

Battery Electric Buses – Electric Powertrain Safety

Issue date: 20 December 2023

Effective date: 20 December 2023

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Document information

Owner: Director Fleet Engineering
Asset Management
Safety, Environment and Regulation

Mode: Buses

Discipline: Fleet

Document history

Revision	Effective date	Summary of changes
1.0	20 December 2023	First issue

Preface

This document is the first issue.

Low floor BEBs have been successfully trialled in NSW. TfNSW is committed to transitioning the current fleet of internal combustion engine buses to BEBs at scale.

BEBs introduce high voltage systems and REESSs which introduce new risks relating to human harm.

The intended outcome of this standard is to reduce the likelihood of human harm by introducing requirements on vehicles with respect to their electric powertrain.

There are no published Australian Design Rules or TfNSW standards to address these risks.

The approach adopted in this document is to apply the technical requirements of the most relevant international standards.

This document forms part of a series of ZEB standards which have been developed in response to TfNSW's program of transitioning the bus fleet to zero emission technology.

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1 Scope

This standard specifies the safety related performance of the electric powertrain and REESSs of BEBs.

The approach adopted is to apply the technical requirements of UN R100 Rev 2, UN R100 Rev 3, and AS ISO 6469.2:2014.

This includes a requirement for a driver warning of a thermal event within the REESS to allow occupants safe exit prior to the presence of a hazardous situation inside the bus.

This standard does not specify requirements of electric components and systems which are not galvanically connected to the high voltage electric powertrain. Nor does it provide design and testing requirements which eliminate the possibility of a thermal event within the REESS.

REESS technology is in phases of continuous evolution. The REESS safety in this standard is focused on lithium-ion REESS risks as these are the most widely used REESS at the time of publication.

This standard does not consider maintenance or recycling.

2 Application

This document applies to bus OEMs in design and manufacture of new BEBs prior to asset handover.

This document applies to all new buses fitted with high voltage electric drivetrain and REESS systems.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS ISO 6469.2:2014 *Electrically propelled road vehicles – Safety specifications – Part 2: Vehicle operational safety means and protection against failures*

Other referenced documents

United Nations, Regulation No. 100 Revision 2, *Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions*

United Nations, Regulation No. 100 Revision 3, *Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be*

Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations

Bus Industry Confederation, July 2023, *Zero Emissions Technology – Electric Power Train Systems*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

ANCAP Australasian New Car Assessment Program

BEB battery electric bus; a bus solely propelled by an electric motor which exclusively draws current from a REESS

bus a passenger vehicle having more than 9 seating positions, including that of the driver. (Source: *Vehicle Standard (Australian Design Rule – Definitions and Vehicle Categories) 2005* – modified as the original definition is for an omnibus)

date of manufacture for a road vehicle entered onto the Register of Approved Vehicles under the Road Vehicle Standards Act 2018, the date of that entry. Otherwise, the date the vehicle is available in Australia in a condition that will enable an 'Identification Plate' to be lawfully affixed to the vehicle. (Source: *Vehicle Standard (Australian Design Rule – Definitions and Vehicle Categories) 2005*)

electric powertrain the complete electrical circuit of a vehicle required to propel the vehicle and charge the REESS including the REESS and traction motor, as well as all harnesses, connectors and associated electrical systems such as voltage converters

high voltage a system or circuit with greater than 60 volts DC or greater than 30 volts AC root mean square

OEM original equipment manufacturer

REESS rechargeable electrical energy storage system; the system that provides electrical energy within the electric powertrain to propel the vehicle. The REESS includes the energy storage, the structure which encapsulates the energy storage as well as associated control and support systems such as temperature control and cell management systems. An additional battery may be used to power systems other than the electric powertrain which is not considered to be a REESS.

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thermal event when the internal REESS temperature has risen significantly above the REESS maximum operating temperature as determined by the REESS manufacturer

UN R100 Rev 2 Regulation No. 100 Revision 2, *Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used*

on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions

UN R100 Rev 3 Regulation No. 100 Revision 3, *Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations*

ZEB zero emissions bus

5 Electric powertrain safety requirements

The electric powertrain safety requirements can be summarised as:

- meeting all technical requirements of UN R100 Rev 2 and specific technical requirements of UN R100 Rev 3 as specified in Sections 5.1 and 5.2 of this document; or
- meeting all technical requirements of UN R100 Rev 3. UN R100 Rev 2 covers safety requirements of the REESS and the other high voltage systems in the powertrain.

Part II of UN R100 Rev 2 relates to the REESS safety which includes requirements to reduce the likelihood of failure which may lead to REESS thermal runaway.

However, UN R100 Rev 2 has no requirement to monitor the safety of the REESS when the vehicle is in operation, nor does it have a requirement to warn the driver of a critical failure which may lead to thermal runaway.

Real time monitoring and adequate warnings are essential elements of REESS safety in ZEBs. UN R100 Rev 3 was published to address these elements and it includes real time monitoring and driver warnings.

5.1 Applicable requirements of UN R100 Rev 2

Vehicles equipped with an electric powertrain and a REESS, shall meet all of the technical requirements in sections 5 and 6 of UN R100 Rev 02.

Sections 3, 4, 7, 8, 9, 10, 11 and 12 of UN R100 Rev 2 shall not apply to ZEBs covered by this standard.

5.2 Applicable requirements of UN R100 Rev 3

Vehicles equipped with an electric powertrain and a REESS, shall comply with paragraphs 5.2.3, 6.13, 6.14 and 6.15 of UN R100 Rev 3.

Where UN R100 Rev 3 paragraphs 6.13 to 6.15 make references to 'technical service', 'TfNSW' shall be substituted.

6 Confidentiality of information

This standard includes specific requirements for OEMs to provide technical documentation that addresses specific aspects, such as REESS warnings, low-temperature protection and thermal propagation. To describe the required aspects sufficiently, such documentation shall include an OEM's confidential and proprietary information. TfNSW shall take necessary measures to protect such intellectual properties.

7 Data requirements

The following safety related data on the REESSs shall be available to both TfNSW and the operator:

- safety related criteria for withdrawing the REESS from service (this should consider all key performance indicators deemed by the OEM as critical for safe operation of the REESS)
- special transport and storage instructions including any special conditions for the REESS, inclusive of defective ones
- descriptions of the battery management systems (BMSs) (logic, control level, diagnostic level, charging management, balancing and so on)
- descriptions of safety related driver warnings regarding the electric powertrain (sequence, significance, action expected of the driver and so on)
- information for emergency services regarding thermal events, isolation procedures and so on.

8 Powertrain operational safety requirements

The electric powertrain shall meet the requirements of clauses 5.1 to 5.5 and 9 of AS ISO 6469.2:2014.

The OEM shall provide comprehensive safety and emergency response information to ANCAP for inclusion in the ANCAP rescue smartphone application.

9 Transition timing

BEBs procured under TfNSW contracts shall comply with this standard as soon as practicable but no later than 1 September 2025.

10 Verification and certification

The bus OEM shall provide documentation which confirms compliance with this standard to both the TfNSW contract representative and the bus operator.

A suitable compliance documentation form is in section 10.1 of *Zero Emissions Technology – Electric Power Train Systems*.

The bus operator shall confirm that they have received compliance documentation prior to acceptance of a bus during the handover process.