

Management of Locomotive Exhaust Emissions

CODE OF PRACTICE



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1 Introduction

1.1 Purpose

This Code of Practice describes recommended practices for the management and improvement of exhaust emissions of diesel freight locomotives in the Australian railway industry.

Diesel locomotives create several emissions with adverse effects on the environment or human health, including diesel particulates (PM), oxides of nitrogen (NOx) and greenhouse gases (GHG).

In the Australian environment, PM and GHG are most important, since NOx has a significantly lower community cost than PM. It is most important that any action required under this Code of Practice does not increase GHG emissions, or impede action to reduce them, which may occur through actions to reduce NOx.

This Code of Practice addresses these Australian environmental priorities

1.2 Scope

This Code of Practice covers all diesel locomotives used for the haulage of freight in Australian States and Territories, including both for hire and reward, and those used as part of the production process.

It is not applicable to—

- heritage locomotives not used for any commercial freight tasks;
- locomotives used solely for the haulage of passengers;
- other on-rail diesel engines e.g. those used in track maintenance machinery.

1.3 Definitions

Approval date: is the date when the Code of Practice is formally published by the RISSB Board.

Capability compliant: a locomotive which meets or exceeds the relevant standards in Table 1.

Certification: means a formal statement from a supplier (or where applicable an operator) of the emission level from a locomotive confirming that equipment (either an engine, locomotive, or parts installed for reducing locomotive emissions) has been tested and is compliant with the relevant emission level in this Code of Practice. Certification of one engine as compliant shall be accepted as evidence of compliance by all locomotives similarly engined, and configured. ("type testing").

Compliant maintenance: means the configuration, operation and maintenance of a locomotive as directed by the original equipment manufacturer (OEM), or in the case of an upgrade, the kit supplier, so that emissions conform to the certification provided.

Due date: is 10 years after the effective date.

Duty cycle: The amount of time a locomotive spends in each throttle notch setting ("notch"). In measuring locomotive compliance with this Standard and COP, the AAR main line duty cycle shall be used to calculate weighted average emissions for line haul duties, and the AAR Switch locomotive duty cycle for Nominated Shunter locomotives.

Effective date: is the first day of the first month falling more than 12 months after the approval date (in the final documents actual dates will be substituted for these terms).

Emission efficiency: shall be measured as diesel particulate emissions (PM) grams /kilowatt hour (g/KWh).

Existing locomotive: a locomotive either ordered for supply to or in service in Australia at the effective date.

Major overhaul: is a scheduled power assembly change out, component change out or other planned maintenance requiring replacement of 75% or more of the pistons and cylinder liners of the engine. A major overhaul will not include unscheduled maintenance to replace these components due to unforeseen failure of engine component(s) prior to scheduled maintenance.

New locomotive: a locomotive ordered after the effective date of this Standard including orders for already manufactured but not used new locomotives.

Nominated shunter: a locomotive, which has a principal operational task of shunting in a yard or terminal. Line haul locomotives which also perform some shunting duties e.g. in train build shall not be considered nominated shunters. The AAR switch loco duty cycle and emissions weighting shall be applied to nominated shunters. If a nominated shunter spends only part of a calendar year in this role, operations in a line haul function shall be considered using line haul data.

PM: particulate matter present in the exhaust emissions of diesel locomotives.

Pre-owned locomotive: a locomotive previously operated overseas and ordered after the effective date for importation and use in Australia. If the locomotive previously operated outside Australia was manufactured after 1 January 2010, or had covered less than 50 000km at the date of importation, it shall be considered a new locomotive for the purposes of this Code of Practice, and shall meet the standards required of a new locomotive.

Reporting organisation: means that organisation nominated by the industry which is independent of any operator subject to this Code of Practice, which will publish annual data on the emissions performance of the freight industry as described in Section 2.5 of this Code of Practice. The identity of the reporting organisation will be confirmed prior to the approval date

Short term: means a period of less than 5 years.

Technical body: means that organisation nominated by the industry which is independent of any operator subject to this Code of Practice, which prepares and publishes the data on locomotive PM emissions by engine model required in Table 2 of this Code of Practice

Testing: means the measurement and determination of the weighted average of a locomotive's PM emissions using the processes and methodology outlined in Section 3.1 of this Code of Practice.

Threshold usage: means 50,000 km/annum and is the maximum level of annual locomotive usage, at which the relevant provisions in Section 2.4.c shall apply.

Upgrade kit: a package of parts generally comprising enhanced pistons, injectors and other components which when fitted to an existing locomotive will reduce PM emission levels to at or below levels specified in this Code.

Upgraded locomotive: an existing locomotive upgraded after the effective date, to meet the standard below.

Weighted average emissions: The weighted average emissions ("emissions") shall be the emissions of PM g/KWh developed from the emissions in each notch weighted by the duty cycle.

2 Improvement by application of mandatory locomotive standards

Table 1 - Required weighted average emission level line haul duty cycle

Locomotive type	PM Emissions g/kWh	Comment
New Locomotives	0.27	UIC II level.
Upgraded locomotives	0.30	USA tier 0+ level
Pre-owned (imported) locos "new"	0.27	Refer above for definition of a "new" pre-owned locomotive
Pre-owned (imported) locos other	0.30	

2.1 Purchase of new locomotives

Locomotives ordered after the effective date shall be certified as meeting the requirements in Table 1 having full regard for planned usage, Australian weather conditions, modifications to meet Australian Standards, and other factors deemed likely to affect the level of locomotive emissions.

This requirement shall be waived if the operator provides documented evidence that—

- no locomotive with this emission standard meeting the operator's specific operational and network requirements was commercially available in Australia at the time of purchase; and
- the locomotive purchased provides the highest available standard meeting these operational and network requirements.

2.2 Upgrading of existing locomotives

Existing non-compliant locomotives shall be upgraded to meet the requirements in Table 1 in this Code of Practice, generally through fitting of an upgrade kit.

An operator may at their discretion upgrade a locomotive through other engine modification works which can be demonstrated to improve emissions sufficiently to satisfy this upgrading requirement, subject to certification.

Operators shall undertake this upgrade on existing locomotives, which are not capability compliant, by whatever method, as required to meet the requirements of Table 1, at the first major overhaul after the effective date, and before the due date unless essential components to undertake such an update are not available.

2.3 Emission /fuel usage optimisation

Changing the engine injection timing and other settings alters the mix of emissions between the three key emission types. Action to reduce fuel usage and emission of GHG may therefore have the effect of increasing emissions of PM and/or NOx.

Operators may alter the engine timing and other settings of their new or upgraded locomotives to optimise fuel usage and GHG emissions, provided that certification of compliance at this new configuration is supplied.

Existing locomotives which have not been upgraded may be similarly optimised without the need to provide evidence from testing.

2.4 Locomotives not compliant by the due date

A non-compliant locomotive which at the due date has not been upgraded to meet the emission levels in Table 1 shall not be in breach of this Code of Practice if—

- a) the locomotive has received a major overhaul prior to the due date, but no parts were available to upgrade its emission standard (as above); or
- b) the locomotive has not received an overhaul, but it will be scrapped within five years after the due date; or
- c) in each year after the due date, the locomotive will not exceed the threshold usage (the operator shall supply data to confirm compliance).

If in any 12 consecutive months after the due date the locomotive does exceed the threshold usage, it shall be upgraded to comply with Table 1 of this Code of Practice not later than 12 months after this exceedance.

2.5 Reporting

Operators shall report to the reporting organisation within two months after the end of each calendar year (or part calendar year in the first year) after the effective date –

- a) the number of new locomotives purchased in the prior calendar year;
- b) of that number, those that met the standard;
- c) that met a lesser but best available standard as addressed in Section 2.2.

Operators shall also report at this time the number of non-compliant locomotives —

- a) receiving a major overhaul as defined above;
- b) receiving an upgrade kit;
- c) for which no kit was available; and
- d) reasons why any non-compliant locomotive receiving a major overhaul, and capable of being upgraded did not receive an upgrade.

The reporting body shall publish summary data above within four months of the end of each calendar year.

3 General actions to reduce emissions

3.1 Testing

Equipment and the methodology used to measure emissions for certification shall comply with one or more of US EPA 1065, EC 595 and Regulation 49. The calculation of the weighted average PM emissions shall be undertaken using the weightings in the US EPA line haul duty cycle, except where the locomotive is a nominated shunter where the US EPA switch loco duty cycle shall be used.

3.2 Certification

Certification of either an engine, locomotive, or parts installed for reducing locomotive emissions must confirm that it has been tested in accordance with Section 3.1 and is compliant with the relevant emission level in Table 1 of this Code of Practice. Certification of one engine as compliant shall be accepted as evidence of compliance by all locomotives similarly engined, and configured. (Type testing).

Certification of capability compliance for new and existing locomotives in the compliant configuration and set up specified by the purchaser and accepted by the supplier shall be satisfied by evidence of certification by the OEM, or for upgraded locomotives, certification by the provider of an emission upgrade kit, and shall be the responsibility of the supplier.

3.3 Maintenance Equipment

The OEM/kit supplier shall provide the information required for compliant maintenance. Variation of the locomotive setup outside these conditions shall require retesting of the locomotive emission levels.

3.4 Geographic usage

No operational restrictions prior to the due date due to locomotive emission levels shall be placed on new, existing or upgraded locomotives as a result of this Code of Practice.

After the due date, operators shall take all reasonable steps to minimise human exposure to the use of non-capability compliant locomotives.

3.5 Reduction through improved operating practices

Operators should take all reasonable steps to reduce emissions from in-service use, particularly from idling, especially in urban areas or adjacent to centres of population, through steps such as—

- a) running locomotives "dead" when not required for operating conditions;
- b) use of software to optimise engine loadings in multi loco consists;
- c) installing idling management equipment such as engine stop/start or similar systems;
- d) use of crew advisory systems to optimise conservation of momentum; and
- e) crew training.

3.6 Network owners/operators to facilitate emission reduction

Network owners/operators shall also take available opportunities to reduce locomotive emissions caused through network conditions, by action to increase network velocity, reduce delays, and enable conservation of momentum.

3.7 Actions to reduce emissions of NOx

Consistent with meeting the emission standards for PM specified above, and minimising emissions of GHG, operators shall take all reasonable endeavours to minimise emissions of NOx.

3.8 Change of ownership

Where either all or part of an operator's fleet, or beneficial control of the operator, is sold, the improvement obligations under this Code of Practice, shall continue.

3.9 Locomotive not owned by the operator

Some locomotives are owned by parties other than the operator. This includes locomotives under financing arrangements, and those owned by a customer, who contracts with the operator to provide haulage services to the owner using these locomotives.

Responsibility for compliance of these locomotives with this COP shall rest with the Operator. The Operator shall, where necessary, secure any agreements from the Owner needed to allow the Operator to achieve this compliance.

This requirement shall not apply to short term commercial leases of locomotives, or those maintained by the lessor, where responsibility for compliance shall reside with the locomotive owner.

Table 2 - Weighted average PM emissions/kWh for engine models operating in the Australian rail freight industry (including non-hire and reward operations)

Note: Preliminary data only pending work by the Technical Body as described in the Code

Engine model	BSFC g/kWh	PM emissions g/kWh	Emission shunting factor
ALCO 12 - 251C	N/A	0.806	1.40
ALCO 12 - 251CE	N/A	0.806	1.40
ALCO 6-251	N/A	0.806	1.40
ALCO 6-251B	N/A	0.806	1.40
Cummins QSK19	N/A	0.134	1.40
Cummins QSK78-18	N/A	0.134	1.40
EMD 6 - 567C	N/A	0.389	1.28
EMD 8 - 567C	N/A	0.389	1.28
EMD 8 - 567CR	N/A	0.389	1.28
EMD 8-645E	N/A	0.389	1.28
EMD 12 – 645F3B	N/A	0.386	1.28
EMD 12 - 645E3B	N/A	0.386	1.28
EMD 12 – 710G3	N/A	0.386	1.28
EMD 12 - 710G3A	N/A	0.386	1.28
EMD 12 - 710G3B-ES2	N/A	0.386	1.28
EMD 16 - 567BC	N/A	0.447	1.28
EMD 16 - 567C	N/A	0.447	1.28
EMD 16 - 645E	N/A	0.447	1.28
EMD 16 - 645E3B	N/A	0.447	1.28
EMD 16 - 645E3C	N/A	0.447	1.28
EMD 16 - 645E3E	N/A	0.447	1.28
EMD 16 – 645F3	N/A	0.452	1.28
EMD 16 – 645F3B	N/A	0.386	1.28
EMD 16 – 710G3	N/A	0.386	1.28
EMD 16 - 710G3A	N/A	0.386	1.28

Engine model	BSFC g/kWh	PM emissions g/kWh	Emission shunting factor
EMD 16 - 710G3A EFI	N/A	0.366	1.28
EMD 16 - 710G3B-EC	N/A	0.366	1.28
EMD 16 - 710G3C-ES2	N/A	0.268	1.28
EMD 16 - 710G3C-T1	N/A	0.603	1.28
EMD 20 - 645E3	N/A	0.463	1.28
English Electric 12CSVT	N/A	0.806	1.40
English Electric 6CSRKT	N/A	0.806	1.40
English Electric-8SRKT	N/A	0.806	1.40
GE 7FDL12	N/A	0.370	1.53
GE 7FDL16 EFI	N/A	0.228	1.53
GE 7FDL16 MEC	N/A	0.483	1.53
GE 7FDL16-C44	N/A	0.134	1.53
GE 7FDL16-Dash9NR	N/A	0.134	1.53
GEVO	N/A	0.215	1.40
MTU-20V4000R43	N/A	0.134	1.40
MTU-20V4000R43L	N/A	0.134	1.40



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