

Topic: RCF UPDATE & RNGIM APPROVAL	Board meeting: 9 April 2021
From: Todd Moyle, Chief Operating Officer	Approved: Greg Miller, Group Chief Executive
<p>It is recommended that the Board receive this paper and RESOLVE to:</p> <ul style="list-style-type: none"> • Approve that KiwiRail make a joint funding proposal with Auckland Transport to increase funding for the Rail Network Growth Impact Management (RNGIM) project by an additional \$140m for rail network renewals and upgrades; and • Delegate authority to the Group CEO to approve the final proposal and, if funding is approved, to approve a funding agreement between KiwiRail and Auckland Transport for the RNGIM project. 	

1. INTRODUCTION

In August of 2020, following a detailed inspection of the Auckland Metro Rail Network (AMRN), it was determined that a 40kph blanket speed restriction was required across the entire metro network to mitigate the risk of rail failures and urgently undertake remedial works.

The hazard underlying the risk was the rapid propagation of both early stage RCF and late stage internal rail defects, initiated by RCF, in a significant percentage of the rails in the AMRN.

Remedial works included re-railing and sleeper replacement and was carried out by the Auckland Region Infrastructure team via the Auckland Metro Recovery (AMR) project. Some of these works were already programmed to be carried out during 2020-24 under the Rail Network Growth Impact Management (RNGIM) project.

RCF is a natural result of wheels passing over the rail. RCF and the consequential internal rail defects can be accelerated by a large number of causes ranging from environmental factors to rail and wheel profiles. That RCF develops in rails in the Auckland Metro Network is normal, but the imposition of blanket speed restrictions to manage the consequent risk is not.

2. ROOT CAUSE

2.1 Root Cause Working Group

KiwiRail, Auckland Transport and CAF (the manufacturer and maintainer of the multiple unit (EMU) rolling stock operating on the AMRN) formed a working group to determine how RCF in the Auckland metro had rapidly progressed to the point where a blanket speed restriction was required by focusing on two common objectives:

- To determine the root causes of Rolling Contact Fatigue (RCF) initiated defects in the Auckland metro area.
- To recommend future maintenance practices with regard to RCF management.

The root cause working group was coordinated and led by an independent track expert and was tasked with investigating three contributors:

- Track
- Vehicles
- The interface between track and vehicles – Known as the Wheel/Rail Interface (WRI)

For the track and wheel-rail-interface (WRI) component the group relied on reports from Autech and SNC-Lavalin which had previously been commissioned by KiwiRail, along with internal expertise from KiwiRail. For the EMU vehicle's contribution to WRI the group relied on modelling from SNC-Lavalin, along with internal expertise from KiwiRail and CAF.

2.2 Working Group Output

The output of the working group was a report which concluded that although a number of factors contributed to the ultimate imposition of a blanket speed restriction:

'The closest single root cause could therefore be stated as a missed opportunity during 2014-2017 to implement the recommendations of the 2014 Network Rail Consulting report. Appropriate responses would have been to:

- a. Upgrade the track asset OR*
- b. Modify or operate the units in a way that specifically recognised the track was not upgraded OR*
- c. Introduce a rigorous grinding regime OR*
- d. Study and implement the lowest TCO approach that optimised all three issues.'*

The 2014 Network Rail report was commissioned by AT in advance of the introduction of the new EMU fleet. KiwiRail provided data and information to Network Rail to support this work. In addition to the above overall root causes the working group identified a number of key causes of accelerated RCF within each of the three contributors.

Key Causes Track:

Track asset related causes of accelerated RCF:

- a. Historic under investment in the track asset prior to 2014 and to September 2020
- b. Insufficient rail grinding from 2015 to 2020
- c. The existence of multiple sites where the track condition is sub-optimal in engineering factors known to accelerate the growth of RCF:
 1. Track geometry and gauge exceedances including at welds and bolted joints
 2. Aged timber sleepers unable to hold rail in place adequately
 3. Historic wheel burns/squats causing sudden dynamic loads
 4. Sub-optimal application of cant, mainly uncorrected past practices
 5. Significant sections of the network that have low track modulus (low combined stiffness of rail, sleeper, ballast, and formation), at times aggravated by poor drainage.
- d. The speed of RCF propagation varies between very dry and very wet climates. It is likely that Auckland's climate has been a partial contributor to the accelerated growth.

Key Causes Vehicles

- a. Wheel profiles modified from KiwiRail standard profiles. Noting that the reason for the profile change was to avoid anticipated high wheel flange wear, itself related to the high vehicle stiffness.
- b. The AM class units were designed with a high primary yaw stiffness to better negotiate KR track irregularities safely and comfortably, however this may increase RCF in rail where track has many irregularities. The modelling brief did not include evaluating "RCF damage index" for "as measured" track.

Key Causes Wheel Rail Interface

- a. Lack of comprehensive grinding since 2015
- b. Lack of artificial rail inclination on track structures
- c. AM class EMU wheel profile favour wheel life over RCF minimisation
- d. Insufficient emphasis on developing and adopting a wheel / rail profile that optimises the total cost of ownership (TCO) of the holistic rail system

In relation to these key causes the working group provided a total of 8 recommendations which are being presented to the AMR project control group for actioning. The first 6 of these recommendations focus on upgrading aged infrastructure and implementation of a regular maintenance grinding program.

The other two recommendations relate to modifications to the passenger carriages, namely:

- It is recommended that the AM class vehicle wheel profile and Auckland network rail profile be optimised
- It is recommended that all existing vehicles be progressively modified to reduce their primary yaw stiffness

3. SUBSEQUENT WORK PACKAGES

3.1 Auckland Metro Recovery (AMR) Project

The first focus of the AMR project was to complete the track repairs so the blanket speed restriction and heat restrictions could be lifted enabling the normal running of metro services. On the 28th of March the final piece of rail programmed under AMR was installed between Papakura and Pukekohe enabling the blanket speed restriction to be lifted over the entire network. This is a major milestone, the equivalent of 3 years' worth of work bank was completed in under 9 months.

The heat restrictions (referred to as a H40) are required to ensure that any heat related bucking of track, which can occur until destressing and ballasting is complete, is mitigated. The final section of H40 restriction is on the section between Papakura and Pukekohe and is scheduled for removal on 5 April 2021.

Table 2 shows the quantum of work completed by the AMR project and provides an indication of the completion status for each work type.

	UNIT	TOTAL PROGRAM	COMPLETED TO DATE	% COMPLETED
Rail	km	134.041	134.041	100
Sleepers	ea.	21,540	21,117	98
Destress	km	134.041	114.22	85
Turnouts - replaced	ea.	29	7	24
Turnouts remediated	ea.	20	20	100

3.2 Short Term Asset Management

Between AMR remediating the immediate RCF risk and the RNGIM project tasked with developing long term maintenance strategies there is a period of time where current/interim inspection and maintenance strategies must be sufficient to ensure that the requirement for a blanket speed restriction does not reoccur. With this in mind, the RCF working group were also tasked with providing an assurance regarding the interim state.

From this task the KR Professional Head of Track was able to provide assurance from for the period January 2021 to January 2024 that:

- The current codes and standards that govern the AMRN maintenance are adequate to prevent any repeat of the sudden imposition of a network wide temporary speed restriction (TSR).
- The current maintenance budget for the AMRN is **not** adequate to meet the operational expectations but in conjunction with a separately funded grinding programme it is adequate to prevent any repeat of the sudden imposition of a network wide TSR due to RCF which will be controlled but not eliminated by grinding.

4. FUNDING GAP

The RNGIM project was originally established with approved funding of \$183m from Waka Kotahi to undertake an accelerated renewals programme on the Auckland Network.. The presence of RCF and the need to rapidly remediate have created a situation where the RNGIM funding is not sufficient to achieve its full objective due to:

- Some but not all of the track related RCF causes identified in the root cause report were included in the RNGIM workbank.
- AMR has accelerated and completed some of the RNGIM workbank – unfortunately, due to the imperative to restore normal train operations, some sites remediated by AMR will need to be revisited by RNGIM.
- The average actual cost of re-railing from the AMR activities allowed the RNGIM team to review their budget unit rates which were too low.
- Progress on design and costing of certain RNGIM elements (e.g. power feeds) has demonstrated that the original RNGIM budget was insufficient.

As a consequence, a cost/scope adjustment has been prepared to justify and quantify a proposal for additional funding of \$140m for rail renewals and upgrades. The detailed reconciliation and adjustment process has been regularly updated to Auckland Transport and Waka Kotahi over the last four months. AT as the Approved Organisation for AMRN will be submitting the business case and Waka Kotahi seeking approved funding from Transitional Rail.

Board approval, and related delegations, are sought for KiwiRail's approval to the revised funding application and, if funding is approved, to enter the related funding agreement with Auckland Transport for the RNGIM project.

5. CONCLUSION

The AMR root cause analysis determined that there were a number of factors that combined to result in the accelerated progression of RCF. The primary cause was not addressing the recommendations of the 2014 Network Rail report through renewing the track or modifying the rolling stock or implementing an enhanced grinding regime or implementing a combination of these factors to deliver the lowest total cost of ownership.

The implementation of the recommendations of this report will be owned by the AMR project control group which has representatives from AT, KiwiRail and TransDev on this group.