permitted. Evaluating the fatigue impact of thresholds is related to better understanding the fatigue that may be caused by local work (section 5.7).

Stakeholder feedback

Stakeholders had diverse views on the value of addressing threshold issues. VicRoads stated that 'anecdotal evidence suggests there is an increase in fatigue problems during local work which then relates to understanding the current effects of record keeping for this type of work'.

The NHVR reported commercial data suggesting that there has been an increase in insurance claims relating to vehicles between 4.5 and 12 tonnes GVM. This could mean that these vehicles are being involved in more crashes, or it could reflect a larger heavy vehicle fleet. The NHVR therefore supports evaluating the fatigue management practices and safety performance of drivers using heavy vehicles less 12 tonnes GVM, while noting that only considerable safety concerns could justify greater regulation.

The NHVR recognised that there is little available evidence to demonstrate any relationship between the strengthening of record keeping requirements and improved safety outcomes.

Police interest in thresholds is primarily enforcement focused. NSW Police, SA Police and Victoria Police noted that drivers who perform both local and longer distance work can be 'invisible to enforcement' and would like the issue of extending the thresholds of the 100+km record keeping requirements in the HVNL to all drivers of fatigue-regulated vehicles to be considered:

The impact of how drivers abuse local work and then carry out 100+km has continued. NSW [has] had several crashes where drivers were carrying out local work far in excess of normal driving hours by underhanded cash payments. It would appear that the carrying and use of a work diary for all regulated heavy vehicles no matter what work is being conducted may prevent this type of activity. All local work should be examined more closely as part of the review (ANZPAA submission).

The ATA agreed with the inclusion of threshold issues in the data framework to support better analysis of the issue. Toll Group stated that regulatory thresholds – especially around why fatigue laws apply at 12 tonne vehicles but not at 4.5 tonne vehicles – are unresolved and should be addressed through the data framework.

Recommendation

Analysis of commercial data can enable us to correlate fatigue-related incidents (including lane swervings and drowsiness alerts) with local and long-distance work and vehicle type. If the data is of sufficient scale and validity, this correlation could help us evaluate current regulatory assumptions, by comparing the safety record of drivers who keep work diary records compared to drivers that do not. The safety record of drivers who use heavy vehicles of less than 12 tonnes could also be compared with drivers that use vehicles regulated by the HVNL.

Data collection and research should evaluate the fatigue-related safety record of drivers:

- required to keep a written work diary (100+km work) compared to drivers that are not (100km work)
- fatigue-related safety record of drivers using a heavy vehicle of less than 12 tonnes GVM compared to drivers that use a vehicle of 12 tonnes GVM or greater.

Commercial scheduling data, longitudinal surveys and Alertness CRC field research can be leveraged to address these research issues. Additional or separate research is not envisaged at this time.

5.9 Driver wellbeing and fitness to work

Driver health and wellbeing captures any aspect of a driver's health that impacts fatigue and road safety. It is a broad concept that includes medical conditions (such as obstructive sleep apnoea), medications that cause drowsiness, body mass index levels, diet, alcohol consumption and stress. Managing driver health and wellbeing is often related to factors that exist in parallel to the work environment but, nonetheless, impact upon a driver's fitness to work.

The current regulatory approach to heavy vehicle driver wellbeing and fitness to work is minimal compared to other transport sectors. While drivers operating under BFM have 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.

Periodic screening for sleep disorders is undertaken in the Australian rail sector, while heavy vehicle operators are screened on a periodic basis in the United States.

Stakeholder feedback

The submissions consistently highlighted the importance of driver health and wellbeing, while recognising that the issues raised are largely broader than the HVNL regulatory framework.

The NHVR noted that driver health and wellbeing is already assessed in driver licensing legislation and, in the case of BFM and AFM, is managed through health and fitness standards. The NHVR suggested that health promotions and education to raise awareness of potential issues should be explored rather than additional regulation in the HVNL.

The ATA supported further analysis of the fatigue impact of driver health and wellbeing. The ATA advocates for the inclusion of fitness for duty medical factors for certain drivers within the Assessing Fitness to Drive (AFTD) guideline, covering such factors as diabetes, sleep apnoea, and cardiac screening. The ATA proposes that a single assessment can capture different accreditation and industry schemes. This is an NTC candidate project for our future work programme.

Toll Group stated that fitness for duty continues to be an unresolved policy question, with links to lengthy commutes and sleeper berth design rules.

Transdev recommended that sleep quantity and quality and fitness to work are inseparable and should be examined together as a whole. Transdev queried the rationale for distinguishing between heavy vehicle licensing and bus operations, given that bus drivers are required to meet relevant

medical standards to operate a passenger vehicle, while other heavy vehicle drivers are not required to meet equivalent standards. Transdev suggested that operators should have better visibility of drivers' medical conditions, and drivers with relevant conditions should be proactively managed by operators and licensing authorities.

By comparison, Transdev cited WA's requirements for bus drivers to undergo pre-employment and ongoing medical checks, the frequency of which are determined by the age of the driver. The driver's medical assessment form is completed by a health professional and submitted directly to the Department of Transport, which has the discretion to grant an individual their driving licence.

Recommendation

The impacts of drivers' health and wellbeing needs to be better evaluated and should be included as a research objective in framework projects.

Data collection and research to measure the fatigue impact of current regulations can inform our understanding of how health issues impact on a driver's ability to safely comply with the law. In particular, the CRC research and industry surveys provide an opportunity to correlate and improve analysis of the relationship between underlying driver health and safety risks with the current laws.

Because driver health and wellbeing is a broader issue than a specific provision in the HVNL, the issue is not a higher priority in the data framework.

5.10 Non-compliance issues

The objective of the data framework is to collect data to better inform future fatigue policy and is therefore focused on the fatigue impact of current laws. That is, the data framework will focus on evaluating what is permitted by the HVNL rather than on prohibited activities. Nonetheless, enforcement challenges with prohibited activities are of concern to enforcement agencies and consistent breaches of particular laws should be taken into consideration in any future review of the fatigue provisions.

Stakeholder feedback

Common non-compliance issues raised in the submissions include heavy vehicle drivers who:

- have record-keeping breaches, namely:
 - drivers who work locally during the day and long distance overnight and do not record local work in the national heavy vehicle work diary
 - drivers who fail to record loading and unloading activities as work in the national heavy vehicle work diary
- work in excess of legal hours
- consume illicit substances, including among accredited drivers.

VicRoads regarded drug-taking as a critical impact issue on road safety and indicated that a significant proportion of heavy vehicle drivers killed in road crashes test positive to drugs. VicRoads recommended that drug use be designated a discrete and important issue in the heavy vehicle fatigue data framework, and that data from drug and alcohol testing of heavy vehicle drivers be expanded to capture whether the driver was operating under standard hours, BFM or AFM.

SafeWork Australia commented that the consumption of drugs, whether legal or otherwise, should be regarded as a mandatory matter for investigation in crash investigation and analysis.

The ATA and Transdev supported the investigation and analysis of the fatigue impact of drug use by heavy vehicle drivers through the data framework. Transdev commented that the 'elimination of substance abuse will never occur whilst 80 per cent of the road transport industry does not perform drug and alcohol testing'. Transdev cited WA's zero tolerance drug and alcohol policy, random alcohol breathalyser testing on a monthly basis and random alcohol and drug testing every 3-4 months as an example of better practice heavy vehicle drug policy.

Dr Howard and Professor Haworth advised that research is required to better understand how some drivers consume illicit substances to stave off drowsiness. Research methods might involve objective testing for the consumption of illicit substances as well as alcohol conducted at the scene of fatigue-related crashes. This could help assessment of whether particular work hours options and other factors are influencing drivers' decisions to consume drugs.

Recommendations

Non-compliance with fatigue laws may be the result of a number of factors, and there is an opportunity with the data framework to assess to what extent the fatigue provisions make it difficult for drivers to comply or are ineffective in managing driver fatigue.

EWD and de-identified commercial data can provide information about which fatigue provisions drivers are not complying with. The linked data feasibility review (**Recommendation 7**) can also link drug and alcohol offence data to BFM and AFM drivers.

At a minimum, the design and implementation of research activities should consider the use of illicit substances to ensure that alertness data is not skewed by drug-taking. We do not envisage additional or separate research at this time.

Appendix A: Glossary

Term	Definition
Actigraphy	A method to monitoring human rest/activity cycles – usually worn like a wrist watch
AFM	Advanced Fatigue Management
Alertness CRC	Cooperative Research Centre for Alertness, Safety and Productivity
BFM	Basic Fatigue Management
Circadian rhythm	Physical, mental and behavioural changes that approximately follow a 24-hour cycle, responding primarily to light and darkness
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)
Open data	Publicly-available data that provide transparency and improved accountability of the impact of government regulations and services on societal indicators
Phenotyping	To measure the inherent characteristics of a thing
Sleepiness	The propensity to fall asleep

Appendix B: Submissions received

The NTC received 17 submissions to *Developing a fatigue data framework discussion paper*, August 2015. All submissions are available on the NTC website at <http://www.ntc.gov.au/submissions/history/?rid=88414&pid=7866>.

- Mr Joe Allen
- Australia and New Zealand Policing Advisory Agency (ANZPAA), encompassing separate responses from police agencies in New South Wales, Victoria, Queensland, South Australia and Tasmania
- Australian Trucking Association
- Mr Arnold Cook
- Mr Rod Hannifey
- Institute for Safety, Compensation and Recovery Research
- National Heavy Vehicle Regulator
- National Road Freighters' Association
- National Road Transport Association
- Northern Territory Government
- Optalert Australia Pty Ltd
- Queensland Department of Transport and Main Roads
- Safe Work Australia
- Toll Group
- Transport for New South Wales
- Transdev Australasia
- VicRoads.

Appendix C: About the Alertness CRC

The CRC program supports industry-led collaborations between researchers, industry and the community. The Commonwealth Government matches funding provided by CRC partners, thereby ensuring that the benefits of applied research are maximised through enhanced use, commercialisation and technology transfer.

CRC participant agreements will govern the use and collection of data – including the handling of intellectual property – and are consistent with the data framework principles.

The CRC program has funded the Alertness CRC from 2014. The Alertness CRC is an industry-focused centre of applied research that 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.⁹ 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. Tools available in the Alertness CRC including alertness monitoring (such as Seeing Machines and Optalert) and sleep actigraphy devices which monitor human rest/activity cycles (usually involving a device worn like a wrist watch).

Seeing Machines¹⁰ uses eye-tracking software to detect drowsiness via micro sleeps, which are measured by monitoring the eyelid behaviour of the driver sixty times per second. Other drowsiness measurements include changes to facial features (drooping mouth edges) and head behaviours (such as head roll).

Optalert¹¹ 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 light to determine the eye and eyelid activity.

⁹ More information about the Alertness CRC objectives and research activities can be accessed on the CRC website.

¹⁰ More information about Seeing Machines' patented technology can be accessed at: www.seeingmachines.com.

¹¹ More information about Optalert's patented technology can be accessed at: <http://www.optalert.com/>.