Should Australia expand rail health assessments?

Discussion Paper

December 2017

NTC AUSTRALIA
National Transport Commission

Report outline

Title	Should Australia expand rail health assessments?
Type of report	Discussion paper
Purpose	For public consultation
Abstract	This discussion paper seeks information from stakeholders to support the development of a RIS to make amendments to the *National Standard for Health Assessment of Rail Safety Workers*.
Submission details	Submissions will be accepted until **Friday 2 March 2018** online at www.ntc.gov.au or by mail to: Att: Should Australia expand rail health assessments? National Transport Commission Level 3/600 Bourke Street Melbourne VIC 3000
Key words	National Standard for Health Assessment of Rail Safety Workers, obstructive sleep apnoea, Category 1 and 2 Rail Safety Workers, Category 3 Around The Track Personnel
Contact	National Transport Commission Level 3/600 Bourke Street Melbourne VIC 3000 Ph: (03) 9236 5000 Email: enquiries@ntc.gov.au www.ntc.gov.au

Contents

Report outline **ii**
Executive summary **1**
1 Introduction **2**
1.1 Assessing rail safety workers' health 2
1.2 Purposes of the discussion paper 5
1.3 Information gathered to date 5
1.4 What information is the NTC seeking? 5
1.5 Making a submission 6
2 Obstructive Sleep Apnoea **7**
2.1 What is obstructive sleep apnoea? 7
2.2 How is obstructive sleep apnoea diagnosed? 7
2.3 How are safety critical workers triggered for testing? 7
2.4 What is the problem with the current sleep disorder criteria? 9
2.5 What metrics can screen for obstructive sleep apnoea? 9
2.6 Possible changes to the screening criteria for testing 10
3 Category 3 around the track personnel **11**
3.1 Who are category 3 around the track personnel? 11
3.2 Category 3 around the track personnel health assessments 11
3.3 Proposed changes to category 3 ATTP health assessments 11
4 Summary and next steps **12**
4.1 Should Australia expand rail health assessments? 12
4.2 What is the project timeframe? 13
Appendix A: Obstructive Sleep Apnoea **14**
A.1 Current standard 14
A.2 Literature review 14
A.2.1 Obstructive sleep apnoea: prevalence, diagnosis and treatment 14
A.2.2 Obstructive sleep apnoea in the road environment 19
A.2.3 Obstructive sleep apnoea in the rail environment 20
A.2.4 Measuring the costs and benefits of potential changes 22
Appendix B: Category 3 Around The Track Personnel **24**
B.1 Current standard 24
B.2 Literature review 25
B.2.1 Examples of category 3 ATTP roles 25
Appendix C: References **27**

List of tables

Table 1. Periodic health assessments **3**
Table 2. Cost, verifiability and OSA correlation of screening metrics **9**
Table 3. Medical criteria for sleep disorders **14**

Table 4. Medical criteria for category 3 around the track personnel 24

List of figures

Figure 1. Risk categorisation of rail safety workers 2
Figure 2. Assessment and reporting framework 4
Figure 3. Sleep disorder assessment and management for safety critical workers (Category 1 and 2) 8
Figure 4. BMI values from 2014-15 National Health Survey 16

Executive summary

The *National Standard for Health Assessment of Rail Safety Workers* (the Standard) is a publication of the National Transport Commission (NTC) that applies to all government, commercial and tourist and heritage rail operators. The Standard specifies Rail Safety Worker (RSW) categorisation and, based on the categories, specifies medical examination type and frequency.

As part of an ongoing maintenance program, the NTC reviews the Standard to ensure that it is current and up to date, and reflects the needs for the safe working environment of the Australian rail industry.

During the last review, significant changes to two specific areas of RSW health assessment were proposed:

- **Sleep disorders:** a proposal to expand obstructive sleep apnoea (OSA) testing to more rail safety workers.
- **Category 3 medical assessments:** a proposal to expand the health assessment criteria for Category 3 around the track personnel (ATTP).

This discussion paper outlines the current requirements and potential options to change the Standard, and seeks supporting evidence from stakeholders to help develop a case for making a change or otherwise.

The NTC has undertaken a literature review on the two issues under consideration. The literature review has not provided sufficient information to the NTC to develop a robust case for change.

This discussion paper has two purposes. To:

- outline the current health assessment framework, the proposed changes and the chain of evidence the NTC needs if it is to make the case for changes, and
- call for that evidence from rail transport operators, rail infrastructure managers, rail safety workers and their representatives, medical experts and others.

The NTC is seeking advice from a clinical and practice perspective, and invites contributions from:

- Medical experts, including researchers and practitioners
- Rail transport operators and peak bodies
- Rail safety workers and associations (such as unions)
- Transport safety experts, and
- Anyone else able to provide informed advice.

The NTC is seeking data and information from stakeholders to develop an evidence-based regulatory impact statement by **Friday 2 March 2018**.

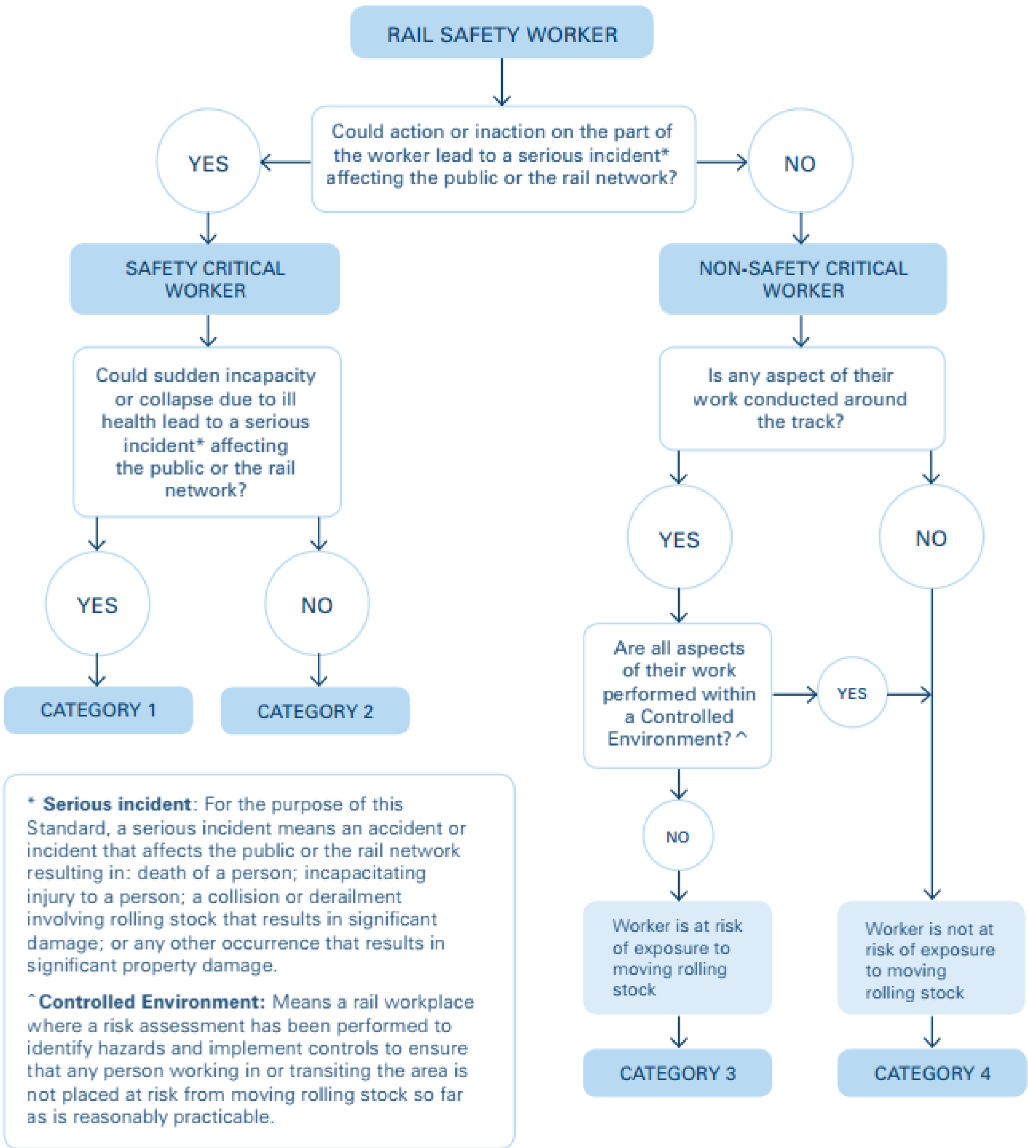
1 Introduction

1.1 Assessing rail safety workers' health

Rail operators must manage the risks posed to the safe operation of the network by the health conditions of their employees. The *National Standard for Health Assessment of Rail Safety Workers* (the Standard) provides a common, evidence-based framework and benchmark for rail operators to manage those risks.

The Standard is a publication of the National Transport Commission (NTC) that applies to all government, commercial and tourist and heritage rail operators. The Standard provides a means to categorise each Rail Safety Worker (RSW) by the criticality of their role and, based on the categories, specifies health assessment type and frequency. Figure 1 illustrates the risk categorisation of Safety Critical Workers (SCWs) and Non-Safety Critical Workers (NSCWs) (National Transport Commission, 2017, p. 31).

Figure 1. Risk categorisation of rail safety workers



Category 1, 2 and 3 RSWs require health assessments:

- at pre-placement (that is, on commencing employment)
- before changing to a position involving tasks of a higher risk category
- periodically, and/or
- if triggered by a health event or change in health status.

Periodic health assessments are based on the time of commencement and age of the RSW, recognising the degenerative nature of some conditions. Table 1 lists the frequency of periodic health assessments for Category 1, 2 and 3 RSWs (National Transport Commission, 2017, pp. 35-36).

Table 1. Periodic health assessments

Category 1 and 2: Safety Critical Workers	Category 3: Around the Track Personnel in an Uncontrolled Environment
▪ At time of commencement (pre-placement) ▪ every 5 years to age 50, then ▪ every 2 years to age 60, then ▪ every year. For Category 1 and Category 2 Safety Critical Workers, despite anything to the contrary in the list, the worker must have a health assessment conducted within 2 years after turning 50 years of age, and within 1 year after turning 60 years of age.	▪ At time of commencement (pre-placement), then ▪ every 5 years from the age of 40 years. Category 3 workers who have had a full health assessment less than 5 years before turning 40 (e.g. for pre-employment) may have their next periodic assessments scheduled 5 years from that date.

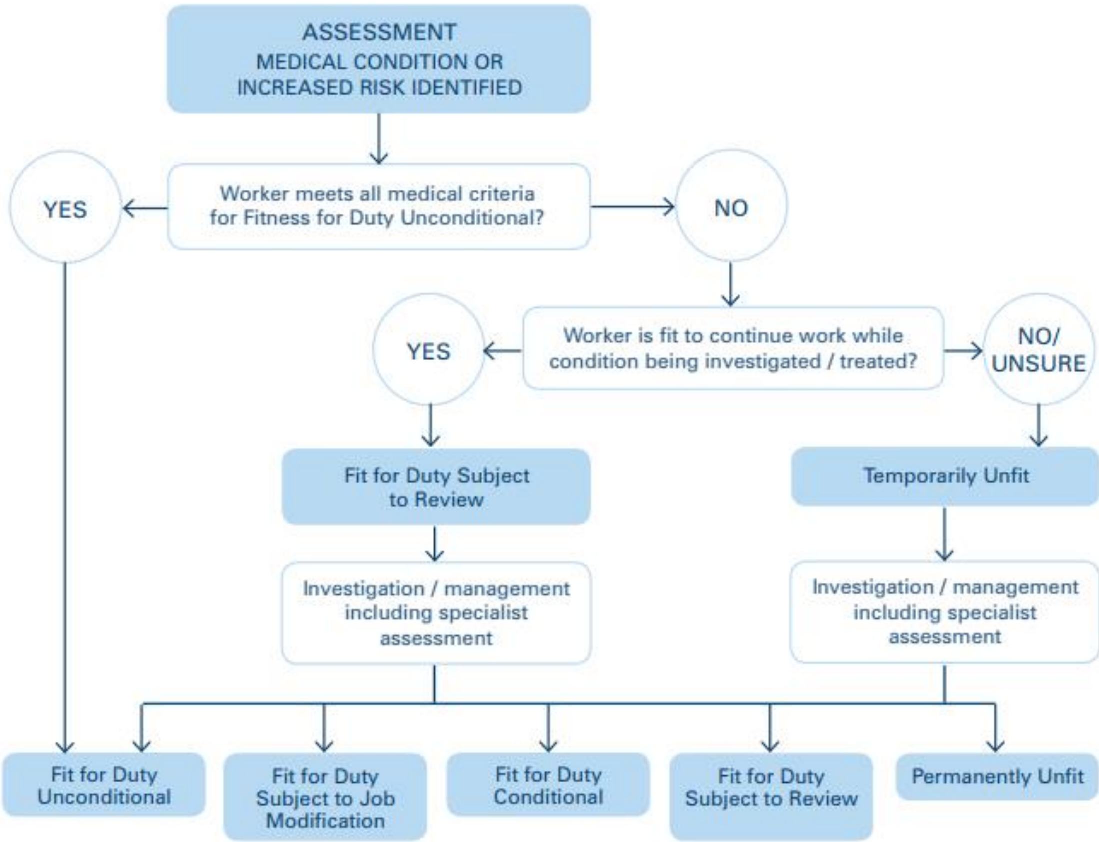
Triggered health assessments are used to investigate health concerns that arise between periodic assessments. Triggered health assessments enable early intervention, appropriate management and timely monitoring of health problems that are likely to affect safety, for example, sudden blackout or diagnosis of a condition outside of periodic review.

RSWs are assessed and their health status classified according to their function and other personal medical criteria:

- **Fit for Duty Unconditional:** RSW meets all criteria, can do their job and no further assessment is needed
- **Fit for Duty Conditional:** RSW meets all criteria provided they wear appropriate aids, e.g. wear spectacles, hearing aids, and no further assessment is needed
- **Fit for Duty Subject to Review:** RSW can do their job, with conditions if applicable, but further assessment is needed
- **Fit for Duty Subject to Job Modification:** RSW can do a modified job, with conditions if applicable, and no further assessment is needed
- **Temporarily Unfit for Duty:** RSW cannot perform function, further assessment or re-assessment is needed
- **Permanently Unfit for Duty:** RSW cannot perform function.

Figure 2 summarises the assessment and reporting framework for RSWs (National Transport Commission, 2017, p. 37).

Figure 2. Assessment and reporting framework



The NTC periodically updates the Standard as part of an ongoing routine maintenance program.

During the last update, some stakeholders sought significant changes to two specific areas of health assessment:

- **Issue 1 – sleep disorders:** The current trigger for testing RSWs for obstructive sleep apnoea (OSA) is based on Body Mass Index (BMI) and co-morbidities such as type 2 diabetes and hypertension. Some stakeholders argue that the current triggers for OSA testing are insufficient, and allow many cases of OSA to go undetected. Undetected OSA, it is argued, represents an insufficiently managed risk to the rail network, RSWs and the community.
- **Issue 2 – category 3 health assessments:** The health assessment for Category 3 RSWs covers hearing, vision and musculoskeletal function. Some stakeholders argue the assessments should be expanded to include additional medical conditions that could affect a worker's safety around the track, particularly those conditions that may lead to a sudden incapacity or cognitive impairment.

1.2 Purposes of the discussion paper

The proposed changes to the health assessment criteria would have significant impacts for RSWs, their employers and health professionals. The cost of implementing the proposed changes – or something like them – must be balanced against the safety benefits that can be associated with them.

The NTC will need to develop a regulatory impact statement (RIS) to outline the benefits and costs, in a broad sense, of these proposed changes to the health assessments.

This discussion paper has two purposes. To:

- outline the current health assessment framework, the proposed changes and the chain of evidence the NTC needs if it is to make the case for changes, and
- call for that evidence from rail transport operators, rail infrastructure managers, rail safety workers and their representatives, medical experts and others.

Developing a RIS is time-consuming and costly. If the NTC is unable to collect sufficient evidence to build a case for changing the Standard, it will not develop a RIS.

1.3 Information gathered to date

Proposals for regulatory change, in particular when it is clear there are costs associated with that change, must be supported by a RIS. A RIS assists in developing and refining policy options, and informs ministers who must agree to a change for it to proceed.

The NTC has undertaken a literature review on the two issues under consideration (see appendices A and B of this discussion paper). The literature review has not provided sufficient information to the NTC to develop a quality RIS.

In the absence of further robust information, the NTC will not undertake a RIS and, therefore, not propose any changes to the Standard.

1.4 What information is the NTC seeking?

The NTC invites submissions of evidence to underpin a RIS that will analyse whether or not there is a robust case to change the Standard.

Issue 1 – sleep disorders

The NTC is seeking evidence of:

- The risk untreated OSA poses to the rail network, RSWs and others
- The level of success in treating OSA for various treatments, once diagnosed, and the implications if treatments are unsuccessful
- The cost of treating OSA, for various treatments
- Correlation of OSA diagnoses with various clinical factors, whether currently considered in the Standard or other clinical factors
- The cost of OSA diagnosis
- The number of SCWs who are currently captured under various screening options (demonstrated sleepiness and clinical risk), including the number with a BMI exceeding 35 kg/m^2 with and without the relevant co-morbidities, and the rate of OSA diagnoses across the screening criteria
- The number of SCWs who would be captured under various alternative screening criteria, and

- Any alternative approaches to managing OSA across employees, such as proactive health programs (e.g. opt-in weight loss programs) run by rail transport operators or others.

Issue 2 – category 3 health assessments

The NTC is seeking evidence of:

- The nature of the risks faced by Category 3 ATTP, and how they differ from other RSWs
- A comparison of the risks faced by comparable workers (mining, road work, construction) and the equivalent medical assessments required in these industries
- The suitability or otherwise of self-reporting conditions that may pose a personal risk
- The costs of various tests that may be added to Category 3 ATTP medical assessments, and
- The current rate of incidents leading to reportable near-misses, injury or death for which a medical condition has been responsible, in whole or as a contributory factor.

1.5 Making a submission

The NTC is seeking advice from a clinical and practice perspective, and invites contributions from:

- Medical experts, including researchers and practitioners
- Rail transport operators and peak bodies
- Rail safety workers and associations (such as unions)
- Transport safety experts, and
- Anyone else able to provide informed advice.

The NTC will determine if it has enough evidence to develop a RIS in early March 2018. Accordingly, we seek submissions by **Friday 2 March 2018**. The NTC may be unable to consider later submissions.

Please note any data provided will be de-identified before publication.

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

Or, you can mail your comments to:

Att: Should Australia expand rail health assessments?
National Transport Commission
Level 3/600 Bourke Street
Melbourne VIC 3000

Your submission should provide robust evidence, such as data and documents, to support your views.

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

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

2 Obstructive Sleep Apnoea

2.1 What is obstructive sleep apnoea?

OSA is a health condition that involves repeated episodes of partial or complete obstruction of the throat during sleep, which may be associated with excessive daytime sleepiness, loud snoring, dry mouth, sore throat and morning headache. Under the current Standard, OSA is recognised as a risk in the rail environment.

2.2 How is obstructive sleep apnoea diagnosed?

Testing for OSA is likely to require a person to participate in overnight polysomnography (PSG) monitoring (a sleep study), a method of recording breathing, cardiovascular activity and brain wave changes during sleep. This test is both onerous and relatively expensive, compared to many other health assessments in the Standard, and is limited to safety critical workers (SCWs) likely to present a higher risk.

2.3 How are safety critical workers triggered for testing?

Current screening for SCWs is based on two distinct and independent assessments: demonstrated sleepiness and clinical risk factors.

A SCW might be tested for OSA at every periodic health assessment. That is to say the cost imposed by screening for OSA is potentially cumulative, not singular.

Demonstrated sleepiness

SCWs are assessed against a self-reported Epworth Sleepiness Scale (ESS) score, any history of self-reported sleepiness at work, and witnessed episodes of dozing off at work.

Under the Standard, if a given SCW is assessed as having demonstrated sleepiness, they will be categorised as 'Temporarily Unfit for Duty' pending a sleep study. Figure 3 shows the sleep disorder assessment and management process for SCWs (National Transport Commission, 2017, p. 144).

Clinical risk factors

SCWs are also screened for sleep disorder testing using clinical factors. PSG will be required for SCWs:

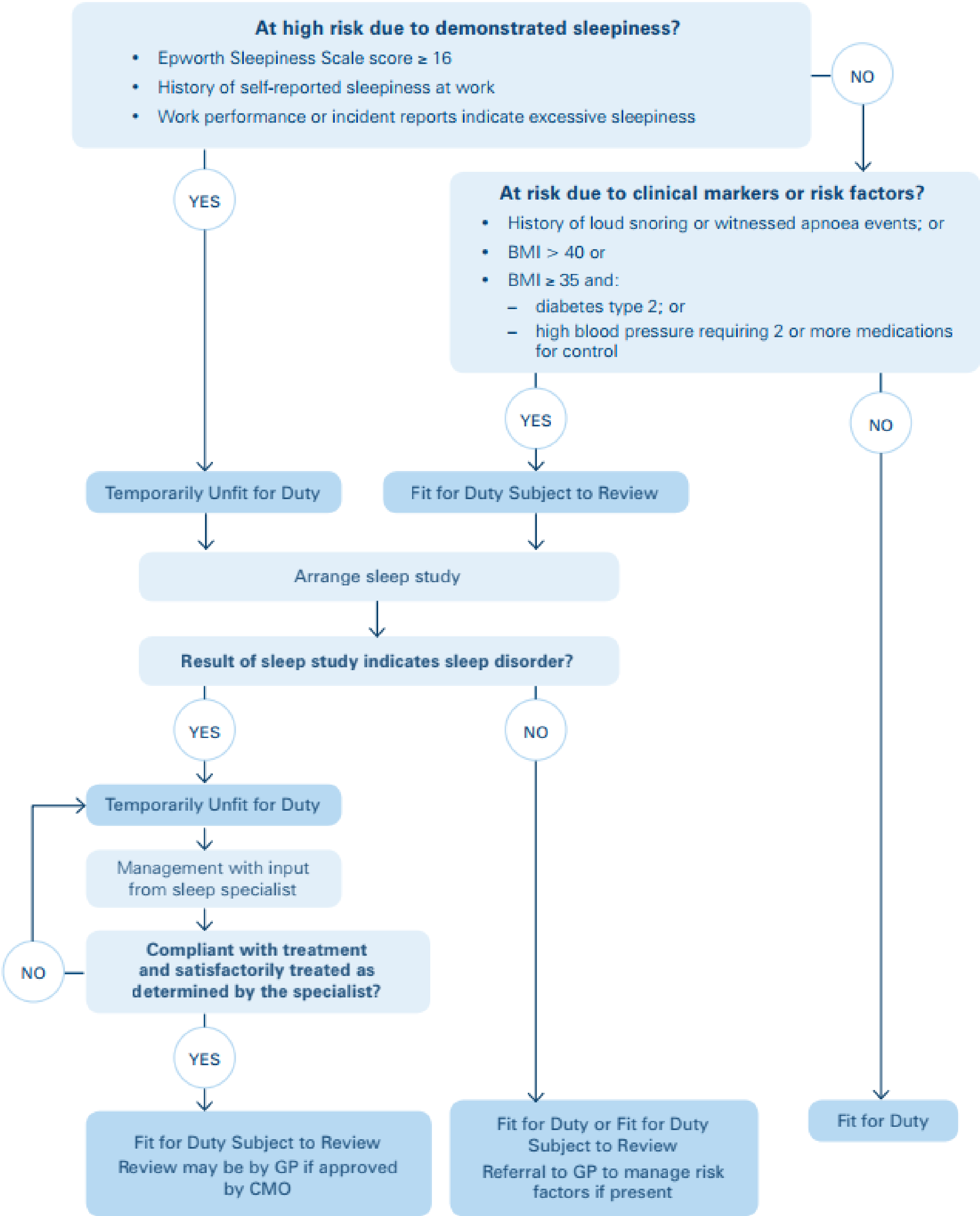
- with a history of loud snoring or witnessed apnoea events, or
- classified as morbidly obese (body mass index, BMI ≥ 40 kg/m^2), or
- classified as severely obese (BMI ≥ 35 kg/m^2), if also presenting with type 2 diabetes or hypertension.

If a SCW provides a 'No' response for demonstrated sleepiness and a 'Yes' response for any of the clinical factors, this categorises the SCW as 'Fit for Duty Subject to Review'. Figure 3 shows the sleep disorder assessment and management process for SCWs (National Transport Commission, 2017, p. 144).

Current screening criteria for demonstrated sleepiness and most clinical factors are inexpensive at the margins, with most diagnoses gathered as a matter of course during a Category 1 and 2 health assessment. Identifying a history of loud snoring or apnoea events, however, may not be possible if the SCW does not sleep with a partner.

See Appendix A for more details about OSA screening, testing and management in the rail environment.

Figure 3. Sleep disorder assessment and management for safety critical workers (Category 1 and 2)



2.4 What is the problem with the current sleep disorder criteria?

A number of stakeholders are of the view that the current trigger for testing RSWs for OSA based on BMI ≥ 35 kg/m^2 and co-morbidities such as type 2 diabetes and hypertension, is allowing many cases of OSA to go undetected, thus imposing an insufficiently managed risk to the rail network, RSWs and the community.

Some stakeholders have sought to amend the criteria to rely on BMI alone – specifically, to use severely obese (BMI ≥ 35 kg/m^2) as the sole clinical trigger for PSG testing (that is, without considering the presence or otherwise of type 2 diabetes or hypertension). There has not been a call to extend OSA testing beyond SCWs.

More testing will almost certainly capture more people who have OSA, delivering benefits in terms of reduced risk in rail operations, but will come at a cost of increased testing.

The challenge is to balance cost and benefit – testing as many SCWs as possible who have OSA, therefore diagnosing and treating it, and avoiding testing those who do not have it. It is clearly impossible to do this (a sleep study is used to diagnose OSA). The key is to build an effective risk screening option with costs commensurate to the risk averted.

2.5 What metrics can screen for obstructive sleep apnoea?

OSA is caused by oesophageal blockages starving the body of oxygen and interrupting sleep. It is dependent on both inherent body morphology and upper-body fat. BMI, though correlated to OSA, is not a perfect predictor.

Studies have shown that other useful screening options for clinical factors include: neck circumference, waist circumference, body fat percentage, age, gender, type 2 diabetes, hypertension and apnoea event/s. As with BMI, each screening option is imperfect at predicting OSA. It may be that one or more metric, in combination with each other and/or BMI, provides an optimised screening option. Table 2 outlines the NTC's understanding of the cost, verifiability and OSA correlation for a number of screening metrics.

Overseas environments with comparable rail workforces, such as the UK and Canada, rely on neck circumference for screening. Some research suggests that neck circumference is the best singular predictor of OSA, or at least better correlated than BMI.

See Appendix A for more details about OSA screening metrics in the rail environment.

Table 2. Cost, verifiability and OSA correlation of screening metrics

Clinical factor	Screening cost	Verifiability	OSA Correlation
BMI	Low	High	Medium-High
Neck circumference	Low	High	Medium -High
Waist circumference	Low	High	Medium-High
Body fat percentage	Medium-High	High	Medium-High
Age	Low	High	Low-Medium
Gender	Low	High	Low-Medium
Type 2 diabetes	Medium	Medium-High	Medium-High
Hypertension	Low	Medium-High	Medium-High
Apnoea event	Low	Low	Medium-High

2.6 Possible changes to the screening criteria for testing

The NTC is investigating whether to change the screening criteria for OSA testing and, if it is to be changed, what screening criteria would best balance safety improvements and costs.

There is no proposal to amend treatment, management or SCW fitness status classification in the event OSA is diagnosed. However, the implications of increasing the number of diagnoses must be considered.

If able to undertake a meaningful regulatory impact analysis, the NTC may consider options that include (but are not limited to):

- Retain the current screening criteria, and management and treatment regime
- Change the current screening criteria thresholds
- Change the current screening criteria to other clinical factors, and
- Consider the costs and benefits of proactive health management programs.

3 Category 3 around the track personnel

3.1 Who are category 3 around the track personnel?

Category 3 and Category 4 RSWs are non-safety critical workers (NSCWs), referred to as around the track personnel (ATTP). The primary concerns for these workers are personal safety, rather than the safety of the public or the rail network.

Workers who either do not access the track, or perform all of their duties in a 'controlled environment', are Category 4 and not subject to health assessments under the Standard.

Category 3 ATTP roles are conducted in whole or in part in an 'uncontrolled' environment, meaning they may be at risk from moving rolling stock. Category 3 ATTP are subject to a health assessment, though it is considerably less onerous than that for SCWs (Category 1 and 2).

3.2 Category 3 around the track personnel health assessments

Category 3 ATTP are subject to hearing, vision and musculoskeletal health assessments, based on the need to be able to see, hear and move themselves effectively to avoid an oncoming train or moving rolling stock.

See Appendix B for more details on the current health assessment requirements for category 3 ATTP.

3.3 Proposed changes to category 3 ATTP health assessments

During the most recent update of the Standard, some stakeholders sought to expand the health assessment criteria to include conditions that may affect the Category 3 ATTP's safety, such as the risk of a sudden collapse in an uncontrolled environment.

Subject to robust data to underpin development of a RIS, the NTC may consider options that include (but are not limited to):

- Retain the current regime
- Introduce alternative or additional criteria for Category 3 ATTP health assessments, and
- Consider alternative delineations between Category 2 and Category 3 RSWs, and between Category 3 and Category 4 RSWs.

4 Summary and next steps

4.1 Should Australia expand rail health assessments?

As outlined earlier, the purposes of this discussion paper are to:

- outline the current health assessment framework, the proposed changes and the chain of evidence the NTC needs if it is to make the case for changes, and
- call for that evidence from rail transport operators, rail infrastructure managers, rail safety workers and their representatives, medical experts and others.

A strong chain of evidence is required to develop a robust RIS. The NTC's literature review did not uncover sufficient evidence to allow us to develop a robust RIS.

If stakeholders do not provide sufficient evidence, the NTC will not develop a RIS and the current health assessments will be maintained in the Standard.

Issue 1 – sleep disorders

The NTC is seeking evidence of:

- The risk untreated OSA poses to the rail network, RSWs and others
- The level of success in treating OSA for various treatments, once diagnosed, and the implications if treatments are unsuccessful
- The cost of treating OSA, for various treatments
- Correlation of OSA diagnoses with various clinical factors, whether currently considered in the Standard or other clinical factors
- The cost of OSA diagnosis
- The number of SCWs who are currently captured under various screening options (demonstrated sleepiness and clinical risk), including the number with a BMI exceeding 35 kg/m^2 with and without the relevant co-morbidities, and the rate of OSA diagnoses across the screening criteria
- The number of SCWs who would be captured under various alternative screening criteria, and
- Any alternative approaches to managing OSA across employees, such as proactive health programs (e.g. opt-in weight loss programs) run by rail transport operators or others.

Issue 2 – category 3 health assessments

The NTC is seeking evidence of:

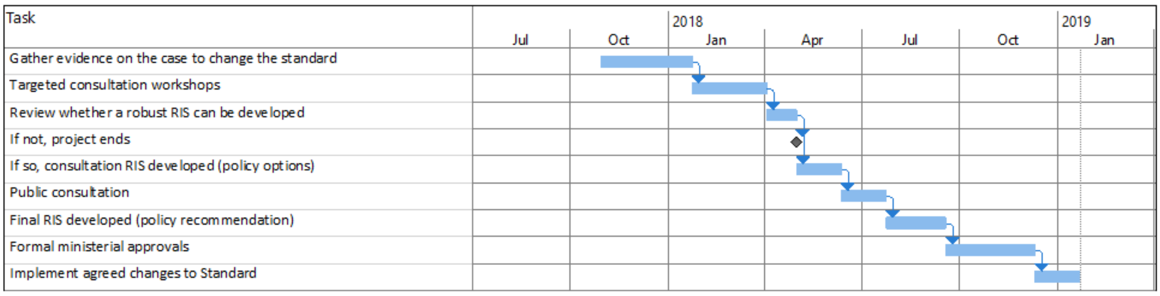
- The nature of the risks faced by Category 3 ATTP, and how they differ from other RSWs
- A comparison of the risks faced by comparable workers (mining, road work, construction) and the equivalent medical assessments required in these industries
- The suitability or otherwise of self-reporting conditions that may pose a personal risk
- The costs of various tests that may be added to Category 3 ATTP medical assessments, and

- The current rate of incidents leading to reportable near-misses, injury or death for which a medical condition has been responsible, in whole or as a contributory factor.

The NTC will determine whether or not it will develop a RIS in March 2018 and, accordingly, requires supporting evidence by **Friday 2 March 2018**.

4.2 What is the project timeframe?

The NTC will adopt the following project schedule to consider whether Australia should expand rail health assessments for OSA and Category 3 ATTP medical criteria.



Appendix A: Obstructive Sleep Apnoea

A.1 Current standard

Category 1 and Category 2 RSWs are required to undergo a health assessment for sleep disorders, such as OSA, if they meet the high-risk or clinical features in the Standard (National Transport Commission, 2017, pp. 142-150).

The medical criteria for SCW health assessment for sleep disorders (including OSA) are contained in Part 4, Section 18.6 of the Standard and apply to Category 1 and Category 2 Safety Critical Workers (see Table 3) (National Transport Commission, 2017, pp. 142-150).

Table 3. Medical criteria for sleep disorders

High-risk features	Clinical features
▪ Epworth Sleepiness Scale score ≥ 16; or ▪ History of self-reported sleepiness at work; or ▪ Work performance or incident reports indicate excessive sleepiness.	▪ History of loud snoring or witnessed apnoea events; or ▪ BMI ≥ 40; or ▪ BMI ≥ 35 and: - diabetes type 2; or - high blood pressure requiring 2 or more medications for control.

The clinical features medical criteria for sleep disorders based on BMI were introduced in the Standard in 2012. Previous identification of OSA relied on self-reporting of sleepiness alone under the Epworth Sleepiness Scale (ESS).

The Standard prescribes that RSWs with clinical features or high-risk features of OSA should have a sleep study, which may be arranged by an Authorised Health Professional (National Transport Commission, 2017, p. 147). They should be classed Fit for Duty Subject to Review or Temporarily Unfit for Duty until the disorder is investigated, treated effectively and fitness for duty status finally determined (National Transport Commission, 2017, p. 147).

A.2 Literature review

The NTC has reviewed a number of domestic and international academic sources on the topic of OSA. The following section provides an overview of OSA, examples of road and rail incidents caused by OSA and studies that discuss the prevalence of OSA in the road and rail environment.

A.2.1 Obstructive sleep apnoea: prevalence, diagnosis and treatment

OSA is a condition which includes the symptoms of wake time sleepiness, fatigue, loss of alertness, impaired performance and apnoeic and hypopnoeic episodes occurring during sleep (Rail Safety and Standards Board, 2006, p. 9). OSA is a condition in which the back of the throat can collapse during sleep, causing breathing to stop. When this happens the brain registers the reduced oxygen levels and activates itself to send a signal to the throat to clear itself. This sequence of events can repeat hundreds of times while a sufferer is asleep.

The risk factors for developing OSA include, but are not limited to: obesity, male gender, advancing age, family history of OSA, large neck circumference, craniofacial variations, nasal obstruction, diabetes, hypertension and other cardiovascular conditions (Firestone & Gander, 2010, p. 24; Olszewski & Wolf, 2013, p. 480).

Prevalence of OSA

OSA is becoming a major public health concern with its increasing prevalence and complications (Senaratna et al., 2016, p. 52). It is estimated that OSA is present in 9% of women and 24% of men (Howard & O'Donoghue, 2016, p. 2; National Transport Commission, 2017, p. 143). It is further estimated that the international prevalence among people aged 30-70 years is 26% for at least mild OSA and 10% for moderate-to-severe OSA (Cheng et al., 2017, p. 21). OSA is recognised as a major public health and economic burden, with an estimated cost to the Australian community of more than $5.1 billion a year in health care and indirect costs (Mansfield et al., 2013, p. 6).

In 2012, a study sought to measure the prevalence of clinical features that merit investigation of OSA. The study used clinical features including: STOP-Bang questionnaire, BMI ≥ 35 kg/m^2, age > 50 years, neck circumference > 40cm and male gender, to estimate the prevalence of clinical features that merit investigation of OSA in 3,007 adults in South Australia (Adams et al., 2012, p. 425). Based on the clinical features, 23.7% of the study population were classified as being at high risk of OSA (Adams et al., 2012, p. 424). The study did not however report the confirmed OSA diagnosis figures of the study population.

OSA, BMI and obesity

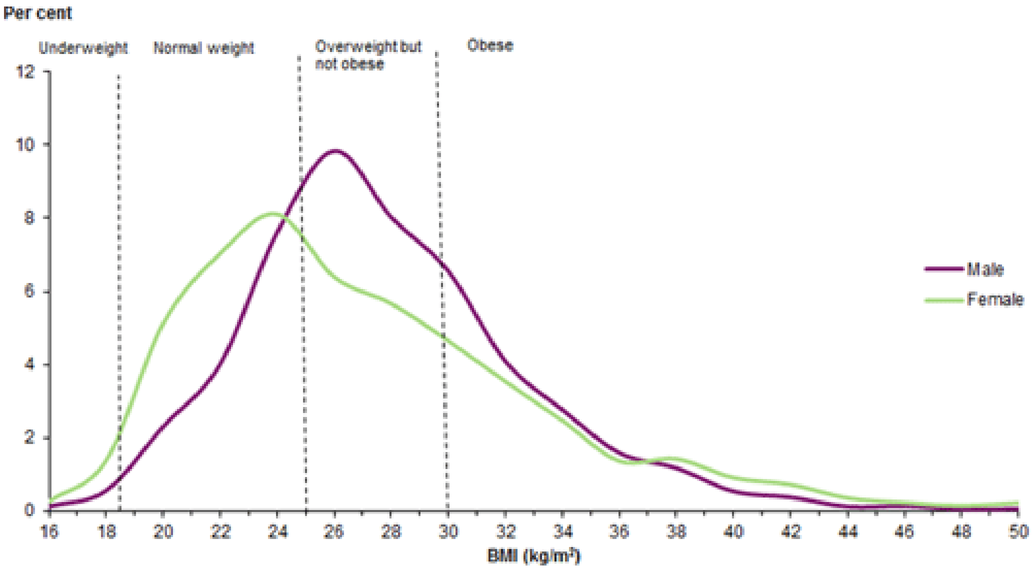
Studies suggest that obese people are more susceptible to OSA (O'Neil, 2010, p. 17). The World Health Organisation (2016) defines overweight as having a BMI ≥ 25 kg/m^2 and obese as having a BMI ≥ 30 kg/m^2. The prevalence of OSA in obese (BMI ≥ 30 kg/m^2) or severely obese (BMI ≥ 35 kg/m^2) patients is nearly twice that of normal-weight adults (BMI ≥ 18.5 kg/m^2 to 24.9 kg/m^2) (Romero-Corral & Lopez-Jimenez, 2010, p. 712). However, the relationship between OSA and obesity is complex. There is compelling evidence showing that OSA may itself cause weight gain as those suffering from OSA may experience reduced activity levels and/or an increased appetite (Romero-Corral & Lopez-Jimenez, 2010, p. 712).

Further complicating the relationship between OSA and obesity, recent research has revealed that non-obese individuals constitute at least 20% of the adult OSA population (Gray et al. 2017, p. 81). Studies suggest approximately 25% of adults with a BMI between 25 kg/m^2 and 28 kg/m^2 have at least mild OSA (Romero-Corral & Lopez-Jimenez, 2010, p. 712). Recent data from a community sample of more than 2,000 individuals aged 40-85 years in Switzerland found very high rates of moderate to severe OSA (23% in women and nearly 50% in men), despite the cohort having a mean BMI of 25.6 kg/m^2 (Gray et al. 2017, p. 85). In addition, data collected from 18 sleep centres across the US between 2004 and 2008 indicated that at least one in five patients who underwent a diagnostic sleep study for excessive daytime sleepiness with confirmed OSA had a BMI < 27 kg/m^2 (Gray et al. 2017, p. 85).

Notwithstanding the complex relationship between OSA and obesity, the consequences of OSA are likely to increase in light of the current trend of increasing obesity levels (Romero-Corral & Lopez-Jimenez, 2010, p. 711). In 2014, the World Health Organisation estimated that 39% of the world's adult population were overweight (BMI ≥ 25 kg/m^2) and 13% were obese (BMI ≥ 30 kg/m^2), indicating that the rates of obesity has more than doubled between 1980 and 2014 (World Health Organisation, 2016). It has been suggested that a 5 to 10% decrease in body weight in some obese individuals with OSA can lead to substantial clinical and objective improvements in sleep-disordered breathing (Veloro et al., 2008, p. 15).

In 2015, the National Health Survey was conducted by the Australian Bureau of Statistics across urban, rural and remote areas of Australia with 19,000 people (Australian Bureau of Statistics, 2015). The Australian Bureau of Statistics (2015) data suggests that in 2014-15, 63.4% of Australians aged 18 years and over were overweight or obese, 35% were of normal weight and 1.6% were underweight. The Australian Institute of Health and Welfare (2017) used the 2014-15 BMI survey data to develop Figure 4 below.

Figure 4. BMI values from 2014-15 National Health Survey



BMI aims to estimate whether a person has a healthy weight by dividing their total weight in kilograms by their height in metres squared (BMI = weight (kg) ÷ height (m)^2). The formula was devised in the 1830s and although it can be a useful tool to determine weight range, it does not distinguish between overall fat or lean tissue (muscle) content and can lead to healthy people being categorised as overweight due to their height and muscle (Nordqvist, 2017).

In 2013, Professor Nick Trefethen, a mathematician from Oxford University, questioned the usefulness of the current BMI formula and argued that it leads to confusion and misinformation, as the formula divides height and weight by too much when people are short and by too little when they are tall (Trefethen, 2013). He recommended a new BMI calculation which multiplies the weight by 1.3 and divides the weight by height to the power of 2.5 (BMI = [1.3 x weight (kg)] ÷ [height (m)$^{2.5}$]) (Trefethen, 2013). Professor Trefethen stated that if great reliance is going to be placed on a single formula for assessing obesity, the justification of the formula deserves careful discussion (Trefethen, 2013).

OSA and neck circumference

In 1990, a study was conducted with 66 people that found that the relationship between obesity, hyoid position, soft palate length and OSA were probably secondary to the variation of neck circumference (Davies & Stradling, 1990, p. 509). A similar study was undertaken in 1992 with 150 people that found neck circumference was more useful than general obesity as a predictor of OSA (Davies et al., 1992, p. 101). However, the study stated that neck circumference alone was not an adequate index for the diagnosis of OSA and formal sleep studies were still necessary (Davies et al., 1992, p. 104).

In 2008, a study evaluated the relationship between collar size and BMI in male patients suspected of having OSA. The study suggested that OSA is reported to be present in 30%

of patients with a neck circumference of 43cm in males or 38cm in females (Veloro et al., 2008, p. 15). The results of the study found that collar size may be an independent parameter for determining OSA (Veloro et al., 2008, p. 15). However, the paper recognised that other studies have not been able to demonstrate a correlation between increasing neck circumference and severity of OSA (Veloro et al., 2008, p. 15).

The Railway Association of Canada does not rely on BMI as a predictor of OSA. The Railway Association of Canada (2016, p. 173) considers medical history, history of reported snoring, history of frequent reported choking or gasping during sleep and/or witnesses apnoeas, systemic hypertension or history of hypertension and large neck circumference when screening employees for OSA. The Railway Association of Canada (2016, p. 174) calculates neck circumference by combining four clinical features, including:

- neck circumference in cm
- + 4cm if history of hypertension
- + 3cm if history of frequent reported snoring, and
- + 3cm if history of frequent reported choking, gasping and/or witnessed apnoeas.

Based on the total score the neck circumference the Railway Association of Canada predicts the probability of OSA as follows (2016, p. 174):

- < 44cm: low probability
- 44 – 48cm: intermediate probability, and
- > 48cm: high probability.

In 2014, the Rail Safety and Standards Board (2014) in the UK published ‘Guidance on Medical Fitness for Railway Safety Critical Workers’ and provided criteria and information to be taken into account when assessing fitness of affected workers. The content of the guide was peer-reviewed by the Association of Railway Industry Occupational Physicians and endorsed as representing current good practice (Rail Safety and Standards Board, 2014, p. 36). The Rail Safety and Standards Board do not rely on BMI as a predictor of OSA. The guidance material states that a history of disruptive snoring, witnessed apnoeas or history of frequent reported choking/gasping during sleep, history of hypertension and neck circumference greater than 40cm should be considered to predict the likelihood of OSA in safety critical workers (Rail Safety and Standards Board, 2014, p. 39).

The guidance document states that an adjusted neck circumference greater than 48cm, when considered in conjunction with the severity of symptoms, indicates a high probability of having a sleep study result that is diagnostic of OSA (Rail Safety and Standards Board, 2014, p. 39). Similar to the approach used by the Railway Association of Canada, the Rail Safety and Standards Board (2014, p. 39) calculates adjusted neck circumference by:

- neck circumference in cm
- + 4cm if hypertension
- + 3cm if reports of frequent snoring, and
- + 3cm if reports of frequent choking/gasping/apnoeas at night.

In addition to the above, the STOP-Bang (2014) questionnaire asks respondents whether their neck circumference is 43cm or larger (if male), or 41cm or larger (if female) to predict the probability of OSA. The STOP-Bang questionnaire relies on BMI as one of the factors to diagnose OSA and classifies patients with any three positive items from eight questions as having a risk of OSA.

OSA diagnosis

The Standard states that RSWs with clinical features or high-risk features of OSA should have a sleep study which may be arranged by an Authorised Health Professional (National Transport Commission, 2017, p. 147). OSA is diagnosed through PSG (a sleep study), a method of recording breathing, cardiovascular and brain wave changes during sleep (Pharmaceutical Society of Australia, 2015, p. 10). The PSG attracts a Medicare subsidy, however at home sleep tests only attract a Medicare rebate if the test is billed and reported by a sleep physician and there is a valid referral from a medical practitioner (Pharmaceutical Society of Australia, 2015, p. 10). The PSG measures the number of apnoeas and hypopnoeas experienced and produces an apnoea-hypopnoea index (AHI) (the combined average number of apnoeas and hypopnoeas that occur per hour of sleep) (Pharmaceutical Society of Australia, 2015, p. 6). The AHI is used to classify the severity of OSA into the following categories:

- Normal: less than 5 interruptions per hour
- Mild: 5 to 15 interruptions per hour
- Moderate: 15 to 30 interruptions per hour, and
- Severe: over 30 interruptions per hour.

The results of the test should be interpreted and reported on by a sleep physician who has established quality assurance procedures for the data acquisition (National Transport Commission, 2017, p. 147). RSWs with a positive result should be examined by the sleep specialist to confirm and explain the diagnosis, to explain treatment options and to explain the monitoring of compliance (National Transport Commission, 2017, p. 147).

OSA treatment

Based on the outcome of the testing, if there is a positive OSA diagnosis, a person may need to use one or a combination of the following to treat the condition: Continuous Positive Airway Pressure (CPAP) machine, oral appliances, weight loss, positional therapy and/or upper airway surgery (Carberry et al., 2017, p. 1).

CPAP remains the first-line and most effective treatment for OSA, as it acts as a pneumatic splint to directly increase pharyngeal cross sectional area and prevent collapse (Carberry et al., 2017, p. 4). This device consists of a mask that is worn over the nose and/or mouth and a pump to deliver a continuous supply of pressurized air (O'Neil, 2010, p. 23). CPAP Australia provides a 'rent to buy plan' for those diagnosed with OSA, with an initial payment of $180 and monthly payments of $60, to determine whether CPAP is effective before the individual purchases the machine. However, due to its perceived invasiveness, CPAP acceptance, tolerance and compliance are low (Carberry et al., 2017, p. 4). In the largest randomized trial of CPAP therapy, average nightly CPAP use was only 3.3 hours and this level of use did not have any cardiovascular benefit (Carberry et al., 2017, p. 4). The Standard prescribes that those treated with CPAP should use a CPAP machine with a usage meter to allow objective assessment and recording of treatment compliance (National Transport Commission, 2017, p. 147).

Oral appliances are used as an alternative to CPAP or as second-line therapy following CPAP failure. They are typically custom-fitted by a dentist and are designed to protrude the mandible (Carberry et al., 2017, p. 4). The Standard prescribes that those treated with oral appliances should only use splints with compliance detection devices (National Transport Commission, 2017, p. 147).

A.2.2 Obstructive sleep apnoea in the road environment

Road OSA accidents

Information about risk of accidents due to sleep disorders mainly comes from road crash data. Evidence suggests that road drivers with untreated OSA are six times more likely to be involved in road traffic accidents (Rail Safety and Standards Board, 2006, p. 11). Such accidents are more likely to be fatal as there is no attempt at braking or avoiding action if the driver is asleep (Rail Safety and Standards Board, 2006, p. 11).

Road OSA research

Research suggests that OSA is up to about ten times more prevalent among commercial drivers, compared to the general population (Williams et al., 2011, p. 13).

From 1996 to 1998 the University of Pennsylvania's Center for Sleep and Respiratory Neurobiology conducted a study to determine whether a relationship existed between OSA and commercial motor vehicle drivers (O'Neil, 2010, p. 13). The study diagnosed 35.9% of participants with OSA (O'Neil, 2010, p. 17). Of these participants, 30.7% were categorised as obese and 40.1% were categorised as excessively obese (O'Neil, 2010, p. 17). The average BMI for participants diagnosed with OSA was 34.2 kg/m^2, compared to an average BMI of 29.1 kg/m^2 for the participants without OSA (O'Neil, 2010, p. 17).

In 2006, the Joint Task Force of the American College of Chest Physicians, American College of Occupational Health and Environmental Medicine and National Sleep Foundation announced that "all those wishing to drive a commercial motor vehicle and are suspected of having OSA should be assessed by a sleep physician and have any diagnosis confirmed" (Williams et al., 2011, p. 35). The recommendations defined an individual who is suspected of having OSA as meeting one or more of the following criteria:

- A sleep history suggestive of OSA (snoring, excessive daytime sleepiness, witnessed apnoeas)
- Two or more of the following:
  - BMI ≥ 35 kg/m^2
  - Neck circumference ≥ 17 inches in men or 16 inches in women
  - Hypertension
- ESS score > 10
- Previous diagnosis of OSA and no information on compliance with treatment
- AHI > 5 but < 30 in a prior sleep study or
- polysomnogram and no excessive daytime somnolence (ESS < 11), no motor vehicle accidents, no hypertension requiring 2 or more agents to control.

The Joint Task Force's recommendations and OSA criteria have not been formally adopted in the US.

In 2010, a study in New Zealand examined the attitudes and prevalence of OSA in taxi drivers (Firestone & Gander, 2010, p. 24). The study found that drivers were generally unaware that a symptom such as sleepiness could be an indicator of an underlying medical problem (Firestone & Gander, 2010, p. 27). Some drivers blamed the sedentary nature of the job as the reason for experiencing daytime sleepiness and described actively concealing any health problems that may impact on them being assessed as medically unfit to drive (Firestone & Gander, 2010, p. 27). The study concluded that drivers need education about the effects of insufficient sleep and OSA on driving skills and safety (Firestone & Gander, 2010, p. 31).

In 2013, data was collected from 25 truck stops on major trucking routes in NSW and WA with 517 drivers (Elkington & Stevenson, 2013). The study found 41% of the sample had moderate to severe OSA (Elkington & Stevenson, 2013, p. 5). While 45% of the long distance heavy vehicle drivers were found to have OSA, only 4% had previously been diagnosed with the condition (Elkington & Stevenson, 2013, p. 5).

In 2016, following a number of road and rail accidents in the US the Federal Motor Carrier Safety Administration and Federal Railroad Administration announced a proposal to require bus drivers, truck drivers and rail workers to be tested for OSA (Halsey, 2016). The agencies opened a 90-day comment period that included public fact-gathering sessions in Washington, Chicago and Los Angeles (Halsey, 2016). However, in August 2017 the Federal Motor Carrier Safety Administration and Federal Railroad Administration announced they had withdrawn their proposal and placed the onus on individual companies to decide how and when to test their employees for OSA (Chappell, 2017).

A.2.3 Obstructive sleep apnoea in the rail environment

Rail OSA accidents – United States

OSA is known to cause excessive daytime sleepiness which can lead to impaired performance. OSA has been linked to a number of rail accidents in the US, including the four incidents summarised below.

In 2003, two trains collided near Kelso, Washington injuring two drivers. The US National Transportation Safety Board (NTSB) determined the probable cause to be neglect of the crew members to act on wayside signal information as they were asleep. The engineer had been diagnosed with moderate to severe OSA two years before the accident and was using CPAP to treat the condition (National Transportation Safety Board, 2003, p. 5). However, the device was never properly adjusted to establish a therapeutic air pressure level and was ineffective in treating the condition (National Transportation Safety Board, 2003, p. 5). The NTSB found that as the engineer's sleep disorder was not being effectively treated this would have caused a long-term sleep debt to accumulate (National Transportation Safety Board, 2003, p. 5). The NTSB described the engineer as significantly obese (National Transportation Safety Board, 2003, p. 5). It is likely that the engineer would have been tested for OSA in Australia under the current medical criteria in the Standard and would have been required to report on compliance and effectiveness of CPAP treatment. Based on this fact, it is unlikely that this incident would have occurred in the Australian rail environment.

In 2008, two trains collided in Newton, Massachusetts killing one driver and injuring eight people (National Transportation Safety Board, 2009, p. 4). The NTSB found that the operator of the striking train was at high risk of having undiagnosed OSA and experienced an episode of micro-sleep at the time of the incident (National Transportation Safety Board, 2009, p. 4). As a result of the investigation, the NTSB issued a safety recommendation to all US rail transit agencies to ensure they screened all drivers for OSA (National Transportation Safety Board, 2009, p. 4). The NTSB reported that the engineer had a BMI of 38.6 kg/m^2 (National Transportation Safety Board, 2009, p. 26). It is not known whether the engineer had diabetes or hypertension. If the engineer did have diabetes and/or hypertension, based on the BMI and co-morbidities the engineer would have been tested for OSA in Australia under the current medical criteria in the Standard. If the engineer did not have diabetes and/or hypertension the engineer would not have been tested for OSA under the current medical criteria in the Standard. Further information is required to determine the likelihood of this incident occurring in the Australian rail environment.

In 2013, a commuter train derailed as it approached Spuyten Duyvil Station in New York City killing four passengers and injuring 61 passengers. The train was travelling at 82 mph when it derailed in a section of curved track where the maximum authorised speed was 30 mph. Following the incident, the engineer underwent a sleep study and was diagnosed with severe OSA (Federal Register Notices, 2016, p. 87650). The NTSB reported that the engineer had a BMI of 36.4 kg/m^2 (National Transportation Safety Board, 2013, p. 3). It is not known whether the engineer had diabetes or hypertension. If the engineer did have diabetes and/or hypertension, based on the BMI and co-morbidities the engineer would have been tested for OSA in Australia under the current medical criteria in the Standard. If the engineer did not have diabetes and/or hypertension the engineer would not have been tested for OSA under the current medical criteria in the Standard. Further information is required to determine the likelihood of this incident occurring in the Australian rail environment. After the incident Metro-North examined 320 engineers and found that approximately 18% had OSA (Halsey, 2016).

In 2016, a commuter train crashed at Hoboken Terminal in New Jersey killing one person and injuring 114 passengers. The NTSB found that 38 seconds prior to the crash, the train's engineer accelerated from 8 mph and was travelling at 21 mph on impact. Following the incident, the engineer was diagnosed with severe OSA (Federal Register Notices, 2016, p. 87651). It is not known whether the engineer had diabetes or hypertension or a high BMI. Further information is required to determine the likelihood of this incident occurring in the Australian rail environment. After the incident, New Jersey Transit examined 190 of its 397 engineers for OSA, with 18 testing positive for OSA (Grayce West, 2017). New Jersey Transit also screened 168 of its 1,051 conductors for OSA, with 23 testing positive for OSA (Grayce West, 2017).

Rail accidents – Australia

Although not directly linked to OSA in the rail environment, between 2012 and 2016, the Office of the National Rail Safety Regulator (ONRSR) (2016, p. 42) reported ten passenger fatalities, two workforce fatalities and 19 public fatalities (note: these figures do not include suspected suicide). Between 2013 and 2016, the ONRSR (2016, p. 14) reported that the rate of fatalities involving passengers, workforce, public and trespass per million kilometres travelled by a train was 0.103 in Australia (excluding Queensland), 0.073 in Great Britain and 0.766 in the US.

The ONRSR (2016, p. 13) reported that a workforce fatality occurred in New South Wales in 2013-14 as a result of a network controller suffering a fatal heart attack while on duty. It is not known whether the network controller had any conditions which increased the chances of a heart attack, or whether any medical conditions had been disclosed to the rail transport operator at commencement or at a periodic review.

The ONRSR (2016, p. 13) reported that a workforce fatality occurred in Clyde, New South Wales in 2016 as a result of a signal maintainer being struck and fatally injured by a passing passenger train. It is not known whether the signal maintainer was suffering from any medical conditions (including OSA). The Australian Transport Safety Bureau (ATSB) is continuing the investigation of the fatality, with the final report expected to be released in October 2017 (Australian Transport Safety Bureau, 2016).

The ATSB (2017a) reported that a workforce fatality occurred at Petrie Station, Queensland in 2017 as a result of a protection officer being struck and fatally injured by a passenger train while he was implementing protection for a track closure on the Moreton Bay rail corridor. The ATSB is continuing the investigation of the fatality, with the final report expected to be released in May 2018.

The NTC reviewed 206 rail safety investigation reports conducted by the ATSB (2017b) between 1998 and 2017 and was unable to find any examples of accidents known to be caused by OSA in the Australian rail industry.

Rail OSA research

Following the introduction of the Standard in 2004, a study was conducted in New South Wales with 743 RailCorp drivers and 283 driver recruits (Mina & Casolin, 2007). The study found the prevalence of obesity in the study population was higher than the average population, with an average BMI of 29 kg/m^2 for drivers and 28 kg/m^2 for recruits (Mina & Casolin, 2007, p. 395). However, the prevalence of OSA was lower than expected given the high rates of hypertension and obesity (Mina & Casolin, 2007, pp. 395-396).

In 2006, the Rail Safety and Standards Board investigated the prevalence of OSA in the rail industry in the UK with 499 train drivers (Rail Safety and Standards Board, 2006). The study found the prevalence of OSA in the rail sector was 7.3%, which was greater than the prevalence in the general population (Rail Safety and Standards Board, 2006, p. 29).

In 2012, the RailCorp study was repeated with train drivers to determine whether there had been a change in the prevalence of health conditions five years after the introduction of the Standard (Mina & Casolin, 2012). The study found there was an increase in the prevalence of overweight/obesity from 80% in 2004/05 to 85% in 2009/10, with 21% of recruits and 15% of drivers having a BMI ≥ 35 kg/m^2 (Mina & Casolin, 2012, p. 644). However, the study found significant decreases in the prevalence of hypertension, high cholesterol and smoking in drivers between 2004/05 and 2009/10 (Mina & Casolin, 2012, p. 646). The rates of OSA were below those expected and it was suggested this may be a result of under-reporting of the condition and under-diagnosis in the community (Mina & Casolin, 2012, p. 646).

In 2015, a study was conducted to assess the potential change in the prevalence of OSA as a consequence of the introduction of clinical risk factors in the Standard (Colquhoun & Casolin, 2015). The study found that the prevalence of OSA increased from 2% to 7% following the introduction of the new Standard (Colquhoun & Casolin, 2015, p. 65). The study showed that the use of objective clinical risk factors to identify RSWs with potential OSA was more effective than using the ESS alone (Colquhoun & Casolin, 2015, p. 67). The study found self-reported sleepiness and the frequency of self-reported symptoms of OSA were significantly lower than expected based on similar populations (Howard & O'Donoghue, 2016, p. 2).

While there is evidence available from other industries, such as commercial vehicle drivers, to show that people with untreated OSA have a greater risk of involvement in accidents, there is little comparable data available for the Australian rail industry. The NTC was unable to locate additional or more recent literature on the topic of OSA in the rail environment outside of New South Wales and the UK.

A.2.4 Measuring the costs and benefits of potential changes

Where a safety measure is proposed to reduce the risk of death, there will always be a question of whether it is worthwhile, whether on economic grounds or some other. If a RIS is to be developed it will include a cost benefit analysis to determine which option delivers the optimal safety benefits for an appropriate cost.

The value of statistical life is often used to estimate the benefits of reducing the risk of death. The value of statistical life is an estimate of the financial value society places on reducing the average number of deaths by one (Office of Best Practice Regulation, 2014). A related concept is the value of statistical life year, which estimates the value society places on reducing the risk of premature death, expressed in terms of saving a statistical life year (Office of Best Practice Regulation, 2014). The value of statistical life is most appropriately measured by estimating how much society is willing to pay to reduce the risk of death for an unknown person (Office of Best Practice Regulation, 2014).

Between 2012 and 2017, the ONRSR (2016, p. 42) and the ATSB (2017a) reported three workforce fatalities in the Australian rail environment. In addition to the three fatalities, the ATSB reported 4,232 safety critical events involving signals passed at danger between 2002 and 2012 (Australian Transport Safety Bureau, 2012, p. 26). Signals passed at danger include a driver misjudging or completely missing a signal or starting against a signal. Due to the large number of signals passed at danger, it is difficult to determine how many, if any, were linked to diagnosed or undiagnosed OSA.

Based on international and Australian research, the Office of Best Practice Regulation (OBPR) recommends that departments and agencies use the estimate of $3.5 million for the value of statistical life and $151,000 for the value of statistical life year (both of these are measured in 2007 dollars) (Office of Best Practice Regulation, 2014, p. 2). In 2017 dollars this amounts to $4.3 million for the value of statistical life and $187,000 for the value of statistical life year (Reserve Bank of Australia, 2017). These estimates represent an average and are based on a healthy person living for another 40 years (Office of Best Practice Regulation, 2014, p. 2).

In contrast to the amount outlined above by the OBPR, the Bureau of Infrastructure, Transport and Regional Economics (BITRE) estimate the human losses for road crashes to be $2.4 million per fatality, $214,000 per hospitalised injury and $2,100 per non-hospitalised injury (Risbey et al., 2010, p. 1). The BITRE use a modified human capital costing approach to estimate human related costs (fatalities and injuries), property damage and general costs for valuing the fatality and injury components of road crashes (Risbey et al., 2010, p. 3).

In 2003, the then Bureau of Transport and Regional Economics (BTRE) (2003, p. 12) estimated the cost of a rail fatality in 1999 to be around $1.9 million, a serious injury about $27,000 and a minor injury about $2,000, including human costs but excluding property and other costs. In 2017 dollars, this amounts to $3 million for a rail fatality, $43,000 for a serious injury and $3,000 for a minor injury (Reserve Bank of Australia, 2017). To calculate this amount the BTRE (2003) considered:

- human costs (value of productivity losses, medical costs, quality of life)
- property loss costs
- delay costs
- environmental and recovery costs
- investigation costs
- emergency services costs
- coronial costs, and
- insurance administration and legal costs.

Appendix B: Category 3 Around The Track Personnel

B.1 Current standard

Category 3 ATTP perform non-safety critical work on or near the track in an uncontrolled environment (National Transport Commission, 2017, p. 184). Their health and fitness may impact on their ability to protect their own safety and that of fellow workers around moving rolling stock.

Category 3 ATTP require health assessments to ensure their own safety while working around the network. The Category 3 ATTP health assessment focuses on medical conditions that could impact on a worker's ability to detect and react quickly to an oncoming train or warnings. The assessment comprises eyesight and hearing tests, and an assessment to ensure safe mobility around the track, as well as a questionnaire to help identify any other serious conditions that could affect safety around the track.

Testing of Category 3 ATTP occurs at the time of commencement and then every five years from the age of 40 (National Transport Commission, 2017, p. 35). Category 3 ATTP who have had a full health assessment less than five years before turning 40 (e.g. for pre-employment) may have their next periodic assessment scheduled 5 years from that date (National Transport Commission, 2017, p. 35).

The medical criteria for Category 3 ATTP are contained in Part 5 of the Standard (see Table 4) (National Transport Commission, 2017, pp. 184-188).

Table 4. Medical criteria for category 3 around the track personnel

Hearing	Compliance with the Standard should be initially assessed by audiometry without hearing aids. A person is not Fit for Duty Unconditional: ▪ if hearing loss is ≥ 40 dB averaged over 0.5, 1 and 2 KHz in the better ear without hearing aids Fit for Duty conditional on wearing hearing aids may be recommended if the standard is met with hearing aids. If a rail safety worker requires hearing aids, the aids should: ▪ suppress feedback ▪ be noise limited to 80 dB ▪ have no noise-cancellation feature ▪ have no directional microphones. Fit for Duty Subject to Job Modification may be considered; for example, if the worker is to be escorted at all times when around the track.
Visual acuity	A person is not Fit for Duty Unconditional: ▪ if the person's best corrected visual acuity is worse than 6/12 in the better eye. Fit for Duty conditional on wearing corrective lenses may be determined if the standard is met with spectacles or contact lenses. Fit for Duty Subject to Review may be determined if the person meets the

	standard but has a condition that may result in their vision deteriorating before the next routine review date.
Visual fields	A person is not Fit for Duty Unconditional: ▪ if their binocular visual field (or the visual field in the remaining eye in the case of monocular vision) does not have a horizontal extent of at least 110° within 10° above and below the horizontal midline; or ▪ if there is any significant visual field loss (scotoma within a central radius of 20° of the foveal fixation or hemianopia). Fit for Duty Subject to Review may be determined if the visual field standard is met and provided that the visual field loss is unlikely to progress rapidly. Fit for Duty Subject to Job Modification may be considered; for example, if the worker is to be escorted at all times when around the track.
Musculoskeletal function	A person is not Fit for Duty Unconditional: ▪ if pain, weakness, instability or other impairment from a musculoskeletal or medical condition results in interference with the ability to walk on coarse ballast and/or move rapidly from the path of an oncoming train. Fit for Duty Subject to Review may be determined, taking into consideration the opinion of the treating doctor and the nature of the work if the condition is adequately treated and function is restored. Fitness for Duty Subject to Job Modification may be considered, for example, if the person is to be accompanied at all times when around the track.

B.2 Literature review

The following section provides examples of Category 3 ATTP roles and explains the medical assessment process used in *Assessing Fitness to Drive*.

B.2.1 Examples of category 3 ATTP roles

The Standard provides guidance to rail transport operators as to how to differentiate between Category 3 and 4 ATTP (National Transport Commission, 2017, p. 43). However, the decision ultimately rests with the rail transport operator and as a result there are various positions deemed to be Category 3.

The NTC has found the categorisation for Queensland Rail and Railtrain Category 3 roles. The following section identifies the types of roles considered to be Category 3 and summarises the responsibilities and qualifications required.

Based on information contained in position descriptions, Queensland Rail requires the following positions to undergo a Category 3 ATTP medical assessment (Queensland Rail, 2017):

- **Authorised Officer:** An Authorised Officer is responsible for providing services which facilitate an environment where passengers and members of the public can access and use Queensland Rail services in a safe and secure environment, through the use of appropriate conflict resolution skills and specific powers to manage inappropriate, anti-social and potentially criminal behaviour. In addition to the Category 3 medical assessment, an Authorised Officer is required to qualify as a Rail Corridor Protection Officer and possess an Australian Open Driver Licence.

- **Facilities Maintainer:** A Facilities Maintainer is responsible for working as a member of a team in the installation, maintenance, repair and construction of Queensland Rail Facilities. In addition to the Category 3 medical assessment, a Facilities Maintainer is required to qualify as a Protection Officer 1 and 2 and possess an Australian Medium Rigid Licence.
- **Senior Scheduling Officer:** A Senior Scheduling Officer is responsible for developing detailed maintenance and project plans to be delivered during the execution of isolations and closures. In addition to the Category 3 medical assessment, a Senior Scheduling Officer is required to qualify as a Protection Officer 1 and 2 and complete the Safely Access the Rail Corridor course.
- **Signal Electrician:** A Senior Electrician is responsible for carrying out the installation, maintenance and repair of all signalling equipment and report on the performance and condition of the signalling asset to ensure it's safe and effective operation. In addition to the Category 3 medical assessment, a Senior Electrician is required to qualify as a Protection Officer 1 and 2, complete the Safely Access the Rail Corridor course and possess an Australian Class C Driver Licence.
- **Signalling Project Coordinator:** A Signalling Project Coordinator is responsible for coordinating a team of signalling projects to ensure the delivery of project outcomes in a timely cost effective manner. In addition to the Category 3 medical assessment, a Signalling Project Coordinator is required to complete the Safely Access the Rail Corridor course.
- **Survey Assistant:** A Survey Assistant is responsible for carrying out accurate measuring, data recording and ground marking duties under the direction of the Senior Surveyor/Engineering Surveyor. In addition to the Category 3 medical assessment, a Survey Assistant is required to qualify as a Protection Officer 1 and 2, complete the Safely Access the Rail Corridor course and possess an Australian Class C Driver Licence.

Based on information contained on Railtrain's website, Railtrain requires the following positions to undergo a Category 3 ATTP medical assessment (Railtrain, 2017):

- **Rail Maintenance and Construction Labourer:** Rail Maintenance and Construction Labourers are responsible for carrying out rail maintenance and construction requirements, including installing railway sleepers and rail fastening systems. In addition to the Category 3 medical assessment, Rail Maintenance and Construction Labourers are required to possess an Australian Class C or HR Driver Licence.
- **Track Machine Operators:** A Track Machine Operator is responsible for operating production/switch tamper and ballast regulator track machines and maintaining track machines. In addition to the Category 3 medical assessment, a Track Machine Operator is required to have Track Machine Operator qualifications and possess an Australian Class MR or HR Driver Licence.
- **Rail Welders:** A Rail Welder is responsible for coordinating works and planning consumable for welding projects in track construction and maintenance.

Appendix C: References

Adams, R.J, Piantadosi, C, Appleton, S.L, Hill, C.L, Visvanathan, R. Wilson, D.H & McEvoy, R.D 2012, *Investigating obstructive sleep apnoea: will the health system have the capacity to cope? A population study,* Australian Health Review, vol. 36, pp. 424-429.

Australian Bureau of Statistics 2015, *National Health Survey: First Results 2014–15*, ABS cat, no. 4364.0.55.001, Canberra, <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4364.0.55.001~2014-15~Main%20Features~Overweight%20and%20obesity~22>.

Australian Institute of Health and Welfare 2017, *Risk factors to health*, <https://www.aihw.gov.au/reports/biomedical-risk-factors/risk-factors-to-health/contents/overweight-and-obesity/who-is-overweight>.

Australian Transport Safety Bureau 2012, *Australian Rail Safety Occurrence Data*, <https://www.atsb.gov.au/media/4042317/rr2012010_final.pdf>.

Australian Transport Safety Bureau 2016, *Track Worker Fatality at Clyde, NSW on 18 June 2016*, <https://www.atsb.gov.au/publications/investigation_reports/2016/rair/ro-2016-008/>.

Australian Transport Safety Bureau 2017a, *Collision between track worker and passenger train at Petrie, Queensland*, <https://www.atsb.gov.au/media/5773474/ro-2017-003_prelim.pdf>.

Australian Transport Safety Bureau 2017b, *Rail safety investigations & reports*, <https://www.atsb.gov.au/publications/safety-investigation-reports/?mode=Rail>.

Austroads 2016, *Assessing Fitness to Drive*, <http://www.austroads.com.au/drivers-vehicles/assessing-fitness-to-drive>.

Bureau of Transport and Regional Economics 2003, *Rail accident costs in Australia,* <https://bitre.gov.au/publications/2003/files/report_108.pdf>.

Carberry, J.C, Amatoury, J & Eckert, D.J 2017, *Personalized Management Approach for Obstructive Sleep Apnea*, *CHEST*, article in press.

Chappell, B 2017, *Regulators pull plan to test truckers, train operators for sleep apnea*, *The two-way breaking news from NPR*, 8 August 2017, <http://www.npr.org/sections/thetwo-way/2017/08/08/542230369/regulators-pull-plan-to-test-truckers-train-operators-for-apnea>.

Cheng, S, Stark, C.D & Stark, R.J 2017, *Sleep apnoea and the neurologist,* Practical Neurology, vol. 17, pp. 21-27.

Colquhoun, C & Casolin, A 2015, *Impact of rail medical standard on obstructive sleep apnoea prevalence*, Occupational Medicine, vol. 66, pp. 62-68, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4700301/>.

Davies, R.J & Stradling, J.R 1990, *The relationship between neck circumference, radiographic pharyngeal anatomy, and the obstructive sleep apnoea syndrome*, European Respiratory Journal, vol. 3, pp. 509-514, <http://erj.ersjournals.com/content/erj/3/5/509.full.pdf>.

Davies, R.J, Nabeel, A.J & Stradling, J.R 1992, *Neck circumference and other clinical features in the diagnosis of the obstructive sleep apnoea syndrome*, Thorax, vol. 47, pp. 101-105, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC463582/pdf/thorax00362-0033.pdf>.

Elkington, J & Stevenson, M 2013, *The Heavy Vehicle Study – Final Report*, <http://c-marc.curtin.edu.au/local/docs/CMARC_HeavyVehicleStudy.pdf>.

Federal Register Notices 2016, *Safety Advisory*, vol. 81, no. 233, <https://www.apta.com/gap/fedreg/Documents/Safety%20Advisory%202016%E2%80%9303.pdf>.

Firestone, R & Gander, P 2010, *Exploring knowledge and attitudes of taxi drivers with regard to obstructive sleep apnoea syndrome*, The New Zealand Medical Journal, vol. 123, no. 1321, pp. 24-33, <https://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2010/vol-123-no-1321/article-firestone>.

Gray, E.L, McKenzie, D.K & Eckert, D.J 2017, *Obstructive Sleep Apnea without Obesity Is Common and Difficult to Treat: Evidence for a Distinct Pathophysiological Phenotype,* Journal of Clinical Sleep Medicine, vol. 13, pp. 81-88.

Grayce West, M 2017, *NJ Transit Tests Only Some Staff for Sleep Apnea*, Wall Street Journal, 13 April 2017.

Halsey, A 2016, *U.S. proposes sleep apnea testing to make roads and rail safer*, The Washington Post, 9 March 2016.

Howard, M & O'Donoghue, F 2016, *The hidden burden of OSA in Safety Critical Workers: how should we deal with it?,* Occupational Medicine, vol. 66, no. 1, pp. 2-4.

Mansfield, D.R, Antic, N.A & McEvoy, R.D 2013, *How to assess, diagnose, refer and treat adult obstructive sleep apnoea: a commentary on the choices*, Medical Journal of Australia, vol. 199, no. 8, pp. 21-26.

Mina, R & Casolin, A 2007, *National standard for health assessment of rail safety workers: the first year*, Medical Journal Australia, vol. 187, no. 7, pp. 394-397, <https://www.mja.com.au/journal/2007/187/7/national-standard-health-assessment-rail-safety-workers-first-year>.

Mina, R & Casolin, A 2012, *The Australian National Standard for rail workers five years on*, Occupational Medicine, vol. 62, pp. 642-647, <https://academic.oup.com/occmed/article/62/8/642/1441603/The-Australian-National-Standard-for-rail-workers>.

National Transport Commission 2016, *Review of the National Standard for Health Assessment of Rail Safety Workers*, <http://www.ntc.gov.au/Media/Reports/(88197E2C-1833-4630-96D0-AE09DB852E16).pdf>.

National Transport Commission 2017, *National Standard for Health Assessment of Rail Safety Workers*, <https://www.ntc.gov.au/Media/Reports/(7B079897-1863-CA93-474F-AD96AD9C6C3F).pdf>.

National Transportation Safety Board 2003, *Railroad Accident Brief*, <https://www.ntsb.gov/investigations/AccidentReports/Reports/RAB0503.pdf>.

National Transportation Safety Board 2009, *Railroad Accident Report*, <https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR0902.pdf>.

National Transportation Safety Board 2013, *Railroad Accident Report* <https://www.ntsb.gov/investigations/AccidentReports/Reports/RAB1412.pdf>.

Nordqvist, C 2017, *Body mass index (BMI): Is the formula flawed?*, Medical News Today, 16 August 2017, <https://www.medicalnewstoday.com/articles/255712.php>.

Office of Best Practice Regulation 2014, *Best Practice Regulation Guidance Note Value of statistical life*,

<https://www.pmc.gov.au/sites/default/files/publications/Value_of_Statistical_Life_guidance_note.pdf>.

Office of the National Rail Safety Regulator 2016, *Rail Safety Report 2015-2016*, <https://www.onrsr.com.au/__data/assets/pdf_file/0017/18800/Rail-Safety-Report-2015-2016-Web-Digital.pdf>.

Olszewski, K & Wolf, D 2013, *Obstructive sleep apnea among commercial vehicle drivers*, Workplace Health and Safety Journal, vol. 61, no. 11, pp. 479-484, <http://journals.sagepub.com/doi/pdf/10.1177/216507991306101104>.

O'Neil, J 2010, *The relationships between obesity, obstructive sleep apnea and commercial motor vehicle operator performance*, Department of Civil Engineering Rochester Institute of Technology, pp. 1-107, <http://scholarworks.rit.edu/cgi/viewcontent.cgi?article=1702&context=theses>.

Pharmaceutical Society of Australia 2015, *Practice guidelines for the provision of sleep apnoea services within pharmacy*, <https://www.psa.org.au/download/sleep-apnoea-practice-guidelines.pdf>.

Queensland Rail 2017, *Career opportunities*, <http://careers.pageuppeople.com/544/caw/en/listing/>.

Railtrain 2017, *Employment*, <http://www.railtrain.com.au/employment/>.

Rail Safety and Standards Board 2006, *Obstructive Sleep Apnoea Syndrome in Train Drivers*, <https://www.rssb.co.uk/pb009483>.

Rail Safety and Standards Board 2014, *Guidance on Medical Fitness for Railway Safety Critical Workers*, <https://www.rssb.co.uk/rgs/standards/GOGN3655%20Iss%202.pdf>.

Railway Association of Canada 2016, *Canadian Railway Medical Rules Handbook*, <https://www.railcan.ca/wp-content/uploads/2016/10/Canadian_Railway_Medical_Rules_Handbook_EN.pdf>.

Reserve Bank of Australia 2017, *Inflation Calculator,* <https://www.rba.gov.au/calculator/annualDecimal.html>.

Risbey, T, Cregan, M & De Silva, H 2010, *Social cost of road crashes,* <https://bitre.gov.au/publications/2010/files/sp_003_Risbey_Cregan_deSilva.pdf>.

Romero-Corral, A & Lopez-Jimenez, F 2010, *Interactions between Obesity and Obstructive Sleep Apnea*, CHEST, vol. 137, no. 3, pp. 711-719, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3021364/>.

Senaratna, C.V, English, D.R, Currier, D, Perret J.L, Lowe, A, Lodge, C, Russell, M, Sahabandu, S, Matheson M.C, Hamilton, G.S & Dharmage, S.C 2016, *Sleep apnoea in Australian men: disease burden, co-morbidities, and correlates from the Australian longitudinal study on male health*, BMC Public Health, vol. 16, no. 3, pp. 51-61, <http://mengage.org.au/MENGAGE/media/MediaLibraryOne/Sleep-Apnoea-Ten-to-Men.pdf>.

STOP-Bang 2014, *Screening STOP-Bang Questionnaire*, <http://www.stopbang.ca/osa/screening.php>.

Trefethen, N 2013, *BMI (Body Mass Index)*, <https://people.maths.ox.ac.uk/trefethen/bmi.html>.

Veloro, L.V, Sarte, M.A.A & Castañeda, S.S 2008, *Collar Size as Predictor of Obstructive Sleep Apnea*, Philippine Journal of Otolaryngology, vol. 23, no. 2, pp. 14-16, <https://apamedcentral.org/Synapse/Data/PDFData/0011PJOHNS/pjohns-23-14.pdf>.

Williams, J.R, Amana, A & Tregear, S.J 2011, *Obstructive Sleep Apnea and Commercial Motor Vehicle Driver Safety: Updated Review*, MANILA Consulting Group, Evidence Report, <https://ntl.bts.gov/lib/44000/44600/44638/OSA_Update_11302011-p.pdf>.

World Health Organisation 2016, *Obesity and overweight*, Fact Sheet, <http://www.who.int/mediacentre/factsheets/fs311/en/>.