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MOOREBANK INTERMODAL TERMINAL PROJECT

Functional and Performance Specification for Permanent Noise Monitor and Proposed Noise and AoA Monitoring Locations

16 October 2019

Tactical Group

TJ741-04F04 AoA and Functional Spec for Permanent Noise Monitor (r8).docx

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1 Introduction

Renzo Tonin & Associates (NSW) Pty Ltd was engaged to prepare a functional and performance specification (FPS) for a rail noise monitoring system (RNMS) to be installed on the Moorebank Intermodal Terminal (MIMT) rail link and to recommend a suitable locations to undertake noise and Angle of Attack (AoA) monitoring.

Rail Noise Monitoring System (RNMS)

The purpose of the RNMS is to address the requirements of Condition G7 of the MIMT approval. The RNMS is required to capture the noise levels from train passbys, calculate the required noise parameters and make data available on a publicly accessible website. The details of Condition G7 are copied verbatim below:

> *G7. The Applicant shall install and maintain a rail noise monitoring system on the rail link at the commencement of operation to continuously monitor the noise from rail operations on the rail link. The system shall capture the noise from each individual train passby noise generation event, and include information to identify:*
>
> *a) Time and date of freight train passbys;*
>
> *b) Imagery or video to enable identification of the rolling stock during day and night;*
>
> *c) LAeq(15hour) and LAeq(9hour) from rail operations; and*
>
> *d) LAF(max) and SEL of individual train passbys, measured in accordance with ISO3095; or*
>
> *e) Other alternative information as agreed with, or required by, the Secretary.*
>
> *The results from the noise monitoring system, shall be publicly accessible from a website maintained by the Applicant. The noise results from each train shall be available on the website within 24 hours of it passing the monitor, unless unforeseen circumstances (i.e a system malfunction) have occurred. The LAeq(15hour) and LAeq(9hr) results from each day shall be available on the website within 24 hours of the period ending.*
>
> *Prior to the commencement of operation, the Applicant shall submit for the approval of the Secretary, justification supporting the appropriateness of the location for rail noise monitoring, including details of any alternative options considered and reasons for these being dismissed. The rail noise monitoring system shall not operate until the Secretary has approved the proposed monitoring location.*
>
> *The Applicant shall provide an annual report to the Secretary with the results of monitoring for a period of 5 years, or as otherwise agreed with the Secretary, from the commencement of operation of the IMEX terminal. The Secretary shall consider the need for further reporting following a review of the results for year 5.*

This FPS addresses the minimum design requirements of the RNMS, including safety, acoustics, durability, design life, maintenance and calibration.

Consistent with the above condition, the RNMS will be installed and used for a minimum of 5 years, to be able to provide an annual report to the Secretary with the results of monitoring for a period of 5 years.

Proposed Noise and AoA Monitoring Locations

Appendix A provides a review of potential noise monitoring locations adjacent the MIMT rail link, and provides justification supporting the appropriateness of the preferred location. This has been prepared in accordance with the requirements of Condition G7.

Appendix B provides a review of potential Angle of Attack (AoA) monitoring locations adjacent the MIMT rail link, and provides justification supporting the appropriateness of the preferred location. This has been prepared in accordance with the requirements of Condition G7A which is copied verbatim below:

> *G7A. The applicant shall install and maintain a wayside angle of attack monitoring system on the rail link at the commencement of operation to continuously monitor the angle of attack to the rail of rolling stock wheels.*
>
> *The system shall capture the angle of attack from a wheel on each axle of every train, and include information to identify:*
>
> *a) Time and date of each axle passby; and*
>
> *b) The identification number of each item of rolling stock.*
>
> *The results from the angle of attack monitoring system shall be:*
>
> *• accessible by train operators from a website maintained by the Applicant. Angle of attack results from each train shall be available on the website within 24 hours of it passing the monitor, unless unforeseen circumstances have occurred.*
>
> *• included in a six-monthly report to the Secretary. The report should at least identify the number of wagons with wheels that exceed the ASA standard angle of attack and the action taken by operators to improve steering performance.*
>
> *Prior to the commencement of operation, the Applicant shall submit for the approval of the Secretary, justification supporting the appropriateness of the location for angle of attack monitoring, the format of the information to be accessible to operators and the format of the public report. The angle of attack monitoring system shall not operate until the Secretary has approved the proposed monitoring location and reporting arrangements.*

2 Glossary of Abbreviations and Acronyms

Abbreviation	Description
AoA	Angle of Attack - As the wheels on a bogie negotiate a tight curve, the leading wheelset typically presents an Angle-of-Attack (AoA) to the rail. The AoA of a leading wheelset with good steering performance can be calculated from AoA = wheelbase (m) / curve radius (m). AoA is normally measured in milliradian (mrad).
ASA	Asset Standards Authority
FPS	Function and Performance Specification
$L_{Aeq(15hour)}$	The energy average A-weighted noise level of train passbys between 7am and 10pm (day)
$L_{Aeq(9hour)}$	The energy average A-weighted noise level of train passbys between 7am and 10pm (day)
L_{AFmax}	The fast response A-weighted maximum noise level during each train passby
MIMT	Moorebank Intermodal Terminal
RFID	Radio Frequency Identification – Used to record the unique ID numbers of locomotives and wagons
RNMS	Rail noise monitoring system
SEL	Single event sound exposure level
SSFL	Southern Sydney Freight Line
Wheelbase	The wheelbase is the distance between the centres of the front and rear wheels on a 2-axle bogie.

3 Document Purpose

The purpose of this FPS is to:

- Provide an overview of the acoustic capability required
- Define a set of requirements for the RNMS which provides a basis for suppliers to prepare quotations to develop, maintain and operate the RNMS
- Incorporate requirements and constraints arising from the approval conditions and relevant noise policies and guidelines
- Provide a summary of the responsibilities of QUBE and the RNMS supplier
- Provide recommendations on the preferred location for the RNMS (see Appendix A)

The monitoring systems will not operate until the Secretary has approved the proposed monitoring locations.

4 General description of MIMT rail operations and requirements for rail noise monitoring

The Moorebank Intermodal Terminal (MIMT) is predominantly located on the eastern side of Moorebank Avenue as shown in Figure 1. Approval for the construction and operation of Stage 1 of the SIMTA Concept Plan is provided in the SSD 6766 Conditions of Consent (Appeal No: 2017/81889, March 2018). The approved facility is proposed to operate 24 hours per day, 7 days per week, handling a container freight volume of up to 250,000 twenty foot equivalent units (TEUs or containers) per annum.

A rail link connecting the southern end of the MIMT site to the Southern Sydney Freight Line (SSFL) forms part of the approved project and is shown in Figure 1. The rail link has a northern and southern connection to the SSFL and will be utilised during day and night-time periods. The typical train configuration is likely to be a 650m long train consist with 600m long wagon rake driven by one or two locomotives. The rail link track design can accommodate train lengths of 1800m.

The design speed limit on the rail link is 60km/h on all tracks except the southern connection where it is 35km/h. Once an incoming train is completely clear of the SSFL, it will commence to slow down. Similarly, an outgoing train will slowly gain speed as it exits the MIMT facility.

As shown in Figure 1, the nearest residential areas in proximity to the new rail link are located to the west, south-west and east (yellow, green and red dots identify the nearest residential receivers in each area). Operational noise associated with train movements is required to be assessed in accordance with the requirements of the *Rail Infrastructure Noise Guideline*. The relevant noise assessment parameters are the maximum noise level for each train passby [L_{AFmax}] and the energy average noise level of all train passbys during the day and night periods [$L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$].

As part of the operational noise assessment of the project, it was identified that there was a risk of curve squeal occurring when locomotives and wagons operate on tight radius curves. The location of the curves and radii on the new rail link are shown in Figure 1.

The preferred location of the RNMS is discussed in Appendix A of this report. At the preferred measurement location, the RNMS will capture all trains entering and exiting the MIMT and quantify noise levels associated with curve or brake squeal should these occur.

Consistent with the requirements of Approval Condition G7, the RNMS is required to monitor and report on the following:

- Measure noise levels for all train passbys on the new rail link. This will include the L_{AFmax} and SEL noise level of each passby. The SEL represents the Single Event Sound Exposure Level of the passby.

- For each 24 hour period, calculate the $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise level based on the measured SEL noise levels of train passbys during the day and night periods respectively.

- Ensure that the time and date of each train passby is associated with the measured noise levels.

- In lieu of imagery or video (as required by Condition G7), capture the RFID of each locomotive and wagon for each passby (train consist). This information shall be used in conjunction with a database of RFID's to determine the locomotive and wagon types for each train consist. The use of RFID to identify locomotive and wagon IDs is considered more reliable than video or still imagery as many name plates on wagons are damaged or not readable (particularly in low light conditions).

- Capture key weather parameters including wind speed, temperature and precipitation during each train passby event to identify if the measured noise levels are likely to be influenced by extraneous noise.

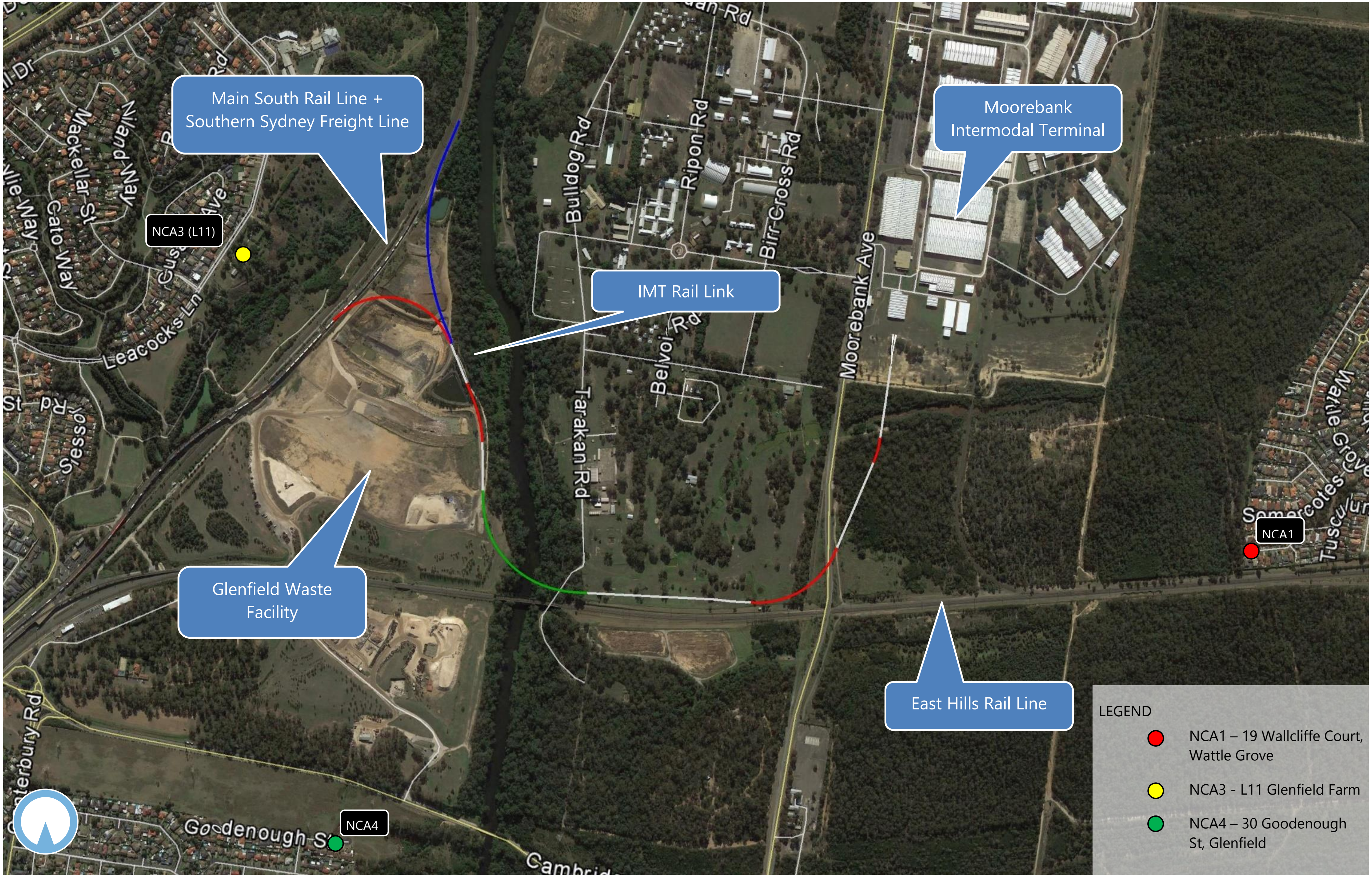
- A website is to be developed by the supplier to make measurement data for each train passby and summary information publicly available within 24 hours of it passing the noise monitor.

The supplier is required to develop and maintain the RNMS and website to meet the minimum requirement in this FPS and ensure that the measurement equipment maintains its calibration.

Justification supporting the appropriateness of the location for rail noise monitoring as required by Condition G7 (see Appendix A) does not form part of the FPS and is provided for information purposes only.

The supplier is not responsible for preparing the annual noise monitoring report for the Secretary (as required by Condition G7), but is required to make noise monitoring data available to QUBE in spreadsheet format for this purpose.

Figure 1 Location of Moorebank Intermodal Terminal, rail link alignment and nearest sensitive receivers



5 References

5.1 References and Applicable Documents

The following standards have been identified and form a part of the FPS to the extent specified herein:

- ISO3095:2013 *Acoustics - Railway applications - Measurement of noise emitted by railbound vehicles*
- Rail Infrastructure Noise Guideline (EPA, 2013)

Unless otherwise specified, the latest issue of these documents at the issue date of this FPS shall apply.

5.2 Order of Precedence

In the event of conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

6 Requirements

6.1 Acoustics and reporting

1) The supplier shall provide one RNMS system which captures the noise from each individual train passby on the MIMT rail link.

2) The supplier shall provide one field calibrator as part of the RNMS. This shall be used to verify calibration of the RNMS once per calendar month. The sound calibrator shall be applied to the microphone of the RNMS to verify the calibration of the entire measuring system at one or more frequencies over the frequency range of interest (20 Hz to 20 kHz). If the difference between two consecutive calibrations is more than 1 dB, all of the measurement results in between shall be rejected. Reasons for any variation in calibration levels of more than 1 dB shall be investigated by the supplier and repairs to faulty equipment undertaken.

3) The noise measurement system and sound calibrator shall meet the class 1 requirements outlined in Clause 4 of ISO3095:2013. Compliance of the sound calibrator and RNMS shall be verified in accordance with the timeframes outlined in Clause 4 of ISO3095:2013.

4) Noise levels during train passbys on the new rail link shall be measured in accordance with the requirements of ISO3095:2013. The measurement time T of the passby event shall generally be in accordance with Figure 1 in ISO3095:2013 and include all locomotives and wagons in the train consist. Alternatively, sensors placed on or near the track (outside the dynamic structure gauge) may be utilised to trigger the start and end of the train passby noise measurements (a wheel induction sensor is preferred or alternatively, an RFID reader could be utilised for this purpose). The -10 dB positions representing the start and conclusion of the passby noise measurement may be approximately 40 m along the track from the microphone. The supplier shall nominate the preferred method and equipment required to establish the measurement time interval T.

5) For each train passby, the SEL, $L_{Aeq,T}$ and L_{AFmax} noise parameters shall be measured over the time interval T. These parameters shall be determined in accordance with Clause 3.10, Clause 3.11 and Clause 3.13 of ISO3095:2013. The measurement parameters SEL, $L_{Aeq,T}$, L_{AFmax} and T shall be stored for each train passby. The date and time of each train passby shall be stored.

6) The microphone of the RNMS shall be fitted with a suitable microphone windscreen at all times.

7) The RNMS shall include a weather station which records the maximum gust wind speed during each train passby, the temperature and whether or not precipitation has been observed within the previous 15-minute period. This information shall be stored for each train passby.

8) The RNMS shall include an RFID reader to read the unique ID of each locomotive and wagon of each train passby. This information shall be stored for each train passby.

9) At the preferred measurement location (refer Appendix A), there are two tracks and noise measurements are required for train passbys in both directions. RFID readers may therefore be required for both tracks.

10) Once per hour, a measurement of the ambient $L_{Aeq,T}$ noise level shall be made for a measurement period T of 20 seconds. The measurement result, together with the date and time shall be stored and labelled as "ambient noise". If a train passby trigger event occurs during a scheduled ambient noise measurement period, the ambient noise measurement shall be discarded and priority given to the train passby measurement.

11) All measurement results shall be transmitted to a secure database established and maintained by the supplier. For each train passby, the database shall include the required noise measurement parameters, date/time information, weather information and locomotive / wagon ID's. This data shall be readily exported into Excel for further processing (csv preferred).

12) The supplier shall establish a publicly accessible website which provides the noise monitoring results of each train passby within 24 hours. This information shall include the date and time of each passby, the associated L_{AFmax} noise level, SEL noise level, $L_{Aeq,T}$ noise level, passby time (T) and a summary of the number of locomotives and wagons in the consist. It shall also include a column which notes if data is likely to be weather-affected (this shall be configurable but initially defined as periods with a wind speed greater than 5 m/s or rain within the previous 15-minute interval). The web page shall include one-week of passby noise measurement results. A search function shall be provided which allows measurement data from previous weeks to be displayed.

13) A separate web-page shall be provided which provides a summary of the calculated $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise levels for each 24-hour period. This shall be made available on the web-page within 24-hours of the period ending and calculated based on the number of train passbys during the day and night periods and the corresponding SEL noise levels, consistent with the procedure in Clause 3.4.1.1 of the *Rail Infrastructure Noise Guideline* (EPA, 2013). The logarithmic average of train passby noise levels that are not weather-affected shall be used in the calculation. The number of train passbys shall be based on the total number of train passbys during the day and night periods. The web page shall include one-month of summary results. A search function shall be provided which allows measurement data from previous months to be displayed.

14) At the preferred measurement location (refer Appendix A), there are two tracks and noise measurements are required for train passbys in both directions. Calculation of the $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise levels for each 24-hour period are therefore required for both tracks. The software shall incorporate the ability to adjust the far track noise levels to a normalised near track distance of 7.5 m. This relationship shall be adjustable but shall initially be based on the following relationship:

   a. Far track noise levels (normalised to near field distance of 7.5m) =

Measured far track noise level + 20 x $\log_{10}$ (12.7 / 7.5) for L_{Amax}

Measured far track noise level + 10 x $\log_{10}$ (12.7 / 7.5) for $L_{Aeq(period)}$

15) The website shall include a "status" section which indicates whether the system is operational or not. The website and RNMS shall be operational for a minimum of 95% of the time.

16) All noise monitoring results, ambient noise level measurements, weather information and RFID information shall be permanently stored in a database to enable detailed post-analysis to be undertaken (if required).

17) The RTMS shall be downloaded remotely without the need to attend site.

18) The RTMS shall have a minimum storage capacity of 1 week so that measurement data can be downloaded manually (without loss of data) in the event that there is a failure with the remote access connection.

19) The RTMS shall capture noise levels for a minimum of 95% of train passbys.

6.2 Physical parameters

20) The location of the RNMS will be selected by QUBE. A concrete slab with nominal dimensions of 2,000mm x 1,000mm x 200mm will be provided. The RNMS and associated equipment (excluding RFID and/or train position sensors) shall be permanently secured to the concrete slab.

21) The RNMS and associated equipment shall be located within a chain-wire (or similar) enclosure (or cage) to minimise the risk of vandalism.

22) The microphone shall be positioned at a height of 1.2 m ± 0.2 m above the upper surface of the rail. No RNMS components other than the mast shall be located within 0.5 m of the microphone to minimise reflections.

23) Access to mains power supply will not be available. The RTMS shall be powered by a sufficient number of solar cells and battery storage to ensure that the monitoring system operates continuously.

24) The RNMS shall be able to be securely locked and not easily damaged.

6.3 Safety

25) Unless specified otherwise, the RNMS is to be installed at a position where the microphone is located 7.5 m ± 0.2 m from the track centreline.

26) No part of the RNMS, inclusive of the protective cage, external sensors, cables or any other component shall be positioned within the dynamic structure gauge of the track.

27) The RNMS shall be designed so that maintenance of the RNMS can be performed in a safe place which does not impede normal operation of the rail line.

28) No visible part of the RNMS shall be coloured red or green, including status lights. The external finish of the RNMS shall be a dull colour (eg, black, grey, metallic) so that it does not cause a distraction to train drivers.

29) All materials used shall be classified as not being Hazardous according to the criteria of the Australian Safety and Compensation Commission (ASCC) guidelines.

30) Materials shall be non-flammable or made of non-combustible materials to prevent easy vandalism.

6.4 Durability and design life

31) The RNMS will be positioned in an outdoor railway corridor environment. The RNMS shall be designed to withstand all weather conditions typical across Sydney, inclusive of wind, rain, solar radiation and temperature extremes.

32) The design life of the RNMS and all components shall be 10 years. The design life shall consider relevant environmental and other aspects at the installation site, including but not limited to:

    a. All reasonable weather conditions expected at the installation site

    b. Wind buffet from passing trains

    c. Hot steel sparks and iron oxide from rail grinding activities

    d. Resistance to fauna (e.g. vermin, parrots) and micro-organisms

33) The RNMS shall not suffer a reduction in acoustic performance of more than 0.5 dB(A) due to a build-up of dust, dirt or other material. If any maintenance activities are required to ensure that no significant loss of performance occurs, these activities shall be clearly stated.

6.5 Materials availability - ease of installation

34) All materials and systems shall be readily available or have a short lead time of less than 10 business days.

35) The design of the protective cage and methods of installation shall be optimised to ensure that fabrication and installation times and costs are minimised.

6.6 Maintenance and calibration

36) It is preferred that the RNMS is maintenance-free with minimal inspection requirements. If maintenance is required, the Supplier shall design the System so that it can be maintained easily and safely, with minimum whole of life cycle costs.

37) Details of any maintenance regime required to attain the minimum required Service Life shall be provided.

6.7 Documentation

38) The Supplier shall provide the following documentation:

    a. Detailed material specifications for each element of the System.

    b. Evidence of compliance with the fire safety requirements of this FPS.

    c. Design Compliance Certificate including evidence which certifies that the design complies with this FPS. This shall address each requirement in this FPS.

    d. An Installation Specification.

    e. Maintenance Manuals.

    f. Details of manufacturer's warranties.

APPENDIX A Preferred noise monitoring location

A.1 Introduction

Approval Condition G7 requires the following:

> *Prior to the commencement of operation, the Applicant shall submit for the approval of the Secretary, justification supporting the appropriateness of the location for rail noise monitoring, including details of any alternative options considered and reasons for these being dismissed. The rail noise monitoring system shall not operate until the Secretary has approved the proposed monitoring location.*

A.2 Review of potential noise monitoring locations

A.2.1 Parameters which influence the preferred noise monitoring locations

The project approval includes several conditions which relate to operational noise on the MIMT rail link. These include conditions related to brake squeal, the use of best practice locomotives and wagons (and bogie steering requirements to minimise the risk of curve squeal).

The preferred noise measurement location will therefore be at a location where all MIMT train pass the noise monitor, freight trains are braking and the risk of curve squeal is greatest.

The preferred measurement distance (refer ISO3095:2013) is 7.5 m from the track centreline. At some locations adjacent to the rail alignment, the corridor is too narrow to install noise monitoring equipment at the preferred measurement distance or a vehicle access road is located at this position.

In areas with small curve radii, the preferred measurement location is on the outside of the curve to minimise the risk of the measurement equipment impeding the sight-line of train drivers. Safe access to the measurement equipment is required to maintain and calibrate the RNMS on a regular basis.

The preferred location of the RNMS will also be in an area of the rail alignment where nearby sensitive receivers are potentially impacted by train noise. The preferred location is also in an area where extraneous noise from non-MIMT trains is minimised.

Each of the above factors have been considered in determining the preferred noise monitoring location.

A.2.2 Review of track alignment and shortlist of preferred noise monitoring locations

Detailed track drawings for the MIMT rail link are provided in Drawing No's N01031-PWD-DRG-001 to N01031-PWD-DRG-063. The preferred noise measurement location is on a curved section of track in order to capture noise levels associated with curve and brake squeal should these occur. A summary of the curves on the rail link is provided in Table 1 and illustrated in Figure 2.

Table 1 Summary of curves on MIMT rail link

Curve Number	Start Chainage	End Chainage	Length of Curve	Curve Radius	Other details
1	39527 m	39699 m	172 m	276 m	North connection to SSFL
2	39931 m	40196 m	264 m	160 m	South connection to SSFL
3 and 4	39954 m	40070 m	56 m (north) 54 m (south)	260 m (north) 244 m (south)	North and South tracks are located parallel at this location. Chainages based on north track.
5 and 6	40289 m	40570 m	280 m (north) 287 m (south)	245 m (north) 250 m (south)	North and South tracks are located parallel at this location. Chainages based on north track.
7	41376 m	41619 m	243 m	200 m	Only 1 track at this location
8	41849 m	41901 m	52 m	200 m	Only 1 track at this location

To assist in identifying the preferred location of the RNMS, the scoring system in Table 2 has been adopted. The noise monitoring location that is feasible and has the highest combined score represents the preferred location.

Table 2 Scoring for preferred location of permanent noise monitor

Category	Description of scores	Additional comments
Are all trains captured at this location?	Score of 1 to 4 representing the approximate percentage of trains that are likely to pass the monitoring location. 1 represents 25%, 2 represents 50%, 3 represents 75% and 4 represents 100%.	
Is train likely to be braking?	Score of 1 represents Yes Score of 0 represents No	Trains are likely to be braking between northern SSFL Link and bridge over Georges River
Risk of curve squeal	Score of 1 represents location with curve radius greater than 200m and less and 300m Score of 2 represents location with curve radius of 200m or less	Smaller curve radii have greater risk if squeal. Score is reduced by 1 point if length of curve is less than 100m due to reduced risk of curve squeal
Are measurements feasible on outside of curve?	Yes = 1 and No = 0	If measurements on outside of curve are not feasible, the measurement location is disqualified from further consideration for safety reasons
Is safe access for maintenance possible?	Yes = 1 and No = 0	If safe access for maintenance is not possible at the measurement location, the location is disqualified from further consideration
Is location near sensitive receivers?	Score of 1 to 4 based on the number of people potentially impacted by curve or brake squeal and the distance between the monitoring location and receivers	Monitoring locations with higher scores are nearer to the monitoring location with a greater number of receivers potentially impacted
Likelihood of extraneous noise	Score of 1 represents a low risk of extraneous noise Score of 0 represents a high risk of extraneous noise	Extraneous noise will influence the quality of the noise measurement results (i.e. measured noise levels may be higher than the train passby noise)

Figure 2 Summary of curves on MIMT rail link

A.2.3 Assessment of preferred noise monitoring location

Table 3 Detailed assessment of preferred locations

Curve number	Are all trains captured at this location?	Is train likely to be braking?	Risk of curve squeal	Are measurements feasible on outside of curve?	Is safe access for maintenance possible?	Is location near sensitive receivers?	Likelihood of extraneous noise	Overall Score	Comments
1	3 only trains on northbound connection	1 Yes	1 lower risk	Yes	Yes	4	1	**10**	Equal highest scoring location. Trains which use southbound connection to SSFL are not captured
2	1 only trains on southbound connection (Note 2)	0 No (Note 1)	2 higher risk	Yes	Yes	4	1	**8**	Trains which use southbound connection to SSFL are not captured
3 and 4	4 All trains captured but on different tracks	1 Yes	0 lower risk and score reduced by 1 point due to short curve length of 56m	No Poor access at this location due to narrow embankment	No Poor access at this location due to narrow embankment	3	0 Extraneous noise from waste transfer activities	**8**	This location is not feasible due to access restrictions, short curve length of 56 m and presence of extraneous noise from adjacent waste transfer facility
5 and 6	4 All trains captured but on different tracks	1 Yes	1 lower risk	Yes	Yes	3	1	**10**	Equal highest scoring location All trains captured
7	4 All trains captured on same track, but not for future IMT extension	0 No	2 higher risk	No Poor access at this between MIMT and East Hills rail corridors	No Poor access at this between MIMT and East Hills rail corridors	1	0 Extraneous noise from trains on East Hills line	**7**	This location is not feasible due to access restrictions and presence of extraneous noise from adjacent East Hills train line
8	4 All trains captured on same track, but not for future IMT extension	0 No	1 higher risk and score reduced by 1 point due to short curve length of 52m	Yes	Yes	2	1	**8**	This location is feasible but has short curve length of 52 m

Table 3 Notes

Braking is unlikely on curve 2 as the train would be decreasing in speed while operating on the SSFL in the kilometre/s on approach to the turnout and act upon the signal aspect of GF24.

If GF 24 is displaying a stop indication the train would cease movement on the SSFL and once the signals clears to allow entry into the terminal the train brakes would be released and the train would commence into the terminal at a low speed in preparation for the signal aspect on MT3.

If GF24 is displaying a proceed aspect, this would be a reduced speed aspect (so not maximum train speed) and the train crew would coast the train past GF24 and then through the turn out (maximum speed 35 km/h) and approach MT3 at decreased speed in preparation for the signal aspect on MT3.

The only times the brakes would be applied through Curve 2 would be:

- When MT3 is displaying a stop indication – the train would be operating at a reduced speed as the signal aspect on the previous signal, GF24, would indicate to the train crew that MT3 would be at stop and the train crew would implement positive train management actions to stop prior to MT3, or

- In the event of an emergency – for example if the train crew are operating the train towards MT3 and are not expecting the signal to be at stop but sight a vehicle on the level crossing, the train crew would implement positive train management actions to stop prior to the level crossing.

What needs to be considered is not the engineered track speed or the maximum train speed but rather the short distance between signals GF24 and MT3 as the train crew need to manage the speed of the train according to the signal aspects, the train would be operating at a reduced train speed according to the displayed signal aspects.

- At curve 2, a score of 1 is given (representing 25% of trains being captured). This is based on the following:

    a. From the expert evidence of Dr Renzo Tonin (Renzo Tonin Expert Report dated 5 October 2017)

        - at 21. "It is forecast there will be 10 train movements per day between Port Botany and the MPE Site with 4 of those movements expected to occur in the night-time period 10:00pm-7:00am (as defined by the NSW Environment Protection Authority - EPA)"

        - at 22. "In respect of use of the southern connection, SIMTA advised the PAC on 29 January 2016 that "only a few trains are likely to run south at this stage"

        - at 83 "In respect of use of the southern connection, I am instructed that in the initial phases of operation that up to three trains per week and more likely one train per week would use the southern connection as part of the operations of MPE Stage 1."

b. Based on the above, 10% is conservative and less than 10% of traffic are likely to use the southern connection.

A.3 Summary of recommended noise monitoring location

Based on the scoring of the potential noise monitoring locations in Table 2 and Table 3, curve locations 3, 4 and 7 were deemed not to be feasible due to poor access requirements to install and maintain the measurement equipment.

Of the remaining feasible monitoring locations, curve location 1, 5 and 6 were the highest scoring options with 10 points, followed by curve locations 2 and 8 (8 points) and curve location 7 (7 points).

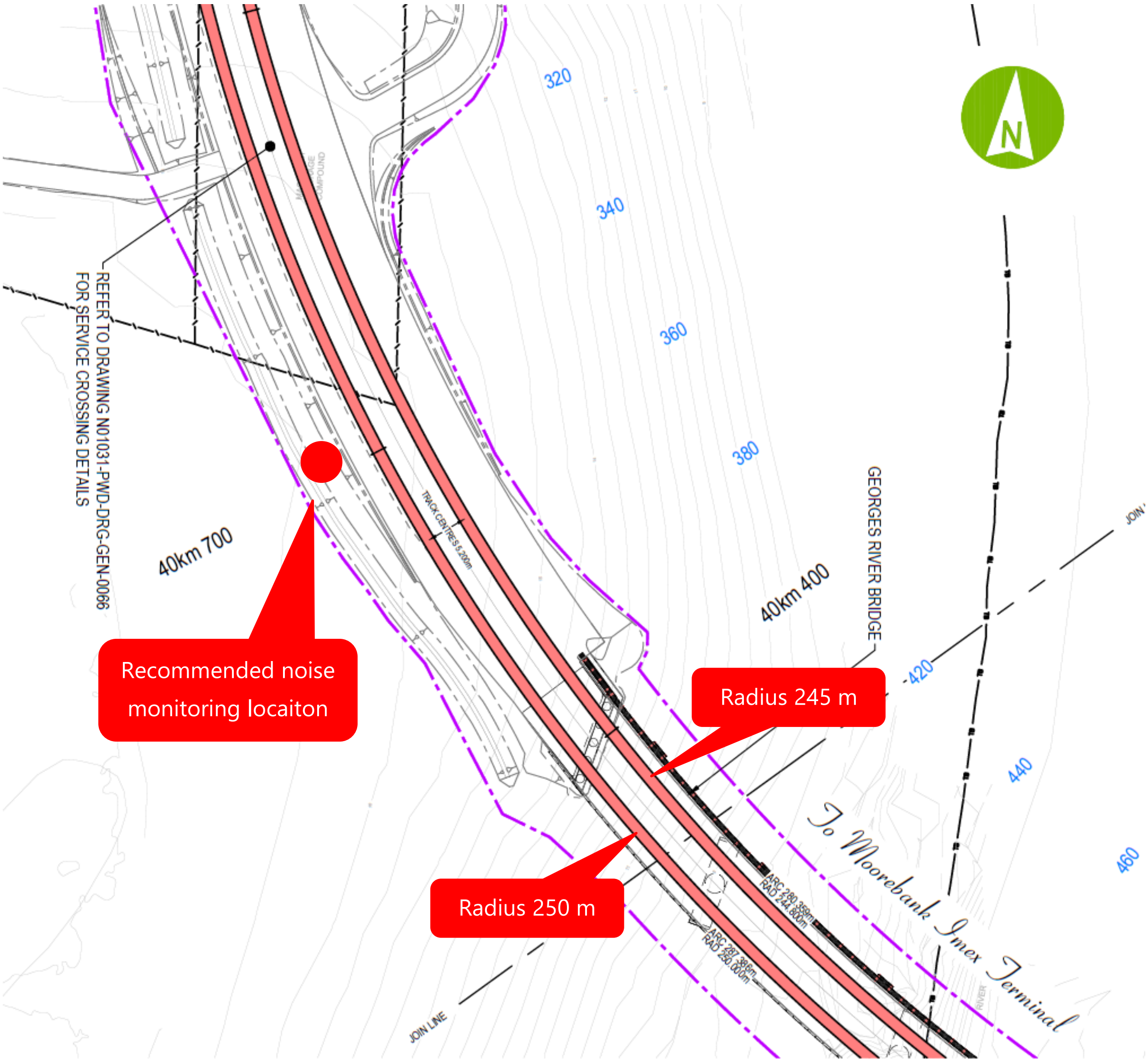
Curve location 5 and 6 is the preferred location to install the RNMS as this locality will capture all trains entering and exiting the MIMT and has the greatest likelihood to capture rail noise levels which may cause disturbance to nearby residential land uses. The preferred monitoring location is on the outside of the two curves with radii of 245 m and 250 m. The preferred monitoring location is near the western abutment of the Georges River bridge (around the south track chainage 40700 m), and not on the bridge. At this locality, the track centres are spaced at 5.2 m. The noise monitoring will therefore be placed nominally at 7.5 m from the south track centreline and 12.7 m from the north track centreline. A concrete slab and access path will need to be incorporated into the detailed design to allow for the RNMS to be installed at this locality. This location is also preferred as it is desirable for the AoA and RNMS to be installed at the same locality to capture noise and AoA data.

Curve location 1 (equal highest score) is not preferred as it would not capture train movements (noise and AoA) on the southern connection to SSFL.

The recommended noise monitoring location is illustrated in Figure 3.

The results from the RNMS on curve 5 and 6 may be used to predict the potential noise impacts at sensitive receivers in NCA3 from curves 1 and 2. 3D noise modelling software such as CadnaA or SoundPLAN would be used, along with one of the standard rail noise modelling algorithms therein, to extrapolate this information.

Figure 3 Recommended noise monitoring location



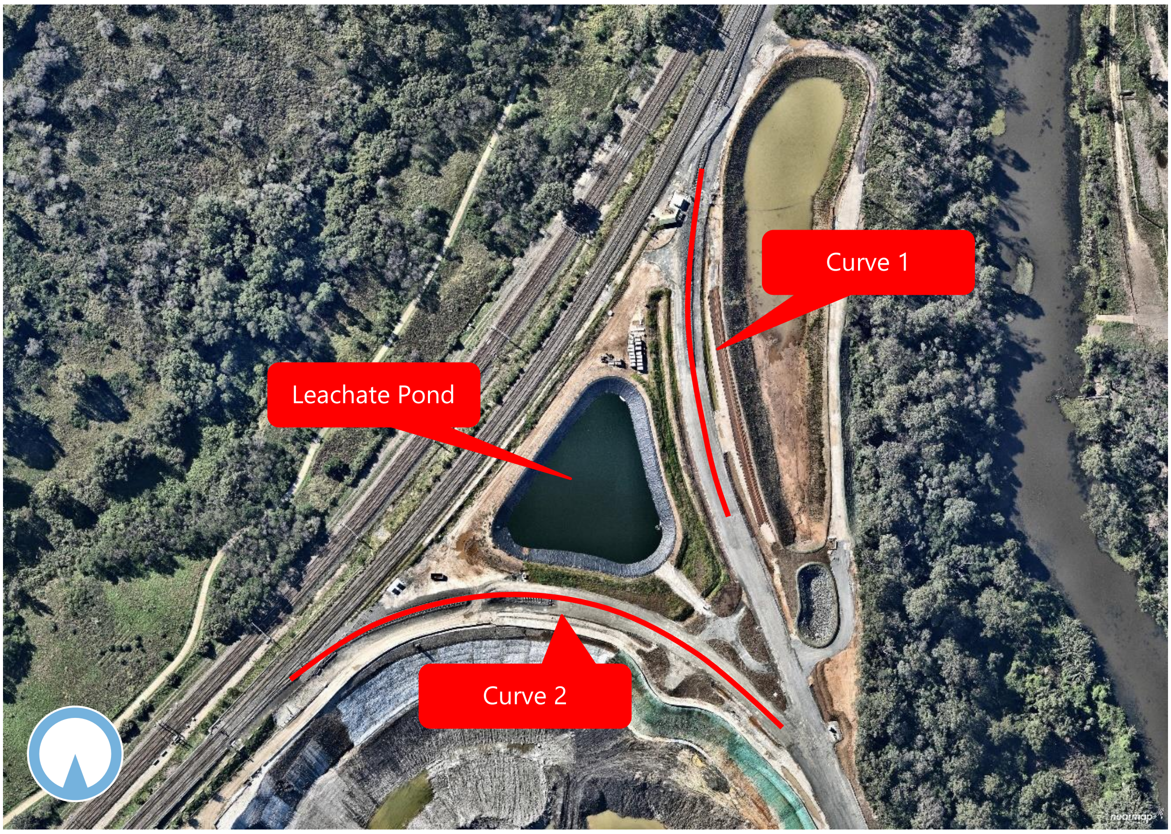
In the Land and Environment Case (*Residents Against Intermodal Development Moorebank Incorporated v Minister for Planning* [2018] NSWLEC 1130), Mr Anderson recommended that the RNMS be established on the curves associated with the northern and southern rail connections (Curve Locations 1 and 2). However, at this locality (refer Figure 4), there is no suitable location to measure noise levels from both curves due to the presence of the GWS Leachate Pond.

If the measurement system was placed adjacent to curve 1 (at the northern end of the leachate pond), curve 2 would be approximately 110 m from this position (i.e. too far for reliable noise measurements). This locality is potentially affected by extraneous noise from the adjacent Main South and SSFL rail lines. If the measurement system was placed adjacent to curve 2 (at the southern end of the leachate pond), it

would be adjacent to a straight section of the northern connection track. This locality is potentially affected by extraneous noise from the Glenfield Waste Facility.

It is acknowledged that Curves 1 and 2 on this section of the rail link have the potential to cause disturbance to nearby residential land if curve gain is present. An Operational Noise and Vibration Management Plan (ONVMP) has been prepared for the MIMT to address the Planning Approval requirements. Section 4.1 of the ONVMP provides a summary of the noise monitoring requirements. The proposed noise measurements in the ONVMP are considered adequate to determine if curve gain is present at this location and whether any further actions are warranted.

Figure 4 Aerial imagery of curves 1 and 2 (image date 31 March 2019, Nearmap)



APPENDIX B Preferred angle of attack (AoA) monitoring location and reporting formats

B.1 Introduction

Approval Condition G7A requires the following:

> *Prior to the commencement of operation, the Applicant shall submit for the approval of the Secretary, justification supporting the appropriateness of the location for angle of attack monitoring, the format of the information to be accessible to operators and the format of the public report. The angle of attack monitoring system shall not operate until the Secretary has approved the proposed monitoring location and reporting arrangements.*

B.2 Recommended AoA monitoring location

The preferred AoA measurement location is at a curve location where the performance of all traffic entering or leaving the MIMT can be evaluated. The preferred measurement location is also at a position where noise monitoring is undertaken in parallel so that curve squeal events can be correlated with AoA measurement results.

In the Land and Environment Case (*Residents Against Intermodal Development Moorebank Incorporated v Minister for Planning* [2018] NSWLEC 1130), Mr Anderson recommended that the AoA monitoring system be established on the curve near Moorebank Avenue (Curve Location 7). However, this location is not considered feasible due to poor access (refer Table 3), and would not capture all freight trains for the expanded facility on the western side of Moorebank Avenue.

For the above reasons, the preferred AoA measurement position is at the same location as the RNMS (Curve Location 5 or 6, illustrated in Figure 3). The AoA monitoring system will be installed on the Up track north of the Georges River Bridge abutment (not on the bridge) and will capture all trains, either as they enter or exit the MIMT. Monitoring at this location means that the AoA is captured from a wheel on each axle of every train. Note that the rail noise monitoring equipment is installed at the same location and due to the nature of the equipment it captures rail noise of all train movements on both tracks.

The location has been selected based on a quantitative analysis that compared different options to identify the location most likely to generate AoA issues and wheel squeal (see Table 3).

The proposed measurement location will allow AoA measurement results to be compared with the limits in the ASA standard referred to in Condition G7A.

B.3 Format of information to be accessible to operators

Section 2.7.1 of Asset Standards Authority Standard T HR RS 00400 ST[2] provides details in relation to the mandatory requirements for bogie AoA and steering performance. Section 2.7.1 of the ASA Standard is copied verbatim below:

> *Wagon steering performance is assessed in terms of the angle of attack (AoA) of the wheelset when the bogie traverses curves. The AoA presented by the wheelsets of any freight bogie, measured at any wayside system on the RailCorp network, shall remain within acceptable limits throughout the service life of the bogie. This includes when the bogie is new and overhauled and when the bogie is at its wear limits.*
>
> *Acceptable AoA is defined as being less than a value given by the following equation:*
>
> *AoA = 2.5 x Bwb / R*
>
> *Where, AoA is angle of attack (Rad), Bwb is bogie wheel base (m) and R is radius of track curvature (m)*
>
> *Note: At the Beecroft AoA detector on the Up Main North at 26.675 km (310 m radius curve), for a typical freight bogie, this corresponds to an acceptable AoA of <15 mrad.*
>
> *This limit will be applied from 01 January 2018. Any wagon that exceeds the AoA limit at any wayside detection system on the RailCorp network from this date shall be held in breach and TfNSW will issue a notification of breach to the operator.*
>
> *The operator shall, within 12 months from the day TfNSW has notified the breach to the operator, either:*
>
> - *Rectify the performance of the wagon; or,*
> - *Submit a plan to rectify the performance of the wagon to the satisfaction of the Lead Rolling Stock Engineer, ASA. The timeline for rectification shall be no longer than the next scheduled overhaul of the bogies on the wagon.*
>
> *If the operator fails to satisfy these requirements, then the affected wagon shall not be operated on the RailCorp Network until its steering performance has been rectified to the satisfaction of the Lead Rolling Stock Engineer, ASA.*
>
> *ASA reserve the right to restrict wagons from entering, or returning to service, onto the RailCorp Network, where the performance of the wagon's steering is clearly noncompliant, or any corrective actions and assurance is ambiguous.*

[2] Transport for NSW Asses Standards Authority T HR RS 00400 ST *RSU 400 Series – Minimum Operating Standards for Rolling Stock – Freight Vehicle Specific Interface Requirements* Version 2.0 dated 24 August 2017

TfNSW shall provide AoA performance data from wayside systems on the RailCorp Network to freight operators in a timely manner sufficient to allow these operators to monitor the performance of their fleets and to ensure compliance with the AoA performance requirements.

From the ASA standard, it can be seen that the acceptable AoA is defined by the following formula where R is the radius of the track curvature at the AoA measurement site (i.e. 250 m at chainage 40.7 km on the western track – outbound trains).

AoA = 2.5 x Bwb / R

For a typical bogie wheelbase (Bwb) of 1.85 m, the acceptable AoA would be 18.5 milliradian at the preferred AoA measurement location, with a curve radius of 250 m.

In accordance with the requirements of Condition G7A, the AoA system will capture the AoA from the lead and trailing axles of every train, and include information to identify:

a) Time and date of each axle passby

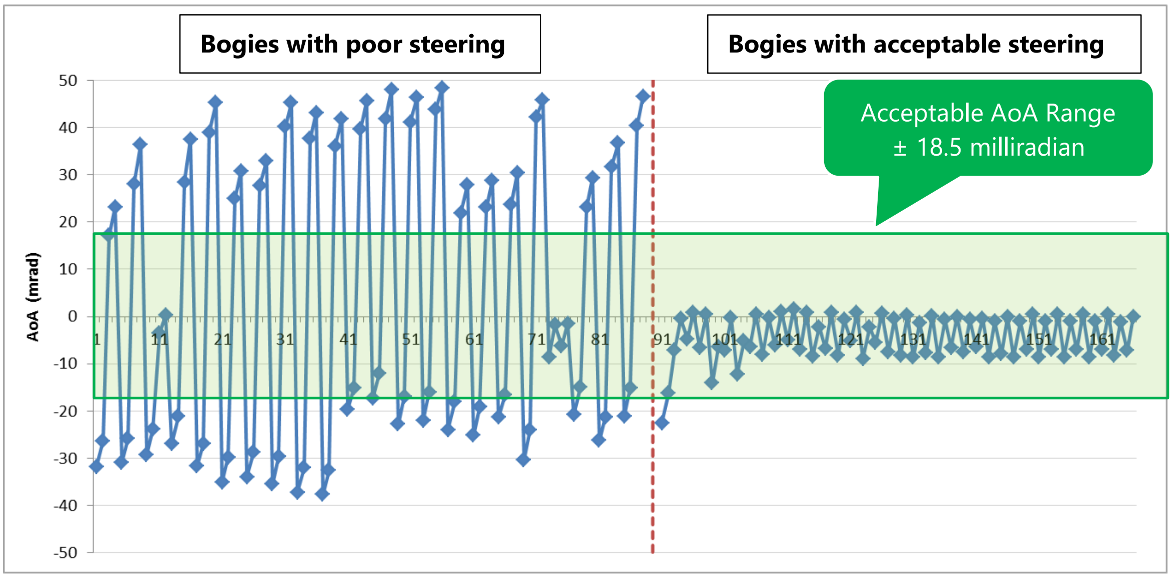
b) The identification number of each item of rolling stock

An indicative sample of the output that will be provided to train operators via the website is provided in Figure 5. This information will be made available to operators for each train passby within 24 hours of it passing the monitor, unless unforeseen circumstances have occurred. Data will be made available to operators in graphical and table format.

In this example, bogies on the first half of the rake have AoA values outside the acceptable range and the second half of the rake have AoA values within the acceptable range.

Figure 5 Example AoA data to be provided to train operators

Passby: 10 April 2019 14:36 Operator: QUBE Train ID: XXXXX



Note: x-axis identifies the axle count

B.4 Format of public report

In accordance with the requirements of Condition G7A, a six-monthly report is required to be submitted to the Secretary which provides the following information:

a) The number of wagons with wheels that exceed the ASA standard AoA

b) The action taken by operators to improve steering performance [of non-compliant wagons]

The ASA standard further requires:

c) Bogies that are in breach of the AoA requirements are required to be rectified by the train operator, or

d) The operator must submit a plan to rectify the performance of the wagon to the satisfaction of the Lead Rolling Stock Engineer, ASA. The timeline for rectification shall be no longer than the next scheduled overhaul of the bogies on the wagon.

An indicative **Table of Contents** for the six-monthly report is outlined below:

1. Introduction (provides a summary of the report and its purpose)
2. Description of AoA monitoring system and measurement site
3. Summary of AoA standards and acceptability limits
4. Summary of six-monthly AoA measurement data including:
    a. Number of trains entering / existing the facility during the monitoring period
    b. Number of trains with AoA measurement results
    c. Number of trains with AoA measurement results within acceptable limits and outside acceptable limits
    d. Number of axles with AoA measurement results within acceptable limits and outside acceptable limits
5. Detailed analysis of wagons with AoA results outside acceptable limits including:
    a. Summary of exceedances by train operator identifying each Wagon ID with exceedances of AoA limit, including associated noise levels and whether curve squeal was present
    b. Summary of steps taken by train operator to rectify non-complying wagons and/or proposed actions and timeframes to rectify the performance of the wagons
    c. Summary of additional steps taken by QUBE to improve best-practice
6. Conclusions and recommendations

B.5 Additional comments based on TfNSW review

TfNSW has advised that the *"AoA monitor installed at Beecroft uses a laser to measure AoA and does not robustly measure AoA in specific light, fog, rain, dust and other conditions. Also, the laser-based AoA*

measurements appear to be affected by surface vibrations. The above factors lead to a current capture rate of around 85% at Beecroft which is not adequate."

The preferred supplier of the proposed AoA system has advised that a laser-based system will not be used for MIMT. The proposed AoA system has an array of 10 x wheel induction sensors on the track, to measure all of the bogie geometry parameters, with AoA being the key one for this project.

TfNSW note: "the specification does not describe the requirements for the AoA system, nor does the specification describe how the AoA system will be integrated with the rail noise monitoring system and other systems (train ID / communications / database). We recommend that the proponent revise the specification to address these gaps, including data capture, analysis and publication".

This document provides a general description of the proposed AoA monitoring system and describes the required format of the AoA measurement data that is required to be generated by the system, consistent with the requirements in Asset Standards Authority Standard T HR RS 00400 ST. In response to TfNSW's comments, the supplier of the AoA monitoring system has provided the following responses:

- Data is captured and has a level one analysis done locally (sensors are analysed to derive measurements. Measurements are associated with vehicles/AVI tags).
- Results from a train pass is streamed to FleetONE cloud hosted server.
- The server stores the results in a database.
- FleetONE server provides two URLS: FleetONE analysis & report automation software suite (login restricted) and a cut-down simplified version that is available on the public web.
- The proposed MIMT system has been configured similar to the Beecroft solution, but with images/video removed (RFID will be used instead) and AoA added in.

TfNSW have requested access to the data feed from the AoA and Rail Noise Monitoring Systems. AoA and Rail Noise Monitoring levels will be made available to TfNSW.