Standard

Rolling Stock - Tram - Bogies

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1 PURPOSE

The purpose of this document is to specify the minimum requirements for function, performance and maintenance of bogies, wheels and bogie mounted equipment in operation on existing Yarra Trams rolling stock fleet.

2 SCOPE

The scope of this standard is only requirements applicable to the maintenance and modifications to existing trams.

This standard does not specify requirements for design or procurement of new trams.

This standard defines the minimum requirements to support the safe maintenance of the bogies and running gear on existing Yarra Trams rolling stock fleet.

This standard considers the differing age profiles and tram designs in use and any changes to the existing trams. This standard recognises that any previous designs or modifications to a tram system will have been designed to those standards in force at the time of the tram design and manufacture. Some of the existing trams will have been designed to standards no longer in force and possibly no longer available. Accordingly, this standard only documents the 'as designed' or current modification level functions, performance characteristics and maintenance requirements for each existing tram type.

The requirements in this standard are derived from the following sources:

- OEM manuals supplied at the time of manufacture
- Previous upgrades/ modifications undertaken since the time of manufacture
- The original specifications for the trams
- Standards available at the time of design
- Local Subject Matter Expert knowledge

Unless otherwise stated, application of this standard is not retrospective to existing trams that are not being modified.

Any future modifications or enhancements to trams, for example for obsolescence, safety or to improve performance, shall, so far as is reasonably practicable, comply with currently accepted standards.

The design and review process shall comply with requirements of the Yarra Trams 'Manage Design Procedure' (CE-021-PR-0006).

3 COMPLIANCE

This standard shall be fully complied to when undertaking maintenance or modifications on the existing tram fleets. Deviation from this standard is only permitted when a Waiver has been sought and approved by the Engineering Design Authority at Yarra Trams.

The Yarra Trams Engineering Change Management Procedure (CE-021-PR-0020) shall be followed in all circumstances where change is proposed to bogies, wheels and bogie mounted equipment. For the avoidance of doubt this shall include, but not be limited to:

- An engineering risk assessment in accordance with the Yarra Trams Safety Management System.
- An assessment to determine the appropriate Safety Integrity Level (SIL) for any modification that has electrical/electronic/programmable electronic safety-related systems. The SIL assessment shall comply with International Electrotechnical Commission's (IEC) standard IEC 61508.
- Complying with the requirements of EN 50155 for any modification that has electronic equipment.
- A list of all applicable laws and standards to be complied with for that modification for review and agreement by Yarra Trams Engineering Design Authority.

A compliance schedule shall be completed and returned for any engineering change activities on bogies, wheels and bogie mounted equipment. 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 and a tolerance level as a percentage or range e.g. [AM 4000mm ± 1%. or 3960mm to 4040mm].

Compliance terminology defined in this standard shall be adhered to with the following definitions:

- ‘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 an engineering risk assessment in accordance with the Yarra Trams Safety Management System and So Far As Is Reasonably (SFAIRP) Guidance Notes (Rail Safety Regulator).

Note: All standards referred to within this document are correct at the time of writing. It is the responsibility of the user to always ensure the most current version of any standard is referred to when applying any given standard.

4 REQUIREMENTS

4.1 General arrangements

The function of the bogies is to support the mass of the trams, to steer the trams and to provide a level of damping of the shocks transmitted by the track and provide a comfortable ride when in motion.

There are bogies from multiple manufacturers currently in operation across Yarra Trams, of two functional types:

- Powered Bogies
- Non-Powered/Trailer Bogies

The arrangements in this standard applies to all bogies.

4.2 Maintenance Plan

4.2.1 General

A maintenance plan shall be in place that identifies all specifications, procedures and processes, including examination, inspection and testing, for maintenance of the bogies and bogie components, which shall be applied at a frequency adequate to maintain the bogies.

4.2.2 Wheel and axle maintenance plan

Wheels and axles are safety-critical components and all maintenance activities shall be controlled and documented to maintain their condition within safe limits (refer EN 15313).

4.2.3 Maintenance records

Records should be sufficient to ensure traceability so that service problems or incidents can be investigated and rectified.

4.2.4 Review of maintenance plan

The maintenance plan shall be reviewed and updated in accordance with the Yarra Trams Engineering Change Management Procedure based on service requirements, maintenance records and time.

4.3 Wheels and Axles

4.3.1 Wheels and Axles Maintenance

4.3.1.1 For information, a wheel and axle arrangement may comprise of an axle with wheels mounted, which can be tyred, bolted or pressed, Monoblock or resilient wheels and includes wheelsets which can also be fitted with axle journal bearings, axle boxes, brake discs, transmissions, resilient couplings and noise damping systems.

4.3.1.2 For any given wheels and axles design type within its scope the maintenance plan shall set out the specific processes, tools, gauges and wear or defect limits that are required for maintenance.

4.3.1.3 A risk assessment shall be undertaken to determine the impact of the change in duty on wheels or axle maintenance requirements. The risk assessment shall consider factors that affect the service life of wheels and axles, including the following;

- Axle load.
- Route change / increase in kilometres run / change in curvature.
- Up-rated speed.

4.3.2 Maintenance processes

Certain processes can damage wheels and axles. To prevent damage the following should not be permitted, except as allowed by the individual sub-clause limitations below.

4.3.2.1 Handling and storing

Wheels and axles shall be handled and stored in accordance with RIS-2704-RST or recognised equivalent standard.

4.3.2.2 Power tools

Power tools shall not be used at any time other than as part of an approved process.

4.3.2.3 Welding, brazing or other thermal process

Except where it is set out in a validated procedure welding, brazing or other thermal process shall not be carried out on or near wheels or axles. Welding or grinding spatter and sparks can damage the surface of component parts of the wheel or axle causing localised imperfections on the material surface that could subsequently develop into a fracture.

4.3.2.4 Electrical connections

The only electrical connections or current returns that are permitted to attach to the wheel or axle are those that are:

- Part of the wheel design, e.g. shunts.
- Needed to carry out magnetic particle inspection (MPI).
- Needed for welding using a validated procedure.
- Needed for electrical resistance testing.

4.3.2.5 Tools

Use of any tool which could cause notches to wheels or axles shall not be permitted other than in accordance with a validated procedure.

4.3.2.6 Grease

Grease should not be applied to axle or suspension tube bearings until the bearings have been assessed for smooth rotation without grease.

4.3.2.7 Grinding

Hand-grinding to remove sharp edges or flanges shall not be permitted other than in accordance with a validated procedure.

4.3.2.8 Welding on vehicles

Electrical welding of a railway vehicle fitted with wheels and axles shall only be undertaken with adequate electrical return current bonding to prevent electrical current passing through the wheelset and bearings.

4.3.3 Wheels and axles examination (refer 2595(RS-022-WI-0129))

4.3.3.1 Wheels and axles shall be examined during routine services by trained employees in accordance with the maintenance plan and maintenance instructions. In addition, wheels and axles shall be examined in the event of:

- Derailment.
- Receipt of an incident report, for example rough riding, striking an object, unusual noise, wheel flats etc.
- Brake drag event (i.e. an unsolicited partial brake application).
- The vehicle or wheelset having been stored for a period of time.
- Identification of other deficiencies associated with wheels and axles.

4.3.3.2 The 'Worst wheels in fleet' condition report from the maintenance management system should be reviewed and wheel maintenance shall be managed in accordance with 2595(RS-022-WI-0129).

4.3.4 Wheelset visual examination

4.3.4.1 Wheelset visual examinations shall include checks for: Corrosion anywhere on the axle, wheel (other than the tread) or wheel center.

4.3.4.2 Examination for damage anywhere on the axle, wheel or wheel center as defined in the relevant maintenance standard, shall include:

- Cracks.
- Scoring.
- Burrs or raised edges.
- Sharp indentations.
- Impact marks.
- Fretting.
- Damage to protective coatings.

4.3.4.3 Examination for flange and tread damage and shall include:

- Wheel flats.
- Flange wear / thinning of flange.
- Tread run-out.
- Flange build-up.
- Steps or sharp radii on the flange (toe radius build-up or sharp flange).
- Circumferential steps in the flange profile.
- False flange / tyre hollowing.

- Flange back distortion.
- Cavities.
- Local tread collapse in the form of a rim face bulge.
- Any signs of overheating anywhere on the wheelset.
- Cracks in the axle, wheel or tyre.
- Any sign of movement at interference fit interfaces.
- Checks for damage to, or missing, oil injection hole plug.
- Damage to wheel shunts.
- Lateral or radial movement between the tyre and wheel centre.
- Integrity of resilient rubbers between wheel and tyre.

4.3.5 Wheelset wear measurement

4.3.5.1 The wheel maintenance plan shall document the intervals at which the wheel tread profile and the wheelset back-to-back measurement are to be measured and associated measurement data is to be analysed for future maintenance decisions.

4.3.5.2 Wheels shall not be allowed to operate with a wheel profile that is beyond the tolerances as specified for the wheel profile being used.

4.3.5.3 Wheels shall not be allowed to operate with a wheel diameter below that specified in Tram Wheel Maintenance Data (RS-022-IS-0002).

4.3.5.4 The wheelset dimensions shall be checked when a wheelset has been involved in a derailment, or when examined as part of planned maintenance to identify if:

- There is evidence of overheating.
- The wheel tread wear groove is not visible.
- There is evidence of unusual wear patterns to the tread or the flange.
- There is any other reason to suspect that dimensions are at variance with requirements.

4.3.5.5 The following parameters shall be checked:

- Back-to-back dimension.
- Wheel tread diameters.
- Wheel tread diameter difference.
- Wheel profile.

4.3.5.6 In the event that a wheel impact load detection threshold is exceeded, but no visible tread damage is observed, the wheel shall be checked for out-of-roundness.

4.3.6 Wheel tread measurement

4.3.6.1 When required, the wheel tread profile should be measured using suitable gauges or measuring equipment to measure the parameters as defined in the maintenance instructions.

4.3.6.2 The flange height and thickness shall not be outside the limits specified for the wheel profile within the maintenance instructions.

4.3.6.3 Where wheelset examination shows that the wheelset requires re-profiling due to defects, measurement of the wheel tread profile shall still be undertaken.

4.3.7 Back-to-back measurement

4.3.7.1 The back-to-back dimension of wheels and axle assemblies shall be taken in accordance with the maintenance plan.

4.3.7.2 The back to beck dimension should consider the potential for axle or axle beam bending under load.

4.3.8 Tyre turning

4.3.8.1 Tyre turning shall only be carried out on approved wheel lathes that have been maintained and calibrated using the appropriate tyre profile.

4.3.8.2 Tram tyres that have been identified as worn or damaged beyond allowable tolerances shall be programmed for tyre turning.

4.3.8.3 Where a regular programmed tyre turning plan is in place forming part of a tyre management strategy then this shall be adhered to within the allowable tolerances for each class of tram.

4.4 Axle Bearings

4.4.1.1 The maintenance plan shall contain maintenance and overhaul instructions for axle bearings for each type of axle bearing in use by Yarra Trams (refer to GM/GN2646).

4.4.1.2 The maintenance plan shall as a minimum, set out the requirements for:

- Floats, clearances.
- Grease (if applicable).

4.4.1.3 The maintenance plan shall include the following where applicable:

- The maximum time or distance between visual examinations of the assembly on the wheelset.
- The maximum time or distance between rotational and end float checks.
- The method to be used and the maximum interval between the injection of a measured quantity of new grease into a cartridge bearing, or introduction of new grease into an axle box bearing.
- The maximum time or distance at which the axle bearings should be overhauled.
- The grease type to be used.

- The criteria (if any) at which the axle bearings should be scrapped.
- The documents specifying the relevant standards for examination and acceptance at overhaul.
- The documents specifying the work instructions for each activity in the maintenance plan.
- The minimum maintenance facilities required for the specified maintenance and overhaul of the axle bearings.
- The minimum level of competence for staff engaged in the execution of the specified maintenance and overhaul of the axle bearings.

4.5 Vehicle Suspension

4.5.1.1 For information, primary and secondary suspension systems are designed to contain the vibrations caused by the interaction between the track and the wheels. The primary suspension consists of spring and damper components that allows the wheels and wheelset to move within the bogie frame. The secondary suspension can consist of springs, rubber or pneumatic suspension components that interconnects the car body and bogie, with the purpose of isolating the car body from excitations transmitted from track irregularities via the wheelset and bogie frame.

4.5.1.2 The maintenance plan shall contain maintenance and overhaul instructions to ensure that the tolerances specified as originally designed (subject to any modifications) are met.

4.6 Bogie to vehicle interface

4.6.1.1 The maintenance plan shall ensure that the integrity of the bogie to vehicle interface is maintained in the event of a derailment.

4.7 Braking system

4.7.1.1 Refer to Yarra Trams Standard, Rolling Stock - Tram - Braking Systems (CE-021-ST-0029) for requirements for brake systems and equipment.

4.8 Motors and Gearboxes

4.8.1.1 Refer to Yarra Tram Standard, Rolling Stock - Tram - Traction Systems (CE-021-ST-0018) for requirements for motors and gearboxes.

4.8.1.2 Gearbox designs should have a breather that is located so as to minimise dust ingress and the ingress of sand from the brake system.

4.8.1.3 Gearbox design loads shall be derived from EN 13749 and the loads shall reflect the mounting arrangement of the bogie i.e. restraints on movement of gearbox mounting to frame and axle shall be taken into account within design load regime.

4.8.1.4 All gearbox components from traction motor to wheel axle shall be designed to withstand the worst-case short circuit torque(s) specified by the motor supplier.

4.9 Bogie Frames

4.9.1.1 Bogie frames shall be inspected and non-destructively tested for corrosion damage, electrical arcing and cracking at periodicities defined within the maintenance plan.

4.9.1.2 Any welding undertaken on low floor tram classes shall comply with the requirements of EN 15085.

4.9.1.3 Any welding undertaken on high floor tram classes shall comply with the requirements of AS 1554.

4.10 Ancillary Systems

4.10.1.1 Bogie mounted systems such as signaling antennas, wheelset lubricators, track brakes, air reservoirs, electrical cabling and pneumatic piping, shall be inspected for damage and security of fixtures and fittings at periodicities defined within the maintenance plan.

4.10.1.2 Any new or modified items that are mounted to the bogie or attached equipment (e.g. gearbox) shall be designed such that they do not resonate with the bogie in any service scenario.

4.10.1.3 Any new or modified items mounted to the bogie frame or axle box need to meet the loads for attachments within EN 13749 in both proof and fatigue.

4.10.1.4 VDV 152 shall be consulted on specific loads for brake systems and dampers.

4.11 Fire

Design changes involving a change of materials used on the bogie shall meet the requirements of Yarra Trams Standard, Rolling Stock - Tram - Fire Safety Systems (CE-021-ST-0024).

5 RELATED LEGISLATION & DOCUMENTS

Document Number	Name
CE-021-PR-0006	EMS04 Manage Design Procedure
CE-021-PR-0020	EMS06 Engineering Change Management Procedure
CE-021-PR-0004	EMS05 Deviation from Standards Procedure
SS-005-MA-0003	Yarra Trams Safety Management System
IEC 61508	Functional Safety
AS 1554	Structural steel welding Set
EN 50155	Railway applications - Rolling Stock - Electronic Equipment
EN 15313	Railway applications - In-service wheelset operation requirements. In-service and off-vehicle wheelset maintenance
EN 15085	Railway applications - Welding of railway vehicles and components - Quality requirements and certification of welding manufacturer
EN 13749	Railway applications - Wheelsets and bogies - Method of specifying the structural requirements of bogie frames
RIS-2704-RST	Railway Standard for Wheelset Handling and Storage
RIS-2004-RST	Rail Vehicle Maintenance
2595(RS-022-WI-0129)	Wheelset Management
2550(RS-022-IS-0002)	Tram Wheel Maintenance Data
GM/GN2646	Guidance on Axle Bearing Maintenance
VDV 152	Recommendations on the Design for Strength of Urban Rail Rolling Stock according to BOStrab
CE-021-ST-0029	Rolling Stock – Tram – Braking Systems
CE-021-ST-0018	Rolling Stock – Tram - Traction Systems
CE-021-ST-0024	Rolling Stock - Tram - Fire Safety Systems

6 DOCUMENT VERSION CONTROL

Version History	Date	Detail
1.0	17 March 2020	Original approved issue

7 GLOSSARY

Term	Definition
Engineering Design Authority	The person or position designated by the Franchisee with the authority to approve engineering design changes, modifications and the TMPs under a system which complies with AS/NZS ISO 9001 Quality Management Systems or similar standard and AS4292 Railway Safety Management as applicable to rolling stock providers.
IEC	International Electrotechnical Commission
OEM	Original Equipment Manufacturers
SIL	Safety Integrity Level
Waiver	Waiver process as per EMS05 Deviation from Standards Procedure.