Standard

Rolling Stock - Tram - Vigilance Systems

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1 PURPOSE

The purpose of this document is to specify the minimum requirements for the function, performance and maintenance of Vigilance Safety Systems on Yarra Trams rolling stock.

2 SCOPE

The scope of this standard is requirements for the function, performance, maintenance and modifications of VSS on existing trams in the Yarra Trams fleet.

This standard does not specify requirements for design or procurement of new Vigilance Safety Systems.

This standard considers the differing age profiles, designs and system types in use at Yarra Trams.

This standard recognises that any previous designs or modifications to a tram system will have been designed to the standards in force at the time of the design, manufacture or modification. Some of the existing trams in the Yarra Trams fleet will may have been designed to standards that are no longer in force and possibly or no longer available. Accordingly, this standard only documents the 'as designed' or current modification level functional and performance characteristics, and maintenance requirements for each 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.

All design and review activity on Yarra Trams assets shall comply with requirements of the Yarra Trams 'Manage Design Procedure' (CE-021-PR-0006).

3 COMPLIANCE

This standard shall be fully complied with 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. 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.
- Compliance 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 existing Yarra Trams assets. 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 Maintenance of Existing Trams

There are two types of Vigilance Safety Systems currently in use across the Yarra Trams rolling stock fleets:

- Deadman's Switch, and
- Vigilance Control System.

These are described below, with the details of which system is fitted to what tram class described in Section 5.

There are two main functions of both types of Vigilance Safety Systems:

- to ensure the driver is at the controls in the active cab when the tram is operating, and
- to monitor the responsiveness of the driver and bring the tram to a standstill if the driver fails to acknowledge the necessary control indications within a specified time interval.

4.1.1 Deadman's Switch

A deadman's switch is designed to be deactivated if the driver becomes incapacitated and removed from control. The term 'deadman' is used but is interchangeable with 'foot pilot valve' or 'driver safety control' or 'thumb sensor' or 'Master Controller Handle' or 'Push Button'.

On Yarra Trams rolling stock, the deadman's switch system performance requirements are:

4.1.1.1 **Immobilisation of vacant tram**: If the deadman switch is deactivated it shall provide the capability for the tram to have its park brake applied and allows the driver to leave the control desk.

4.1.1.2 **Deadman Function:** The deadman shall be activated to enable operation and movement of the tram. Releasing the switch results in removal of traction power and brake application, either immediately or after a predetermined time.

4.1.1.3 **Safety Braking/Deadman:** In the case of the foot pedal system, full depression of the pedal shall result in cessation of traction and activation of braking in accordance with Tables 1 and 2 of Section 5.

4.1.2 Vigilance systems

The Vigilance Control System is a timed cycle of warning events, starting with an auditory warning on all tram classes and supplemented with a visual warning on some classes of trams. On Yarra Trams rolling stock, the Vigilance Control System performance requirements are:

4.1.2.1 If the warning event is not acknowledged by the driver, brakes shall be applied in accordance with Tables 1 and 2 of Section 5.

4.1.2.2 The task linked vigilance system shall monitor the progress of the tram and shall reset when a tram driver performs a specific linked activity or driving function (e.g. sound gong, drop sand,

accelerate or deaccelerate). This activity shall indicate to the vigilance system that the tram driver is in control of the tram.

4.1.2.3 Task linked vigilance system activation shall be either time or distance based linked to speed. In either case, if no linked task is carried out within a specified time or distance, a visual alert followed by an audible alert shall be activated. If the alert is ignored after a specified time or distance, a brake application shall be made. The system shall reset if an acknowledgement is made within the specified time or distance.

4.2 Modifications to Existing Trams

4.2.1 Change of Vigilance Safety System

4.2.1.1 Unless specified to do so, there is no requirement to upgrade the Vigilance Safety System (for example from a deadman system to a task-based system) during a modification.

4.2.1.2 Any modification that does not upgrade the Vigilance Safety System shall ensure the system retains its functionality and performance.

4.2.2 Driver incapacitation

4.2.2.1 The interface between the driver and the Vigilance Safety System shall be designed such that it is necessary for the driver to remain at his or her workstation, either sitting or standing, and maintain the detection circuit continuity whilst the tram is in motion.

4.2.3 Circumvention

4.2.3.1 The Vigilance Safety System shall be designed, so far as is reasonably practicable, to prevent intentional or unintentional circumvention of its operation whilst the tram is in motion. Intentional circumvention of the Vigilance Safety System shall only be possible while the tram is stationary using the approved procedure for the tram.

4.2.4 Fail-safe

4.2.4.1 The equipment providing the Vigilance Safety System function shall provide a fail-safe function whenever the tram is not held stationary.

4.2.4.2 This requirement shall apply unless the Vigilance Safety System is isolated in accordance with an authorised procedure to allow the tram to proceed. The Vigilance Safety System shall be designed to make a brake application if the system becomes inoperative due to technical failure or due to inappropriate actions by the driver whilst the tram is moving with the brakes released.

4.2.5 Operation

4.2.5.1 The function of the Vigilance Safety System is to monitor the responsiveness of the driver and shall bring the tram to a standstill if the driver fails to acknowledge the necessary control indications within a specified time interval.

4.2.5.2 The driver control system shall incorporate a timed cycle of warning events that occur before the brakes are applied. These warning events shall follow the following sequence:

- A visual flashing light.
- If flashing light not responded to an auditory warning is given.
- If neither the flashing light or auditory warning is acknowledged, a safety brake application shall be made.

4.2.5.3 Resetting the Vigilance Safety System shall be readily achieved by moving any of the controls back to their predetermined position or range within a specified time interval or otherwise a full safety brake application shall occur.

4.2.5.4 A means shall be provided to suppress the Vigilance Safety System without driver input, whilst the tram is held stationary.

4.2.5.5 Only the cab under the control of the driver shall be able to enable the Vigilance Safety System.

4.2.6 Human Factors

4.2.6.1 The in-cab, visible warning (vigilance) light shall be clearly visible to the driver at any time of the day or night and not diminish the driver's night vision.

4.2.6.2 The vigilance acknowledgment button or buttons shall be located such that the driver shall be able to reach the button with a distinct motion without upper body movement.

4.2.6.3 The vigilance audible warning shall be distinguishable from any other audible information devices from within the cab.

5 MAINTENANCE PARAMETERS

The systems and parameters table below sets out what is currently in operation.

Table 1: Tram class Vigilance Safety Systems and parameters (Class W8 to D2)

Parameter	Class W8	Class Z	Class A	Class B1/ B2	Class C1&C2	Class D1&D2
System type:	Task linked vigilance	Deadman	Deadman	Deadman	Vigilance Control	Vigilance Control
Operating mode:	Transition on Deadman switch, manual sanding, operation of power controller, operation of brake handle.	Applied when the safety pedal is released or pushed to the floor.	Applied when the safety pedal is released or pushed to the floor.	Applied when the safety pedal is released or pushed to the floor.	Controlled by a capacitive thumb sensor on the driver Master Controller or a foot pedal on the floor below the driver's desk.	Deadman function by depressing Master Controller Handle or Push Button on Left Hand Arm Rest.

Parameter	Class W8	Class Z	Class A	Class B1/ B2	Class C1&C2	Class D1&D2
Timing and warnings:	8 second timer, then buzzer for 4 seconds, then safety brake.	Instantaneous	Instantaneous	Instantaneous	If either the thumb sensor or foot pedal are released for more than 3 secs or maintained for more than 32 secs an alarm will sound in the drivers cabin for a further 2 secs. If no action is taken by the driver in this time the emergency brakes without track brakes will apply automatically and remain engaged until the tram has stopped.	Must be released every 30 seconds or buzzer will sound for 4 seconds and Safety Brake (Full Service) will apply until standstill. On release you have 4 seconds to re-apply otherwise full-service brake applies.
Braking application type:	Safety brake	Safety brake	Safety brake	Safety brake	Full-service brake level plus.	Safety brake
Braking until stand still:	Safety brake to standstill.	No	No	No	Yes	Yes
Recording type:	All data recorded on TRAS.	None	None	None	TCMS stores “Dead Man activation” event in the log that also includes if the cause of the activation was	Data recorded in VCU and Event Recorder.

Parameter	Class W8	Class Z	Class A	Class B1/ B2	Class C1&C2	Class D1&D2
					sensor held on too long or released for too long. The tachometer (event recorder) also records a Deadman activation.	
Other notes:	The original Deadman function is still implemented whereby if the brake handle is let go for 5 seconds the safety brake will apply.	None	None	None	Controller when released whilst in traction mode will spring back to neutral or partial braking mode. Drivers display indicates "emergency braking" when vigilance brake has been applied but the actual brake level is full-service plus and no track brake.	When handle is released whilst in traction mode the tram will maintain traction until the 4 seconds time out, then safety brake will apply. The "Mushroom Pushbutton" activates the "Emergency Brake System".

Table 2: E Class Vigilance Safety Systems and parameters

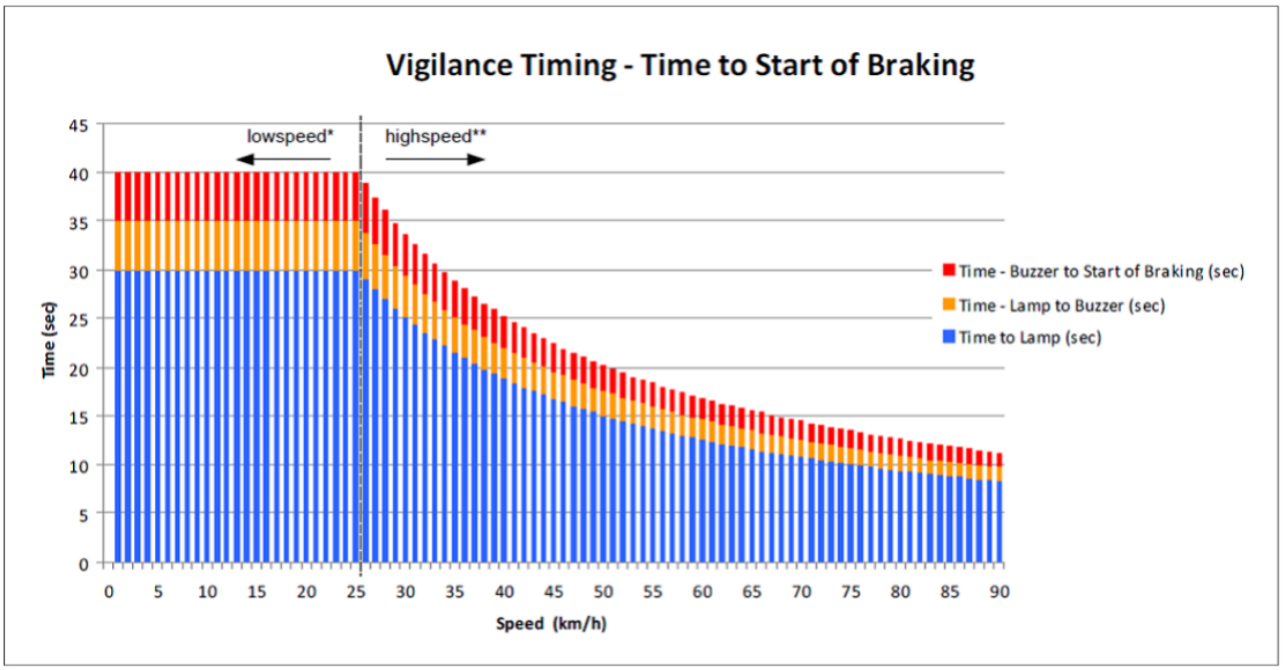
Parameter	Class E	
System type:	**Deadman**	**Task linked vigilance - time / speed dependant**
Operating mode:	Deadman function by depressing Master Controller Handle.	Transition on deadman switch, operation of the master controller (movement greater than 5 degrees), use of the buttons located on the driver's armrest (Hazard Lights, Headlight flasher, Gong, Horn, Track Brake, Door Open, Door Close, Sand, Vigilance).

Parameter	Class E	
Timing and warnings:	If the Master Controller Handle is released a 2 sec alarm will sound. The timer is reset if the Deadman button is re-activated or speed is <0.5km/hr. If no action is taken by the driver the tram will initiate a Force brake application. Brakes will apply automatically and remain engaged until the tram has stopped.	Varies depending on operating conditions. If the tram speed is below 26 km/hr, Vigilance is time-based and if it is above 26 km/hr, Vigilance is distance-based: 1. If no tasked linked signal for 30 sec (time-based) or 210 m (distance-based), then vigilance light is activated. 2. If no action taken by driver for a further 5 seconds (time-based) or 210 m (distance-based), the vigilance alarm is activated. 3. If no action taken by driver for a further 5 sec (time-based) or 35 m (distance-based) a Force Brake Application is made. Prior to the Vigilance alarm sounding, if the driver operates any of the task linked controls then the cycle resets. Once the Vigilance alarm is activated, the cycle can only be reset via activation of the Vigilance Button or the Deadman switch.
Braking application type:	Force Brake	Force Brake
Braking until stand still:	Yes	Yes
Recording type:	TCMS Fault log will record a "Force Brake - VCU" message. OTMR (Data Recorder) will log status of "Force Brake", "Deadman Button" and "Vehicle Speed".	TCMS Fault log will record a "Force Brake - VCU" message. OTMR (Data Recorder) will log status of "Force Brake", "Vigilance signal" and "Vehicle Speed.
Other notes:	5 different Braking Modes on the E-Class tram.	5 different Braking Modes on the E-Class tram.

6 DIAGRAMS AND GUIDANCE

6.1 Diagram 1: Vigilance Timing – Time to Start of Braking

The following diagram illustrates the E class the timing requirements for the current Vigilance Safety System for varying speeds. Its inclusion in this standard is to benchmark any future systems against the current E class performance.



* lowspeed
40sec. -> Criteria for emergency brake is the time.

** highspeed
280m -> Criteria for emergency brake is the distance

Figure 1: E Class Vigilance Safety System speeds and timing

7 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
IEC 61508	Functional Safety
EN 50155	Railway Applications - Rolling Stock - Electronic Equipment
	Yarra Trams Safety Management System

8 DOCUMENT VERSION CONTROL

Version History	Date	Detail
1.0	12 Mar 2020	Original approved issue

9 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.
Force Brake	Combination of Dynamic and disc brakes used when braking application is triggered by the tram. May also be referred to as a safety brake.
IEC	International Electrotechnical Commission
OEM	Original Equipment Manufacturer
OTMR	On Tram Monitoring Recorder
Safety Brake	Combination of dynamic and disc brakes used when braking application is triggered by the tram. May also be referred to as a force brake.
Standstill	The condition where all movement and activity has stopped.
Stationary	Not moving or movable.
TCMS	Tram Control Management System
VCU	Vehicle Control Unit
Waiver	Waiver process as per EMS05 Deviation from Standards Procedure.