OPERATIONAL NOTICE

Notice No. **RACN 24-004**

Notice Type: Route Access Condition Notice

Subject Title: Guidance for determining trailing load limits

Effective From: 12/09/2024 Effective To: 12/09/2025

Reference Documents:

Route Access Standard: RAS General Information

TOC Manual: TOC Section 2, Section 10

General Details / Operating Condition:

Summary of changes:

This "Route Access Condition Notice" (RACN) updates and supersedes RACN 23-001. All changes are in red text and is summarised as follows:

- Added QE and MAN class locomotives
- Added notes to constraining gradients regarding deviations and variations in operation factors

Details of RACN:

1. Introduction

This RACN is intended to provide guidance only. Advice within this RACN is general in nature and does not consider any specific driving methodology, routing constraints or locomotive performance modifiers that may be applied by a knowledgeable Rolling Stock Operator (RSO).

Section 4.3 of the "ARTC Route Access Standard" (RAS) applies to all trains that are operating. RSO's are expected to ensure that trailing load are suitable for the specification and condition of the locomotives that they are operating.

Note: As the content of this Operational Notice is intended as "guidance", the RSO may choose to set their own trailing load limit. The RSO's nominated load limit may be more or less than the limit recommended by this Operational Notice provided that the RSO complies with "ARTC RAS General Information" (RAS GI) – Section 4.3.

a) Background

The ARTC RAS was introduced in 2013 with the intent so standardise advice relating to train operating conditions. ARTC's inherited the "TA02 NIC Plan" and "TOC Manual" from the Rail Infrastructure Managers that preceded it for Victoria, NSW & Qld.

The NIC Plan does not specify any load limits and only recommended power to weight (hp/t) ratios that is required to be deemed to comply with a specific schedule. Without consideration for the specific locomotives load limits, some locomotives could be overloaded and become unreliable and others would be able to continue operating with a slower schedule but, would be unduly delayed to wait for a rescue locomotives.

The TOC Manual approach primarily managed locomotive adhesive limits and tries to address thermal limits and variations in locomotive control systems by applying a nominal load reduction of 10% or 20% depending on the circumstances. Supporting this approach requires a significant amount of technical vehicle information and unrestricted access to locomotive performance data that can only be sourced from event recorders. Additionally, the TOC Manual prescribed train scheduling at a level that is very restrictive to ARTC's network operations & planning teams.

By 2013 train scheduling and planning was no longer being limited by the NIC Plan or TOC Manual instead ARTC's and its customers would manage scheduling as a commercial function rather than a technical function. All TOC Waiver updates to the "Loads & Conditions" tables within the three TOC Manual Section Pages have been to approve load increases above the tabulated "Full Sectional Loads". This content in the ARTC TOC Manual was last updated prior to the implementation of the RAS.

Sighting the issues with both the NIC Plan and TOC Manual approaches the RAS GI Section 4.3 has included since the first issue obligations for RSO's to ensure that the locomotive allocation for every train is:

- rated for the track speed and capable of meeting the schedule to which the train is allocated and
- fit for use on the ARTC Network in terms of:
    - multiple unit compatibility;
    - mechanical and electrical condition; and
    - the task to be performed.

Following this change RSO's have only been required to appropriate demonstrate (through theoretical analysis, testing and trials) that the trailing loads are within the locomotives capability to reliably haul its loads to attain a TOC Waiver.

A condition of standing down the NIC Plan and TOC Manuals is to ensure that appropriate guidance is provided to rolling stock operators that may not have the capability or capacity to generate their own advice. With specific reference to the above limitations of the NIC Plan and TOC Manual methodologies to managing Trailing Load Limits, ARTC has deemed that it's not appropriate to simply provide the same advice as is in the TOC Manual. Broadly speaking RSO's will either be:

- Fully dependant on the TOC and thus will be fully reliant on this advice and thus treat each should in this advice as "shall"
    - Any operators that are in this category and find circumstances where this advice is more restrictive than the legacy TOC advice, should contact ras@artc.com.au. Some Ruling Gradients and the method for calculating trailing loads is different and should more accurately represent the trailing load performance limits of locomotives that are maintained to the level of performance of which they have been registered.
- Partially dependant on the TOC and thus will use their guidelines to enhance/develop their own processes.
- Constrained by the TOC and thus will use their internally developed & mature processes to create their own advice, completely independently of this advice.

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Table 1 Reference Table for superseded Operational Notice s

OPERATIONAL NOTICE /REFERENCE	CONTENT	NEW REFERENCE
TOC Section 2 "Locomotive(s) dead attached or offline"	"and for the purpose of train load calculations the live weight of the locomotive/s is multiplied by 1.1 (covers an increase in rolling resistance)"	RACN 23-001 "Process Overview" within this Operational Notice
TOC Section 2	"Mixing of Locomotive Types"	RACN 23-001 "Locomotive Interchangeability" and "Selection of Lead Locomotive" within this Operational Notice
TOC Section 2 & TOC Section 10 TOC Section Pages	"Locomotive Categories" "Maximum Trailing Load" tables & "Full Sectional Loads"	RACN 23-001 "Basic Trailing Load Limits" within this Operational Notice supersede "Load Categories", "Maximum Trailing Load" tables & "Full Sectional Loads"

Contents

2. Process Overview

The information in this Operational Notice is broken into various sections. Some trains may need to apply multiple sections to determine the haulage capacity of the locomotives and the marshalling sequence.

There are several services that require run-around movements to complete their planned journey(s). These trains should give due consideration to the advice in this Operational Notice after each run-around movement.

RSO's must consider compliance to all applicable requirements of the ARTC RAS when applying the advice in this Operational Notice. Related mandatory requirements include but are not limited to:

- RAS General Information, Sections 4.1, 4.3, 4.5, 4.8, 7 & 10.3
- RAS HG Section Pages, Section 3 & 4
- RAS D52 Section Pages, Section 3

3. Selection of Lead Locomotive

Locomotive throttle response times vary between types and classes. This can lead to drivers increasing throttle before other locomotives under their control have finished building up "amps" and producing rail burns by overloading the locomotives. The best administrative control available to prevent this is to give the driver in control of the train visibility of the amp meter of the locomotive that is the slowest to respond.

Refer to locomotive RSO manuals for "Locomotive Features". Where a locomotive has been modified, the RSO is responsible for updating the RSO manuals to suit current state. When any train is hauling more than 80% of its maximum load, the lead locomotive should be the locomotive with the highest priority in the table below:

PRIORITY FOR LEAD POSITION	LOCOMOTIVE FEATURES
1st	GE 7FDL & Alco powered, DC traction locomotives
2nd	EMD 567, 645 & 710 powered, DC traction locomotives
3rd	Passenger EMD Locomotives with the "full field start" feature
4th	DC traction locomotives built with modern traction control systems
5th	All AC traction locomotives

4. Nominal Ruling Grades

The "Ruling Grade" generally refers to the section of track on a given journey where the train size is constrained by the locomotive's ability to haul the train up the gradient. The table below is intended to give an indication of the "Nominal Ruling Gradient" of the Ruling Grade to inform the RSO of what gradient to lookup to find the maximum trailing load. Note: The source for the table below is the diagrams in the ARTC RAS General Information, some train & route combinations need specifically defined Constraining Gradients. Refer to section 8 for further information on determining the appropriate gradients.

Nominal Constraining Grades		Origin																
		Acacia Ridge	Carrington	Cootamundra	Dry Creek	Dynon	Enfield	Goobang Jct	Goulburn	Junee	Moss Vale	North Star	Oaklands	Parkeston	Port Botany	Portland	Unanderra	Werris Creek	Whyalla
Destination	Acacia Ridge		1:66	#	1:66	#	#	1:66	#	#	#	1:40	#	1:66	#	#	#	1:40	1:66
	Carrington	1:66		#	1:70	#	#	1:70	#	#	#	1:40	#	1:70	#	#	#	1:40	1:70
	Cootamundra	#	#		1:75	1:40	1:40	1:75	1:40	1:50	1:40	1:60	1:40	1:75	1:40	1:40	1:30	1:60	1:75
	Dry Creek	1:46	1:46	1:75		1:45	#	1:100	1:40	1:50	1:40	1:60	1:45	1:80	#	1:45	1:30	1:60	1:100
	Dynon	#	#	1:40	1:45		1:40	1:40	1:40	1:40	1:40	1:40	1:50	1:45	1:40	1:50	1:30	1:40	1:45
	Enfield	#	#	1:66	#	1:40		#	1:66	1:50	1:80	#	1:40	#	1:100	1:40	#	#	#
	Goobang Jct	1:46	1:46	1:75	1:80	1:40	#		1:40	1:50	1:40	1:60	1:40	1:80	#	1:40	#	1:60	1:80
	Goulburn	#	#	1:66	1:66	1:40	1:66	1:66		1:50	1:66	1:60	1:40	1:66	1:66	1:40	1:30	1:60	1:66
	Junee	#	#	1:40	1:40	1:40	1:40	1:40	1:40		1:40	1:40	1:40	1:40	1:40	1:40	1:30	1:40	1:40
	Moss Vale	#	#	1:66	1:66	1:40	1:70	1:66	1:66	1:50		1:60	1:40	1:66	1:70	1:40	1:30	#	1:66
	North Star	1:40	1:40	1:50	1:50	1:40	#	1:50	1:40	1:50	1:40		1:40	1:50	#	1:40	1:30	1:50	1:50
	Oaklands	#	#	1:40	1:45	1:50	1:40	1:40	1:40	1:40	1:40	1:40		1:40	1:40	1:50	1:30	1:40	1:45
	Parkeston	1:46	1:46	1:75	1:80	1:45	#	1:80	1:40	1:50	1:40	1:60	1:40		#	1:45	1:30	1:60	1:80
	Port Botany	#	#	1:66	#	1:40	1:100	#	1:66	1:50	1:80	#	1:40	#		1:40	#	#	#
	Portland	#	#	1:40	1:45	1:50	1:40	1:40	1:40	1:40	1:40	1:40	1:50	1:45	1:40		1:30	1:40	1:45
	Unanderra	#	#	1:66	1:66	1:40	#	1:66	1:66	1:50	1:75	#	1:40	1:66	#	1:40		#	1:66
	Werris Creek	1:40	1:40	1:70	1:60	1:40	#	1:70	1:40	1:50	1:40	1:68	1:40	1:70	#	1:40	#		1:70
	Whyalla	1:46	1:46	1:75	1:100	1:45	#	1:100	1:40	1:50	1:40	1:60	1:40	1:80	#	1:45	1:30	1:60	

Notes:

Loading for the most direct path is constrained by an adjacent network (Sydney Trains, Country Regional Network or ARC infrastructure), seek advice for Trailing Load Limits from these networks.

5. Basic Trailing Load Limit Table

The following is a table of the maximum recommended trailing loads for specific locomotive classes. Trailing load limits below are based on AAR recommended traction calculations, with the recommended 12 N/t of rolling resistance allowance.

Locomotive Class	Nominal Ruling Grade									
	1:30	1:40	1:45	1:50	1:66	1:77	1:80	1:90	1:100	1:120 Level
5000, 5020	1989	2678	3016	3682	4396	5093	5280	5895	6497	7661
90	1362	1848	2086	2555	3058	3549	3680	4113	4537	5357
6000, 6020, 92, 93, AC, ACA, ACB, ACC, ACD, CEY, CF, FIE, GWA, GWB, GWU, LDP, LDP10, MAN, MRL, PHC, QE, QL, SCT, SSR, TT, WH, XRN	1189	1611	1818	2225	2663	3090	3204	3581	3949	4661
CSR, QBX	1106	1500	1694	2075	2483	2882	2989	3340	3684	4350
AN, FQ, NR, Q, V544	956	1300	1470	1803	2161	2509	2603	2911	3212	3794
82, CM	879	1200	1359	1669	2003	2328	2416	2703	2983	3527
1100, 81, BL, BRM, C502-C510, G, GL, RL, VL	827	1130	1280	1573	1888	2195	2277	2548	2813	3326
31, DL, LQ, LZ, XRB, XR-2	775	1060	1201	1477	1773	2061	2139	2394	2643	3125
3200, ALF, ALZ, CLF, CLP, L	677	930	1055	1299	1562	1818	1887	2113	2334	2762
14 (MZ), EL, X37-X54	663	910	1032	1271	1528	1778	1845	2066	2282	2700
C-501	628	870	990	1224	1475	1720	1786	2002	2214	2623
1200, 80, 80s, X31-X36	542	750	853	1054	1270	1481	1537	1723	1905	2257
18, 22, 422, DC, FL, HL, NA, NB	526	730	831	1029	1242	1449	1505	1688	1867	2213
442, 442s, 700, D46-D51, K	474	660	752	933	1127	1316	1366	1533	1696	2012
42, 421, 43, 44, 44s, 45, 45s, 103, 600, B, GM12-47, S	444	620	707	878	1061	1240	1288	1445	1599	1898

Locomotive Class	Nominal Ruling Grade									
	1:30	1:40	1:45	1:50	1:66	1:77	1:80	1:90	1:100	1:120 Level
47, 48, 48s, 48200, 49, 79, 830, 900, CK, GM1-GM11, GPU, H, KL, MM, PL, T	302	410	464	569	681	791	820	917	1012	1195
73	140	200	230	288	351	412	428	482	535	636

6. Locomotive Compatibility

Locomotive performance characteristics lead to relatively ideal minimum operating speeds (nominal speed) while operating at maximum load. Locomotives should only be considered as "compatible", if the nominal speeds tabulated below match and all the control interfaces enable a single driver to control all locomotives with a single set of controls. Where the nominal speeds do not match, refer to section 7 "Mixing inharmonious locomotives".

Locomotive Class	Nominal Speed (km/h)	Nominal Power (MW) [1]
14 (aka MZ)	30	2.24
GM1	29	1.07
C-501	25	1.79
3200, ALF/ALZ, CLF, CLP, EL	24	1.79
18, NA, NB	24	1.43
AN, FQ, NR, Q, V544	23	2.39
L	23	1.79
1200	23	1.43
6000, 6020, 92, 93, AC, ACA, ACB, ACC, ACD, CEY, CF, FIE, GWA, GWB, GWU, LDP, LDP10, MAN, MRL, PHC, QE, QL, SCT, SSR, TT, WH, XRN	22*	2.63
CSR, QBX	22*	2.52
422, 22, DC, FL, HL	22	1.31
442, 442s, 700	22	1.19
44, 44s, 45, 45s, 103, 600	22	1.16
73	22	0.39
31, DL, LQ, LZ, XRB, XR-2	21	1.79
80, 80s	21	1.28
K, D46-D51	21	1.16
421, B	21	1.07
1100, 81, BL, BRM, C, G, GL, RL, VL	20	1.79
43, GM12, S	20	1.07
82, CM	19	1.79
N (V/Line)	19	1.34
47, CK, H, T367-T412	19	0.67
X37-X54	18	1.31
X31-X36	17	1.07
90	16	2.39
T320-T366, T413	16	0.54
48, 48s, 48200, 49, 830, 900, CAR, GPU, KL, MM PL	15	0.54
5000, 5020	13	2.63
79	7	0.23

General note: Nominal power is expressed in Megawatts (MW) and is calculated based on the maximum load and nominal speed of the locomotive.

Notes:

* These AC Traction type locomotives are able to reliably operate with locomotive that have a minimum speed at or above 18km/h. When working exclusively with locomotives that have nominal speeds below 22km/h the AC Traction loads should be calculated separately to the other locomotives per "Example 2" in section 7. If the operator wants to, this note can be ignored and normal process in "Example 1" will produce a reliable trailing load limit.

7. Mixing Inharmonious Locomotives

Mixing inharmonious locomotives requires a trailing load that ensures that the train has a sufficient power-to-weight ratio to maintain the Nominal Speed of the highest speed locomotive that is coupled to the train. The maximum recommended trailing load for any combination of locomotives can be found by follow this process:

- From the table in clause 6 "Locomotive Compatibility"
  - Identify Locomotive with the fastest "Nominal Speed"
  - Take the sum of the "Nominal Power" for the locomotives that are hauling the train
- Identify the steepest ruling gradient for the route (refer to clause 4 "Nominal Ruling Grades" or RAS GI section 2.7 "Ruling Gradients")
- Lookup the number that corresponds with the "Nominal Speed" and "Ruling Gradient"
- Multiple this number by the sum of the "Nominal Power"

Nominal Speed (km/h)	Nominal Ruling Gradient									
	1:30	1:40	1:45	1:50	1:66	1:77	1:80	1:90	1:100	1:120 Level
30	264	369	420	519	623	723	750	836	919	1077
29	276	385	437	540	647	751	778	868	954	1117
25	333	459	520	639	764	884	916	1019	1119	1308
24	350	481	545	669	799	924	957	1065	1169	1366
23	368	506	572	701	837	968	1002	1115	1223	1429
22	389	532	602	737	879	1015	1051	1169	1283	1497
21	411	561	634	776	925	1067	1105	1229	1347	1572
20	436	594	670	818	975	1125	1165	1294	1419	1655
19	463	629	709	866	1030	1188	1230	1366	1498	1746
18	493	668	753	918	1092	1259	1303	1447	1585	1848
17	527	712	802	977	1161	1337	1384	1537	1683	1961
16	565	762	858	1043	1239	1426	1476	1638	1793	2089
15	608	818	920	1118	1326	1526	1579	1752	1918	2233
13	713	956	1074	1302	1543	1774	1835	2034	2226	2589
7	780	1043	1170	1417	1678	1928	1994	2210	2418	2812

Example 1: where a G-FIE-EL-3200 combination is hauling from Narrabri to Carrington:

- Referring to the table in clause 6 "Locomotive Compatibility"
  - The locomotive with the fastest "Nominal Speed" is both the EL and 3200 class
  - The sum of the "Nominal Power" is 2.63 + 1.79 + 1.79 + 1.79 = 8.00 MW
- Clause 4 "Nominal Ruling Grades" shows this route as North Star to Carrington with a Ruling Gradient of 1:40
- The table above correlates 24km/h and 1:40 with haulage number of 481
- **Therefore, the maximum recommended trailing load is 481 x 8.00 = 3,848 tonne**

Example 2: where a CSR, 90, BRM combination is hauling from Narrabri to Carrington:

- Referring to the table in clause 6 “Locomotive Compatibility”
  - The locomotive with the fastest “Nominal Speed” is the CSR (22*) however referring to note (*) it may be reduced to 18 km/h thus the BRM class is the fastest at 20 km/h
  - The sum of the “Nominal Power” for the excluded locomotive 2.59 MW
  - The sum of the “Nominal Power” for the locomotives is 1.79 + 2.39 = 4.18 MW
- Clause 4 “Nominal Ruling Grades” shows this route as North Star to Carrington with a Ruling Gradient of 1:40
- The haulage number from the table above for a 1:40 is of 532 @ 22km/h & 594 @ 20km/h
- **Therefore, the maximum recommended trailing load is 532 x 2.59 + 594 x 4.18 = 3,860 tonne**

8. Determination of Ruling Gradients

RSO’s should perform a train specific assessment of the route that the train is travelling to determine their own Ruling Gradient. This assessment should consider:

- The train length and the interaction of the whole train over the topology (combination of gradients and curves) of the route.
- Sufficient power-to-weight ratio to maintain an appropriate minimum speed (to prevent traction motor overload)
- The Locomotive’s ability to restart the train from any control point (may include Signal, Yard Limit, Block posts) with consideration of the topology from the restarting location to where the train can achieve its minimum speed without causing rail burns.
- The impact of the Ruling Gradient and Trailing Load Limit where a train fails mid-section and is required to restart, any recovery plans should include the outcomes of this assessment to assist with recovering disabled trains.

9. Process for Demonstrating Kinematic Trailing Load Limit

The RSO may use fully dynamic assessment tools to determine a fully optimised trailing load limit for the service.

10. Asynchronous Controls and Train Crew Distributed Power

Distributed Power operations offer asynchronous control via moving the “fence” or changing the instructions to the Rear Train Crew via radio calls on the wayside channel. Whilst there are many potential advantages to this, it is not recommended to do this without a detailed analysis as recommended in RISSB’s Code of Practice for “Distributed Power Freight Trains”.

b) Asynchronous RFDP / WDP

The analysis conducted must consider the increased workload and any potential impacts to the driver’s ability to adhere to all applicable ARTC Safeworking Rules.

c) Notch/Power Limiting Devices & Train Crew Distributed Power

For the purposes of determining the maximum trailing load, RSO’s may decide to conduct the detailed analysis of this operation and give specific instructions to train crew that allow a higher degree of harmonious operation for locomotives that are normally considered “inharmonious”.

11. Degraded Performance Conditions

a) Single Engine Services

Single engine services typically experience poor adhesion conditions for the first axles. These trains are often shorter and thus are hauling at the maximum traction motor current (amps) for longer and thus it is recommended to reduce the trailing load limits for these services by up to 50%. RSO's are expected to understand the performance parameters of their locomotives and thus develop processes to assess and manage the required load reduction for any degraded performance condition.

b) Isolated Sanding System

For compliance with ARTC RAS, some locomotives may be required to isolate the Sanding System. As the dependence on the Sanding System varies with the position in the train, it is recommended to derate the locomotive performance based on the position in the train as tabulated below:

Locomotive Position	Load reduction [1]	Description
LEAD	50%	Lead Locomotive
MU	20%	Locomotive in a head end group
REMOTE & REMOTE-MU	10%	Locomotive operated in a Distributed Power Mode such as: Train Crew (includes assisting movements), RFDP or WDP

Note:

1. The Load Reduction applied to the locomotive's contribution to the maximum trailing load.

c) Traction Motor Isolations

Where traction motors require isolation to continue operating, the trailing load should be decreased by the proportion of the total number of traction motors isolated. For example, a locomotive with 2 traction motors and one is isolated, the trailing load should decrease the trailing load by 1/2.

d) Compensation for Dead-Engine and Isolated Locomotives

The live mass of the locomotive no longer needs to be multiplied by 1.1 (10% increase) to compensate for the maximum trailing load. It is however recommended that when hauling any vehicle (including passenger rolling stock) with a mechanical drive system or an electro-mechanical drive system and has an axle load less than 20TAL, the vehicle mass is multiplied by 1.1 when determining the maximum trailing load.

12. Hauling Load limits for maintaining schedule

The haulage limits with respect to this document are agnostic of any scheduling constraints. Management of scheduling may be informed with simulations and a power : weight ratio may be found to be a useful guide for comparing simulation and trial results with normal operations. Due to the number of variables that are not able to be quantitively assessed, management of schedules has been handed over to Network Operations and indicative schedules are published in the customer portal.

Approval:

Prepared by:	Drew Palmer	Date:	12/09/2024
Approved by:	Carolyne Southern	Date:	12/09/2024