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Contents

1	Introduction.....	4
1.1	Purpose	4
1.2	Scope	4
1.3	Definitions.....	4
2	Improvement by application of mandatory locomotive standards	6
2.1	Weighted average emissions	6
2.2	Purchase of new locomotives	6
2.3	Upgrading of existing locomotives.....	6
2.4	Emission /fuel usage optimisation	6
2.5	Locomotives not compliant by the due date	7
2.6	Review of emission standards for new locomotives	7
2.7	Reporting	7
3	General actions to reduce emissions.....	8
3.1	Testing.....	8
3.2	Certification.....	8
3.3	Maintenance Equipment	8
3.4	Geographic usage.....	8
3.4.1	Reduction through improved operating practices	8
3.5	Network owners/operators to facilitate emission reduction	9
3.6	Actions to reduce emissions of NOx	9
3.7	Change of ownership	9
3.8	Locomotive not owned by the operator	9
4	Data for determining compliance	9

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 context, PM and GHG emissions are considered higher priority issues than NOx emissions. This Code of Practice seeks to address these Australian environmental considerations through a balanced approach to these competing emissions outcomes. As such this Code of Practice has reflected the broader priorities in addressing locomotive emissions.

It is recognised that equivalent or better ways of achieving the required emissions outcomes may be possible. For this reason, compliance with this Code of Practice is not mandatory, providing that any other method used provides an equivalent or improved emissions outcome than is defined in this Code of Practice.

1.2 Scope

This Code of Practice covers all diesel locomotives used for the haulage of freight in Australia, 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

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").

Testing data or certification of an engine or kit undertaken overseas shall be accepted as evidence of performance in Australia unless such use is expressly forbidden by the supplier.

Compliant maintenance: means the configuration, operation and maintenance of components and systems affecting locomotive emissions as directed by the original equipment manufacturer (OEM), or in the case of an upgrade, the kit supplier, or as modified by changes to best practice, 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").

Effective date: is 1 December 2018 being the first day of the first month falling more than 12 months after the publication of this Code of Practice.

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

FROEPG (Freight Rail Operators' Environmental Policy Group): is a group open to all freight rail operators in Australia and comprising the majority of such operators. It was formed in 2012, with the endorsement of RISSB and the Australasian Railway Association (ARA), with the purpose to address environmental matters resulting from rail freight operations.

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 Code of Practice including orders for already manufactured but not used new locomotives.

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 50 000 km 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 2.7 of the Code. At the effective date the reporting body was the Australasian Railway Association (ARA).

Review period: means the maximum period between formal reviews of this Code of Practice commencing from the publication of this Code of Practice. The review period is four years.

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

Should: The use of the word 'should' indicates a recommendation.

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. FROEPG may by majority vote of the FROEPG members act as the Technical Body if no other body is nominated.

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 2.5.c shall apply.

Upgrade kit: means 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 of Practice.

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. Calculation of weighted average emissions should preferably use the AAR main line duty cycle

2 Improvement by application of mandatory locomotive standards

2.1 Weighted average emissions

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

Locomotive type	PM Emissions g/kWh	Comment
New Locomotives	0.27	
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	

2.2 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:

- (a) 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
- (b) the locomotive purchased provides the highest available standard meeting these operational and network requirements.

2.3 Upgrading of existing locomotives

Existing locomotives found to be non-compliant 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 an existing 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.

2.4 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.

2.5 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.

Operators using this provision should avoid operating these locomotives in or around urban areas or population centres.

2.6 Review of emission standards for new locomotives

It is recognised that over the review period of this Code of Practice that improved technology may become available. It is anticipated that, to remain relevant, it is likely that this Code of Practice will be updated at intervals less than the review period; in particular, the content of Table 1 and Table 2.

2.7 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 meet the standard;
- (c) that meet a lesser but best available standard as addressed in Section 2.3.

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.
- (e) disposals of locomotives net of any purchase of non-compliant locomotives

The reporting body shall publish this data per operator within four months of the end of each calendar year.

3 General actions to reduce emissions

3.1 Testing

Equipment and the procedures used to measure emissions for certification in Australia 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.

3.2 Certification

Certification of either an engine, locomotive, or parts installed for reducing locomotive emissions shall 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.

Certification/testing undertaken overseas will be acceptable if meeting either US EPA or EU UIC requirements. However, any Australian testing will take precedence over such overseas information.

If no certification, either from independent sources or local testing, is available for an engine it shall be deemed as non-compliant.

3.3 Maintenance Equipment

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

3.4 Geographic usage

Prior to the due date, no operational restrictions 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.

3.4.1 Reduction through improved operating practices

Operators should take actions to reduce emissions from in-service use, 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.

3.5 Network owners/operators to facilitate emission reduction

Network owners/operators should consider maximising available opportunities to reduce locomotive emissions exacerbated through network conditions. For example, to increase network velocity, reduce delays, and enable conservation of momentum.

3.6 Actions to reduce emissions of NOx

Consistent with meeting the emission standards for PM specified above, and minimising emissions of GHG, operators should endeavour to minimise emissions of NOx.

3.7 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.

3.8 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 Code of Practice 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.

4 Data for determining compliance

Table 2 data below, unless provided by an OEM or testing, provides guidance only for determining compliance of existing locomotives. Operators should establish compliance in accordance with Section 3

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

Engine Model	PM Emissions g/kWh	Source
Alco 12-251C	N/A	No
Alco 12-251CE	N/A	No
Alco 12-251E	N/A	No
Alco 6-251	N/A	No
Alco 6-251B	N/A	No
Cummins QSK19	0.134	O.E.M
Cummins QSK78-18	0.134	O.E.M
EMD 12-567C	N/A	No

Engine Model	PM Emissions g/kWh	Source
EMD 12-645C	N/A	No
EMD 12-645E3B	0.386	O.E.M
EMD 12-645E3C	N/A	No
EMD 12-645F3B	0.389	O.E.M
EMD 12-710-G3B-ES (Upgraded Tier 0+)	<0.268	O.E.M
EMD 12-710G3	0.386	O.E.M
EMD 12-710G3A	0.386	O.E.M
EMD 12-710G3B-EC	N/A	O.E.M ³
EMD 12-710G3B-ES2	0.386	O.E.M
EMD 12-645E	N/A	O.E.M ³
EMD 16-567BC	0.386	O.E.M
EMD 16-567C	0.447	O.E.M
EMD 16-645E	0.447	O.E.M
EMD 16-645E3	N/A	O.E.M ³
EMD 16-645E3B	N/A	O.E.M ³
EMD 16-645E3C	0.447	O.E.M
EMD 16-645E3C (Tier 0+ kit already fitted)	<0.268	O.E.M
EMD 16-645F3	0.452	O.E.M
EMD 16-645F3B	0.386	O.E.M
EMD 16-710 SLAC (SD90MAC)	N/A	O.E.M ³
EMD 16-710G3	0.386	O.E.M
EMD 16-710G3A	0.386	O.E.M
EMD 16-710G3A SD60 JWAC	N/A	O.E.M ³
EMD 16-710G3A (Tier 0+)	<0.268	O.E.M
EMD 16-710G3A-EC	0.366	O.E.M
EMD 16-710G3A-EFI	0.366	O.E.M
EMD 16-710G3B-ES	N/A	No
EMD 16-710G3B SD70M JWAC	N/A	O.E.M ³
EMD 16-710G3C-ES	N/A	No
EMD 16-710G3C SD75M JWAC	N/A	O.E.M ³
EMD 16-710G3C-ES2	<0.241	O.E.M
EMD 16-710G3C-T1	0.3	O.E.M

Engine Model	PM Emissions g/kWh	Source
EMD 16-710G3C-T3	<0.107	O.E.M
EMD 20-645E3	0.463	O.E.M
EMD 6-567C	0.389	O.E.M
EMD 8-567C	0.389	O.E.M
EMD 8-645E	0.389	O.E.M
EMD 8-710G3B	N/A	No
EMD 8-710G3B (Tier 0+)	0.10	O.E.M
EMD16-645E3B	0.447	O.E.M
EMD16-710G3A EFI	0.366	O.E.M
English Electric 12CSV	N/A	No
English Electric 6CSRKT	N/A	No
English Electric 8SRKT	N/A	No
GE 7FDL12 EFI 2800	N/A	O.E.M ¹
GE 7FDL12 MUI	N/A	O.E.M ¹
GE 7FDL16 Dash8 EFI	N/A	O.E.M ¹
GE 7FDL16 Dash8 MUI	N/A	O.E.M ¹
GE 7FDL16-C40ACi-AU	0.134	O.E.M
GE 7FDL16-C44ACi-AU	0.134	O.E.M
GE 7FDL16-Dash9 EFI	0.19	O.E.M
GE 7FDL16-Dash9 NR	0.134	O.E.M
GE EVO12-ES44ACi-AU	0.134	O.E.M
GE EVO12-ES44DCi-AU	0.134	O.E.M
GE P616-PH37ACi-AU	0.134	O.E.M ²
MTU-20V4000R43	0.134	O.E.M
MTU-20V4000R43L	0.134	O.E.M

Notes:

1. No PM test data is available for these engine types according to Section 3.1 of the RISSB Locomotive Emissions CoP
2. GE P616-PH37ACi-AU PM is an estimate for US EPA LH Duty Cycle based upon EU3a certification test results.
3. Performance varies with specific configuration and some models are compliant; refer to O.E.M or Supplier for details
4. Further data affecting entries in this Table may be issued from time to time



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