NSW GOVERNMENT

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Standard

Battery Electric Buses – Functional Range

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Document information

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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.

The energy consumption of the bus traction systems as well as the range of the REESS both play significant roles in determining the most appropriate BEB for specific applications.

The intended outcome of this standard is to assist TfNSW to compare the electrical energy use and range of BEBs to assist with selection of the best value for money BEB based on practical standardised test results in route service bus applications.

There are no published Australian Design Rules or TfNSW standards to aid like for like comparisons on energy consumption and range.

The approach adopted is to apply an internationally recognised energy consumption test.

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 sets out a standard method for determining energy consumption from the traction systems and range from REESSs. It also specifies a requirement for reporting HVAC system energy consumption.

The standardised testing method was developed to provide like for like comparisons of energy consumption and range using repeatable tests which eliminate major variables. The test results provide the maximum possible range due to the elimination of these variables. Real world energy results will vary according to number of passengers, outside temperature, topography, and driver behaviour.

The approach adopted is to apply the UIPT SORT cycles in *UITP Project 'SORT' – Standardises On-road Test Cycles* and *UITP Project E-SORT – Cycles for electric vehicles.*

2 Application

This standard is intended to be followed by bus OEMs and HVAC suppliers prior to offering new BEBs to TfNSW.

The energy consumption and range tests called upon in this standard were created for stop and go operation of scheduled bus services. This standard applies to route service buses.

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.

Other referenced documents

UITP, 2014, *UITP Project 'SORT' – Standardised On-road Test Cycles*

UITP, 2017, *UITP Project E-SORT – Cycles for electric vehicles*

4 Terms, definitions and abbreviations

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

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')

charging the process of adding electrical energy to the REESS of a BEB

charging supply equipment the equipment or combination of equipment providing dedicated functions to supply electric energy from a fixed electrical installation or supply network to a vehicle for the purpose of charging (Source: IEC 62196–1:2022)

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

energy consumption the amount of electrical energy used

E-SORT electric-standardised on-road test; tests specified in *UITP Project E-SORT – Cycles for electric vehicles*

full charge the REESS state associated with maximum off-board stored energy capacity established by using the OEM's recommended charging procedure

GVM gross vehicle mass

HVAC heating ventilation and air-conditioning

OEM original equipment manufacturer

range the distance in kilometres a BEB can travel on a REESS from full charge until the low battery warning on the vehicles dashboard appears

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.

route service bus a bus specially designed with spaces for standing passengers(Source: *Vehicle Standard (Australian Design Rule – Definitions and Vehicle Categories) 2005* – modified as the original definition is for a 'route service omnibus')

SOC state of charge; the percentage of charge available within a REESS compared to its rated capacity

SORT standardised on-road test; cycle tests specified in *UITP Project 'SORT' – Standardised On-road Test Cycles*

supplier any party other than the bus OEM that supplies equipment covered by this standard

TfNSW Transport for NSW

two door city BEB a low floor, wheelchair accessible, two door bus, two axle configuration (Source: *TfNSW Zero Emission Bus (G) Specification* – modified as the original definition is for 'two door city bus')

usable energy the REESS energy available between

- the maximum SOC accepted by the REESS when charging until the charging supply equipment automatically stops charging
- the SOC of the REESS when the driver first receives a dashboard warning for low REESS

UITP International Association of Public Transport (Union Internationale des Transports Publics)

ZEB zero emissions bus

5 Electric powertrain testing requirements

The energy consumption, usable energy and range shall be provided to TfNSW at the RFP (request for proposal) stage for TfNSW consideration prior to panel selection on route service buses in accordance with *UITP Project 'SORT' – Standardises On-road Test Cycles* and *UITP Project E-SORT – Cycles for electric vehicles* .

The energy consumption for the electric powertrain shall be stated in kWh/km for the SORT cycle 1, SORT cycle 2 and SORT cycle 3 tests in accordance with *UITP Project E-SORT – Cycles for electric vehicles*.

The usable energy shall be stated in kWh in accordance with *UITP Project E-SORT – Cycles for electric vehicles*.

The range shall be stated in km in accordance with *UITP Project E-SORT – Cycles for electric vehicles*.

If multiple REESS options are offered, the usable energy and range shall be provided for each variant. The optional usable energy and range data may be provided by calculation where the REESS characteristics are common. For example, if the standard offer includes 6 battery packs which make up the REESS but the optional offer is one additional battery pack of the same type, then the range and useable energy may be provided by calculation.

The E-SORT cycle tests can be conducted by the OEM or by a separate organisation. These tests do not require a specific track or set of conditions. The testing equipment used shall be calibrated, the conditions noted and the results consistent. Testing may be performed locally or in other jurisdictions.

The OEM shall clearly define the test vehicle specifications, test methods and conditions during the tests. The information describing the vehicle, test method and conditions shall be sufficient to allow the test to be repeated to validate the results without dispute or misinterpretation.

The tester shall complete sheets 3 and 4 in the annex of *UITP Project E-SORT – Cycles for electric vehicles*.

The E-SORT test procedures require the tested vehicle to be run-in for at least 20,000km. In the interest of reducing cost and complexity, TfNSW will accept test results conducted on buses with lower distances travelled, with the reported results adjusted to simulate the effects of 20,000 km of travel on the total state of charge.

6 Configurations to be tested

The OEM shall physically test at least one bus configuration.

If multiple bus configurations are offered, additional configurations may be either tested or simulated via calculations using data from the tested configuration.

Table 1 shows the defining characteristics and specifications of a two door city BEB.

Table 1 – Defining characteristics and specifications of two door city BEB

Characteristic	Specification
Axle configuration	4 x 2
GVM	16,000 to 18,000 kg
Length	11.5 m to 12.5 m
Width	2.5 m
Deck	Single deck

Changes in axle configurations, driveline ratios, number of decks and lengths beyond 12.5 m shall require new SORT data.

Changes in REESS type or size shall require new SORT data.

Width variations up to 2.55 m shall not require new SORT data.

A change in the number of passenger doors shall not require new SORT data.

Buses with a GVM higher than 18,000 kg shall not require new SORT data.

7 HVAC energy consumption

HVAC energy consumption data shall be provided for the BEB configuration that is submitted by the OEM for tender valuation.

The HVAC energy consumption data shall be linked to the specific HVAC make, model and input parameters.

Where a specific HVAC model is offered to multiple bus OEMs tendering for the same BEB configuration, the HVAC energy data supplied shall be the same.

The differences in energy consumption related to specific body designs shall be excluded.

The consumption data shall be presented in kWh unit of measure.

All assumptions shall be documented. Energy consumption shall be provided for a 60 minute period within the following conditions:

- environmental conditions for the duration of the energy consumption measurement period
    - outside temperature 38°C
- bus conditions for the duration of the energy consumption measurement period
    - inside temperature 22°C
    - 30 passengers with 170 Watt/passenger
    - doors open for 20 seconds every 3 minutes.

The humidity during the test period shall be recorded.

This energy usage data is intended to represent the worst-case situation in operation.

8 Transition timing

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

9 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.

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