

Standard

Rolling Stock - Tram – Sanding Systems

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PROUD OPERATOR OF



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1 PURPOSE

Low adhesion between wheels and rails during traction and braking increases the risk of not achieving the required traction and braking requirements specified in CE-021-ST-0029 Rolling Stock - Tram - Braking Systems and from CE-021-ST-0018 Rolling Stock - Tram – Traction Systems. This risk shall be controlled in order to meet the safety requirements as per section 3.3 of AS 4292.3 Railway Safety Management – Part 3: Rolling Stock.

This Standard defines the minimum requirements for tram mounted sanding equipment used to improve adhesion between wheels and rails in the Yarra Trams Network. This Standard also describes sanding systems and sand types currently used in the trams that operate on the Yarra Trams Network.

2 SCOPE

The requirements described in this Standard apply to

- all trams introduced from other networks onto the Yarra Trams Network for the purpose of continual passenger operation unless otherwise specified, and
- all heritage trams reintroduced to the Yarra Trams Network for the purpose of continual passenger operation unless otherwise specified.

The requirements described by this standard are applicable to all existing trams operating on the Yarra Trams Network SFAIRP. Appendix B describes the specific applicability of this standard to those trams that presently operate on the Yarra Trams Network.

Appendix C describes the operation of sanding equipment fitted to trams that presently operate on the Yarra Trams Network.

This standard does not cover requirements for the sanding machines used for replenishment of sand on trams.

3 COMPLIANCE

This standard shall be fully complied with. Deviation from this standard is only permitted when a waiver has been sought and approved by Yarra Trams.

‘Shall’ statements are mandatory in the context of compliance with requirements stipulated in this standard.

‘Should’ statements are considerations in the context of compliance with requirements stipulated in this standard.

‘Information’ statements provide additional content for clarification purposes only and are not requirements in the context of compliance with this standard.



‘So far as is reasonably practicable’ statements must at a minimum result in the provision of a technical risk assessment including proposed list of design controls to demonstrate compliance to this standard.

Any third party or contractor undertaking activities on Yarra Trams assets shall complete and return a compliance schedule for this standard. Assessment of compliance shall be provided for each requirement, defined by one of three permissible responses:

- Compliant;
- Partially Compliant;
- Non-Compliant.

Absolute requirements in this standard are defined within square brackets i.e. [AM 4000mm +/-1%]. Absolute values shall not be accepted without prior consultation and acceptance by Yarra Trams. Deviation beyond Absolute values shall not be accepted under any circumstances.

4 REQUIREMENTS

4.1 Design Requirements

The design, construction and commissioning of sanding systems to be used on trams in the Yarra Trams Network shall comply with:

- AS 4292 Railway Safety Management, and
- This Standard

4.1.1 General

- 4.1.1.1 All trams operating on Yarra Trams Network shall be designed and constructed with a sanding system that deposits silicate sand or a proven and qualified alternative to silicate sand.
- 4.1.1.2 For the purpose of specifying the adhesion enhancement system, the term *sand* in its various forms, shall be taken to mean Silicate Sand or alternative adhesion improving medium as is proven and qualified for use on trams operating on the Yarra Trams Network, or the operational application of the medium; *sanding, sanding system, etc.*; unless expressly indicated.
- 4.1.1.3 The sanding system shall be operable during both braking and traction conditions. It shall be able to be operated at standstill for testing purposes.
- 4.1.1.4 The sanding system shall be designed to maximise the effectiveness of operation whilst minimising the rate of consumption of sand. Sanding systems on existing trams on the Yarra Trams Network shall comply with this requirement SFAIRP.



- 4.1.1.5 The position of any part of the sanding system shall comply with the tram's kinematic outline as per the Yarra Trams CE-021-ST-0019 Rolling Stock - Tram - Outlines and with STD_T0306 *Standard Drawing for Tram Kinematic Outline*.
- 4.1.1.6 The sanding system shall interface with the TCMS SFAIRP.
- 4.1.1.7 Sand shall be delivered to both rails.
- 4.1.1.8 Operational requirements for the sanding system are set out in section 4.2.
- 4.1.1.9 Where the medium used for low adhesion compensation is silicate sand, the sanding system shall be designed to use sand that complies with Appendix D.
- 4.1.1.10 Upon delivery, silicate sand shall be inspected and certified to compliance with relevant standards as described in Appendix D, using BS 812.1 - *Methods for sampling and testing of mineral aggregates sands and filters*.
- 4.1.1.11 With respect to new trams offered for use on the Yarra Trams Network; adhesion enhancement systems not involving the use of silicate sands shall perform in accordance with CE-021-ST-0029 Rolling Stock - Tram - Braking Systems and from CE-021-ST-0018 Rolling Stock - Tram – Traction Systems.

4.1.2 Sand Boxes

The following applies to the design of the on-tram storage and replenishment of the medium.

- 4.1.2.1 The tram shall carry sufficient sand to enable the sand containers to be re-filled at twice the normal operational interval for re-sanding trams, the interval of such may vary with seasonal demand for the use of the sanding system; therefore the Sand boxes shall be designed to cater to twice the operational worst case demand.

Information: The current normal operational interval for W, Z, A, B, D and E Class trams is on a daily basis for re-sanding trams. The current normal operational interval for C Class trams is every 2 weeks.

- 4.1.2.2 Sand box shall be designed and constructed to prevent the ingress of moisture and that the sand flows freely and is distributed as required.
- 4.1.2.3 The sand box shall be replenished through weatherproof filling points external to the tram.
- 4.1.2.4 The sand filling points shall have the ability to be locked closed.
- 4.1.2.5 Driver shall be able to ascertain the level of sand in each sand box.
- 4.1.2.6 Sand levels shall be monitored, and a warning provided to the driver in the active cab when at least one sand box has a low sand level SFAIRP.



4.1.3 Sand Delivery System

- 4.1.3.1 The quantity of sand delivery positions shall be sufficient to achieve the required performance.
- 4.1.3.2 Rate of sand delivery shall be adjustable by an authorised person to meet braking / traction requirements.
- 4.1.3.3 The discharge hose or nozzle, shall be located as close to the wheel rail interface as possible, aimed at a point on the rail just in front of the wheel rail contact point.
- 4.1.3.4 Sand delivery hoses should be designed such that they do not become blocked with sand or any other material when operating in all weather conditions experienced on the Yarra Trams Network. Anti-blockage performance shall also apply to recovery from immersion in water; where this occurs at known locations in the Yarra Trams Network.
- 4.1.3.5 The discharge nozzle shall have provision for adjustment to allow for optimal deposition of sand onto the rail head.

4.2 Operational Requirements

Taken from internal Yarra Trams standard CE-021-ST-0029 Rolling Stock - Tram - Braking Systems and from CE-021-ST-0018 Rolling Stock - Tram – Traction Systems, the following table lists each application mode and the need for the application of sand to that mode.

Table 1 - Application of sand to mode of operation

Adhesion Mode	Mode Description	Sanding	Requirement
Service Brake	General in-service braking	Automatic	Automatically applied and metered by a control system
Emergency Brake	Brake to be used in emergencies.	Always	Sanding is to be applied whilst emergency braking is applied and the tram is in motion. Sanding shall always be applied to pull tram up
Safety Brake		Yes	
Holding Brake	Static braking to hold stationary tram whilst in service	No	Tram is at rest. Sanding will not assist stopping effort
Parking Brake	Static brake to immobilise the tram	No	Tram is at rest. Sanding will not assist stopping effort
Sand Button Tram Power On	Driver Operated Sand Button Power to tram is on	Manual	Used for testing by Driver during pre-start and at the Driver’s discretion whilst in motion



Adhesion Mode	Mode Description	Sanding	Requirement
Acceleration	Tram is operational and attempts to move from rest	Automatic & Manual	Automatically applied and metered by a control system. Automatically applied but may be manually operated by the driver to provide additional traction

4.2.1 Automatic Sanding

4.2.1.1 The sanding system shall be automatically activated by a request from the slip/slide control system;

Example: Slip/slide control system activates the sanding equipment when any wheelset on the vehicle containing the sanding equipment suffers a significant level of slide or slip due to low adhesion in both braking and traction.

4.2.1.2 The sanding system shall be activated by emergency braking, as defined in CE-021-ST-0029 *Rolling Stock - Tram - Braking Systems*.

4.2.1.3 The sanding system shall be activated by safety braking, as defined in CE-021-ST-0029 *Rolling Stock - Tram - Braking Systems*.

4.2.2 Manual Sanding

4.2.2.1 The driver shall have the ability to manually activate the sanding system during traction, service braking and at standstill (e.g. during pre-driver checks and maintenance).



5 RELATED LEGISLATION & DOCUMENTS

The following table lists documents that shall be read with this Standard.

Name	Document number
Railway Safety Management – Part 3: Rolling Stock	AS 4292.3
Rolling Stock - Tram - Braking Systems	CE-021-ST-0029
Rolling Stock - Tram – Traction Systems	CE-021-ST-0018
Rolling Stock - Tram - Outlines	CE-021-ST-0019
Methods for sampling and testing of mineral aggregates sands and filters	BS 812.1
American Water Works Association B100 (Grade 16/30)	AWWA B100 (Grade 16/30)
American Foundry Association 41 for Silica Sand	AFS-41 Silica Sand
Rocla 40 (Considered the equivalent of AFS-50)	Rocla 40
AMS03 Taxonomy	CE-023-IS-0001

DOCUMENT VERSION CONTROL

Version History	Date	Detail
1.0	11 Mar 2020	Original approved issue.
2.0	21 May 2020	Correction of errors in Appendix B and amendments to main document



APPENDIX A – GLOSSARY

The following table lists the specific terms used within this Standard. Further guidance on engineering terms used within Yarra Trams is on the AMS Glossary.

Word	Definition
AMS	Asset Management System.
Emergency Braking	The emergency brake is the highest level of braking used to bring a tram to a top as quickly as possible. It usually consists of electric and mechanical braking along with track brakes and sanding.
Grandfather Rights	In specified and approved situations only; assets afforded Grandfather Rights need not be made to comply with the current version of the specific standard.
High floor trams	A high floor tram is a tram that has one or more step between entrance and the passenger cabin. Class W/Z/A & B trams operating on Yarra Trams Network are high floor trams.
Low floor tram	A low floor tram is a tram that has no step between entrance and the passenger cabin. Class C/D & E trams operating on Yarra Trams Network are low floor trams. In these trams the saloon floor is level with the platform stops of the Yarra Trams Network.
Operator	The entity responsible by reason of ownership, control or management, for the provision, maintenance or operation of Trams, or a combination of these, or a person or body acting on its behalf.
Safety Braking	The safety brake is a brake triggered by the vigilance control, deadman system or “green loop” function. This brake brings the tram to a standstill at a rate generally greater than the service brake, but less than the emergency brake.
Sand Box	An on-board storage vessel for the sand supply to sanding equipment.
Sand Delivery Rate	Mass of the sand delivered to each rail head during operation of the sanding valve.
Sanding Position	The location at which sand is delivered.
Service Braking	Braking used under normal operation of the tram by driver to control the tram’s speed, or stop the tram under normal conditions (e.g. coming to stop at an intersection or a tram stop).
SFAIRP	So Far As Is Reasonably Practicable
Shall	With reference to the CE-023-IS-0001 - AMS03 Taxonomy, the word “Shall” is taken in this context to mean a non-optional activity or requirement.
Slide	The condition in which rotational speed of wheelsets is less than tram linear speed.
Slip	The condition in which rotational speed of wheelsets is more than tram linear speed.
TCMS	Tram Control Monitoring System



APPENDIX B – APPLICABILITY MATRIX

Tram Classes listed below will have Grandfather Rights with respect to compliance with the listed clauses of this standard.

Table 2 - Application of clauses to Tram class

Clause	Class W8	Class Z	Class A	Class B2	Class C1&C2	Class D1&D2	Class E
4.1.1.1	✓	✓	✓	✓	✓	✓	✓
4.1.1.2	✓	✓	✓	✓	✓	✓	✓
4.1.1.3	✓	✓	✓	✓	✓	✓	✓
4.1.1.4	✓	✓	✓	✓	✓	✓	✓
4.1.1.5	✓	✓	✓	✓	✓	✓	✓
4.1.1.6	✓	✓	✓	✓	✓	✓	✓
4.1.1.7	✓	✓	✓	✓	✓	✓	✓
4.1.1.8	✓	✓	✓	✓	✓	✓	✓
4.1.1.9	✓	✓	✓	✓	✓	✓	✓
4.1.1.10	✓	✓	✓	✓	✓	✓	✓
4.1.1.11	✗	✗	✗	✗	✗	✗	✗
4.1.2.1	✓	✓	✓	✓	✗	✓	✓
4.1.2.2	✓	✓	✓	✓	✓	✓	✓
4.1.2.3	✓	✓	✓	✓	✓	✓	✓
4.1.2.4	✓	✓	✓	✓	✓	✓	✓
4.1.2.5	✓	✓	✓	✓	✗	✓	✗
4.1.2.6	✗	✗	✗	✗	✗	✗	✓
4.1.3.1	✓	✓	✓	✓	✓	✓	✓
4.1.3.2	✓	✗	✗	✗	✗	✓	✓
4.1.3.3	✓	✓	✓	✓	✓	✓	✓
4.1.3.4	✓	✓	✓	✓	✓	✓	✓
4.1.3.5	✓	✓	✓	✓	✓	✓	✓
4.2.1.1	✗	✓	✓	✓	✓	✓	✓
4.2.1.2	✓	✓	✓	✓	✓	✓	✓
4.2.1.3	✓	✓	✓	✓	C1: ✓ G2: ✗	✗	✗
4.2.2.1	✓	✓	✓	✓	✓	✓	✓



APPENDIX C – SANDING EQUIPMENT OF YARRA TRAMS FLEET

This section is for informative purposes.

W7 & W8 Class Trams

- Equipped with four (4) sanding boxes. Sand is delivered to the rail head by the nozzles positioned in front of the leading wheelset of each bogie in the selected direction of travel as shown in figure 1. Each sand box has a clear window to show the sand level, which can be viewed from inside the saloon.
- Sand to the rails is administered by a gravity drop system.
- Type of sand specified for these trams is American Foundry Society AFS 41 Silica Sand. Rocla 40 is also suitable. American Water Works Association AWWA B100-89 (Grade 16/30) can be used if these trams are stabled in depots having a majority of low floor trams.
- Sand is automatically delivered to the rail head during safety and emergency braking.
- Manual operation of sanding system is provided by pushing “Sand” foot paddle by driver.

Z & A Class Trams

- Equipped with four (4) sanding boxes. Sand is delivered to the rail head by the nozzles positioned in front of the leading wheelset of each bogie in the selected direction of travel as shown in figure 1. Each sand box has a clear window to show the sand level, which can be viewed from inside the saloon.
- Sand to the rails is administered by a gravity drop system.
- Type of sand specified for these trams is American Foundry Society AFS 41 Silica Sand. Rocla 40 is also suitable. American Water Works Association AWWA B100-89 (Grade 16/30) can be used if these trams are stabled in depots having a majority of low floor trams.
- Sand is automatically delivered to the rail head during safety and emergency braking.
- Sand is automatically delivered to the rail head in case of sanding request by the slip/drive control system.
- Manual operation of sanding system is provided by pushing “Sand” button by driver.

B Class Trams

- Equipped with eight (8) sanding boxes. Sand is delivered to the rail head by four (4) nozzles positioned in front of the motorised wheelset in the selected direction of travel. Four (4) nozzles located at the middle of each vehicle in both sides as shown in figure 1. Each sand box has a clear window to show the sand level, which can be viewed from inside the saloon.
- Sand to the rails is administered by a gravity drop system.
- Type of sand specified for these trams is American Foundry Society AFS 41 Silica Sand. Rocla 40 is also suitable. American Water Works Association AWWA B100-89 (Grade 16/30) can be used if these trams are stabled in depots having a majority of low floor trams.
- Sand is automatically delivered to the rail head during safety and emergency braking also in case of sanding request by the slip/drive control system.
- Manual operation of sanding system is provided by pushing a “Sand” button by the driver.



C Class Trams

- Equipped with eight (8) sanding boxes. Sand is delivered to the rail head by the nozzles positioned in front of the leading wheelset of each motorised bogie in the selected direction of travel as shown in figure 1. Sand level usage is estimated by the traction control unit and a warning is displayed to the driver when the sand level falls to a reserve level.
- The air compressor supplies the sand distribution system with compressed air. The air compressor is operated with a voltage of 24 VDC.
- Type of sand specified for these trams is American Water Works Association AWWA B100-89 (Grade 16/30).
- Sand delivery rate: 820 – 950 gr/min/rail, which can be adjusted during maintenance.
- Sand is automatically delivered to the rail head during safety and emergency braking also in case of sanding request by the traction control system in the event of a wheel slide.
- Manual operation of sanding system is provided by pushing a “Sand” button by driver. In the event of a wheel slip (i.e. when accelerating) the Sand button illuminates to indicate the occurrence of low adhesion.

D Class Trams

- Equipped with eight (8) sanding boxes. Sand is delivered to the rail head by the nozzles positioned in front of the leading wheelset of each motorised bogie in the selected direction of travel as shown in figure 1. Each sand box has a clear window to show the sand level, which can be viewed from inside the saloon.
- The air compressor on each sand box supplies the sand distribution system with compressed air. Each air compressor is operated with a voltage of 24 VDC.
- Type of sand specified for these trams is American Water Works Association AWWA B100-89 (Grade 16/30).
- Sand delivery rate: 1032 – 1356 gr/min/rail, which can be adjusted during maintenance.
- Sand is automatically delivered to the rail head during emergency braking, also in case of sanding request by the traction control system in the event of a wheel slide.
- Manual operation of sanding system is provided by pushing a “Sand” button by driver. In the event of a wheel slip (i.e. when accelerating) the Sand button illuminates to indicate the occurrence of low adhesion.

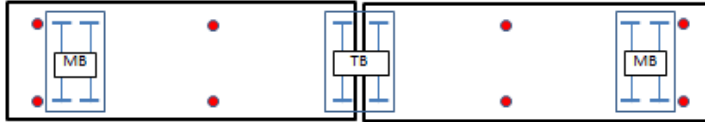


E Class Trams

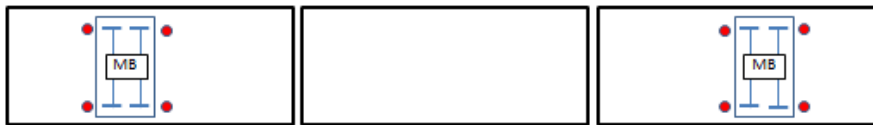
- Equipped with twelve (12) sanding boxes. Sand is delivered to the rail head by the nozzles positioned in front of the leading wheelset of each motorised bogie in the selected direction of travel as shown in figure 1.
- Air compressors supply the sand distribution system with compressed air. The air compressor is operated with a voltage of 24 VDC.
- Type of the sand used for these trams is American Water Works Association AWWA B100-89 (Grade 16/30).
- Sand delivery rate: 1200 gr/min/rail, which can be adjusted during maintenance.
- Sand is automatically administered to the rail head during emergency braking also in case of a sanding request by the slip/drive control system.
- Manual operation of sanding system is provided by pushing a “Sand” button by driver.



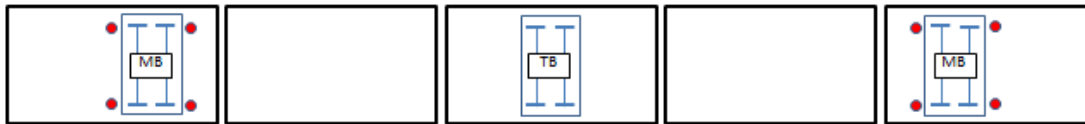
W, Z & A Class



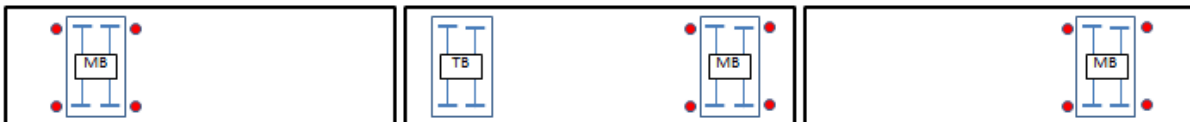
B Class



C1 & D1 Class



C2 & D2 Class



E Class

● Sanding Nozzle

MB: Motorised Bogie

TB: Trailer Bogie

Figure 1– Location of sanding nozzles on Yarra Trams fleet



APPENDIX D – SILICATE SAND SPECIFICATION

For adhesion enhancement systems using Silicate Sand as the medium; sand shall be clean, sharp and free from loam, salt or other deleterious material. The minimum requirements for both mechanical and chemical specification follow: -

- moisture content to be < 1% by mass;
- acid content to be < 0.2% by mass;
- when tested for clay, silt and dust in accordance with method B of BS 812, the percentage of material passing a 75micron sieve shall not exceed 0.3%, and;
- maximum particle size <= 1.7mm.
- Sand provided to Low Floor Trams shall conform to AWWA B100 (Grade 16/30)
- Sand provided to High Floor Trams shall conform to AFS-41 Silica Sand