

Zero Emission Vehicle Repower Accreditation Standard (ZEVTRAS)
– Code of Practice

Code of Practice for Accreditation of Zero Emission Repower
Systems for Buses – M2 & M3

This Code of Practice is the technical standard for repower buses
to achieve Zero Emission Bus Accreditation

Issue history

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ZEVRAS Technical Requirements

1. Scope and accreditation process

- 1.1 ZEVRAS technical requirements in this Code of Practice are applicable to zero emission bus repowers. This document defines the technical requirements for accreditation under the UK Government ZEVRAS accreditation.
- 1.2 ZEVRAS Code of Practice technical requirements do not replace or change any of the legal requirements outlined in the DVSA VTP5 process.
- 1.3 This Code of Practice applies to all M2 and M3 vehicles, excluding Trolleybuses.
- 1.4 This requirement applies only to vehicles that are already registered for use on UK roads.
- 1.5 The objective of this requirement is to establish a base level of performance for vehicles that are to be grant some level of government funding before or during their use in service.
- 1.6 In order to reduce cost and complexity, this technical requirement will use worst casing and model report approaches wherever possible.

2. Definitions

- 2.1 M2 and M3 as defined in UN ECE Consolidated Resolution on the Construction of Vehicles (R.E.3)
- 2.2 AVAS: Acoustic Vehicle Alerting System
- 2.3 DVSA: Driver and Vehicle Standards Agency
- 2.4 GVM: Gross Vehicle Mass
- 2.5 TPMLM: Technically Permitted Maximum Laden Mass
- 2.6 IVA: Individual Vehicle Approval

- 2.7 UN ECE: United Nations Economic Commission for Europe
- 2.8 COIF: Certificate Of Initial Fitness
- 2.9 ESC: Electronic Stability Control
- 2.10 VSF: Vehicle Stability Function (as defined at ECE Regulation 13.11, Annex 21)
- 2.11 EST: Energy Saving Trust
- 2.12 HVAC: Heating, Ventilation, and Air Conditioning
- 2.13 Trolleybus: A vehicle, electrically driven by energy from external, overhead contact wires. For the purposes of this Code of Practice, it also includes such vehicles having an additional internal means of propulsion.

3. Base vehicle age, condition and systems

The condition of the base vehicle should be assessed by the repower manufacturer and all relevant stakeholders. No age limit is applied to vehicles that can be repowered in accordance with this standard, however it should be recognised by all parties that vehicles will be required to continue to perform well throughout their intended life.

Grant funding using ZEVRAS as a requirement for qualification may place additional limitations on vehicle age and/or condition.

- 3.1 Existing/new vehicle systems
 - 3.1.1 New vehicle systems such as traction control and dynamic stability control are not required as part of the repower system, however any existing systems fitted to the base vehicle should continue to operate with the same level of functionality as was achieved on the base vehicle.
 - 3.1.2 Any new vehicle systems such as traction control and dynamic stability control that are fitted as part of the repower activity should, even if not specifically required meet the ZEVRAS standard, meet the relevant applicable test standards.

3.1.3 Examples of such systems include, but are not limited to:

- Traction control
- Dynamic stability control
- Automatics Steering Functions
- Automated Lane Keeping Systems
- Antilock Brake Systems
- Emergency Braking Systems

4. Provenance of parts

All parts being newly fitted to M2/M3 vehicles as part of the repower process shall be new unless otherwise agreed with Zemo Partnership / EST.

5. Vehicle safety

In addition to the requirements set out in this document, attention is drawn to section 100 and section 104 of The Road Vehicles (Construction and Use) Regulations 1986 as amended which states that no vehicle, parts or accessories should constitute a danger to any passengers or other road users.

6. Test facilities

Zemo Partnership / EST reserves the right to witness any testing completed in accordance with this Code of Practice.

Test facilities used, test dates and any requirements for test witnessing shall be agreed in advance of any testing with Zemo Partnership / EST.

Test facilities, equipment, testing methodologies and testing personnel competency levels shall be in line with the requirements of the relevant test standard detailed in this document.

In general, test work shall be completed at an independent facility, however some tests completed by the repower manufacturer at their own facilities may be accepted with prior agreement from Zemo Partnership / EST. Independent facilities shall be given authority by the repower manufacturer to share test results and reports with EST / Zemo.

Any test facility used shall have suitable facilities and equipment for the type of testing in question. Tools and equipment shall be demonstrably calibrated appropriately with suitable and traceable calibration records available.

Test reports shall detail at least the following:

- Test organisation and location
- Test dates
- All relevant vehicle / system / component details
- Instrumentation used including sufficient details, where applicable, to allow traceability of calibration records
- Test standard including any subsection requirements that are applicable or not applicable as a result of testing on a already registered vehicle
- Facilities used
- Test results in sufficient detail to confirm compliance or otherwise with the relevant test standard
- Final confirmation of compliance / non compliance
- Sign-off and date

7. Technical requirements

Exact test requirements, test specifications, test facilities and test dates shall be agreed with Zemo Partnership / EST ahead of any testing activities.

As a point of principle, read across of test results will be used whenever appropriate in order to reduce test requirements. Read across allowance will be agreed with Zemo Partnership / EST in conjunction with the repower system manufacturer, test providers and other subject matter experts as appropriate.

Specific requirements are set out in the relevant annex to this document as defined in Table 1.

Item	Subject	Requirement	Applicability	
			M2/M3 Battery-Electric (BEV)	M2/M3 Hydrogen Fuel-Cell (HFC)
1	Brakes	Annex 1	X	X
2	Static stability (Tilt)	Annex 2	X	X
3	Acoustic Vehicle Alerting System (AVAS)	Annex 3	X	X
4	Steering Effort	Annex 4	X	X
5	Masses and Dimensions	Annex 5	X	X
6	Power / Torque	Annex 6	X	X

Item	Subject	Requirement	Applicability	
			M2/M3 Battery-Electric (BEV)	M2/M3 Hydrogen Fuel-Cell (HFC)
7	Identification of Controls	Annex 7	X	X
8	HVAC systems	Annex 8	X	X
9	Defrost / Demist	Annex 9	X	X
10	Speedometer and Reverse	Annex 10	X	X
11	Speed Limiter	Annex 11	X	X
12	Lighting Installation	Annex 12	X	X
13	Electromagnetic Compatibility (EMC)	Annex 13	X	X
14	Electrical Safety	Annex 14	X	X
15	Hydrogen and Fuel Cell Safety	Annex 15		X
16	Charging	Annex 16	X	X
17	Statutory Plates	Annex 17	X	X
18	Telematics	Annex 18	X	X

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Item	Subject	Requirement	Applicability	
			M2/M3 Battery-Electric (BEV)	M2/M3 Hydrogen Fuel-Cell (HFC)
19	End of Life	Annex 19	X	X
20	Fire suppression	Annex 20	X	X
21	Bus safety information standard	Annex 21	X	X
22	Labelling of fill ports	Annex 22	X	X
23	Energy Efficiency and range	Annex 23	X	X

8. Other vehicle standards

8.1 Functional Safety

Repower manufacturers are encouraged to consider the requirements of ISO 26262.

8.2 UK CA marking

Repower manufacturers are urged to take account of UK CA product marking requirements for parts not specifically covered by standards referenced in section 7 Technical requirements.

8.3 Non-powertrain related changes

This standard is applicable to changes made to a vehicle in order to change its motive power from an existing powertrain (eg internal combustion engine, hybrid ICE/BEV, or other) to a pure electric powertrain (using a battery and/or fuel cell to provide motive power).

Any changes that are made to a vehicle BECAUSE of the repower are within the scope of this standard.

This standard does not apply to any changes that are unrelated to the repower, even if they are done at the same time.

Example 1: If a vehicle is re-trimmed at the same time as being repowered then the retrim activity itself is not covered by this standard. This would be covered by any existing vehicle requirements, eg flammability requirements. Changes would be authorised by DVSA in the normal way.

Example 2: If a vehicle's exterior lights are changed from the existing components to new LED lights purely to improve the look of the vehicle, then they are outside of the scope of this standard. However, if the exterior lights are changed to LED as part of the repower because the repower requires lower power consumption then they are within the scope of this standard.

8.4 Driveability assessment

Before a vehicle is handed to an in-service operator, a drivability assessment shall be completed by the operator and repower manufacturer together to ensure that the repowered vehicle is suitable for operation over the types of terrain to be experienced in service.

This assessment shall include aspects of vehicle operations such as, but not limited to:

- a) throttle pedal operation including tip-in and tip-out
- b) assessment of other driving controls including warnings and driver control screens and displays
- c) interaction of throttle, brakes and regenerative braking
- d) hill hold and hill start
- e) ride and handling
- f) interior noise

8.5 VTP5 process

This standard defines the requirements that need to be met in order to meet the UK government ZEVRAS. This standard does not replace or augment any existing UK legal requirements. Any changes made to vehicles will need to be approved by DVSA under existing UK VTP5 processes.

8.6 Speed Limiter certification

Vehicles are required to either be fitted with a Speed Limiter or have confirmation that a Speed Limiter is not required due to their naturally limited maximum speed, eg powertrain gearing.

Whilst Speed Limiters shall be assessed in accordance with Annex 11, attention is drawn to the requirement for individual vehicles to meet Speed Limiter anti-tampering requirements. Assessments are made at an approved local approved speed limiter centre. Details of Speed Limiter Centres can be found at: <https://www.gov.uk/find-approved-speed-limiter-centre>.

8.7 Tachographs

Depending on the type of vehicle and the in-service use, vehicles may or may not require a tachograph.

The tachograph system should operate independently of any other system on the vehicle, ie it should not rely on a speed signal that goes via any other vehicle systems.

Any existing tachograph fitted to a vehicle shall be accompanied by a valid Tachograph Certificate from a UK Tachograph Centre. Zemo Partnership / EST reserves the right to confirm the validity of any such certificate.

If an existing tachograph system has been modified / replaced and the finished repowered vehicle continues to require a tachograph, then a new Tachograph Certificate will be required. Whilst this is the responsibility of the vehicle operator, the repower manufacturer's attention is drawn to this requirement to ensure that a repowered vehicle is able to comply.

Tachograph Certificates are issued by a UK Tachograph Centre, details of which may be found at <https://www.gov.uk/find-approved-tachograph-centre-atc>.

UK Tachograph regulations are covered in: GB TRANSPOSED VERSION OF REGULATION (EU) No. 165/2014 as amended by Regulation (EU) 2020/1054, S.I. 2019 No. 453(*), S.I. 2021 No. 135 and S.I. 2022 No. 126.

9. Conformity of Production

Conformity of Production will be assessed in line with the ZEVRAS process detailed in "ZEVRAS Guidance on company audit process" section on Quality Standards. This document can be found on the EST website at www.energysavingtrust.org.uk/service/zero-emission-vehicle-repower-accreditation-scheme

It should be noted that a requirement of the above document is that repower manufacturers shall hold an ISO 9001:2015 certification.

10. Installers

Any installers used by a repower manufacturer shall be demonstrably approved by that repower manufacturer in accordance with their ISO9001:2015 procedures. The repower manufacturer shall remain responsible for and accountable for the work undertaken by the installers.

11. Warranty

The repower adaptation should be designed and manufactured to have a working life as follows:

200,000 km or five years, whichever is the sooner.

The manufacturer of the repower system must provide an in-service warranty (to cover both technical performance & function, and quality of manufacture & installation) valid for at least two years to provide full cover for parts, labour and onsite support costs.

Note that service life and warranty period may also be subject to specific contractual requirements.

12. Review

This Code of Practice shall be reviewed annually to ensure that standards remain appropriate and applicable to vehicles being put into service.

This Code of Practice should be expanded to cover other vehicle categories as the vehicle repower industry evolves.

Annex 1

Technical requirements: Brakes

1. Target Standard: UN ECE Regulation 13.11 or base vehicle approval standard.
2. Technical requirements

This requirement relates to vehicles fitted with hydraulic or pneumatic brake systems only. If vehicle are fitted with any other form of brake system, eg electric, then requirements shall be agreed with Zemo Partnership / EST in advance of any test work.

Changing of any components in the vehicle brake system will require evidence to confirm continuing compliance with the Target Standard.

The exact test requirement will be as agreed with Zemo Partnership / EST in conjunction, where appropriate, with the repower manufacturer and a suitable independent test facility.

For clarity, and in accordance with paragraph 3.1 of this document,;

- a) the repowered vehicle's regenerative braking system shall meet the requirements set out in ECE Regulation 13.11 for regenerative braking.
- b) interaction of the vehicle braking system with existing/new ESC and VSF systems shall be taken into account.

All existing systems fitted to a vehicle and newly fitted systems shall demonstrably operate and meet the requirement of the Technical Standard.

3. The following is given as a guide to the type of evidence likely to be required for example changes to vehicle specification:

Vehicle change	Type of evidence
Change of vehicle unladen mass distribution	Evidence that percentage of mass on rear has not decreased or track test data to support the change.
Change of air-brake compressor	New/old compressor specification comparison to show that new compressor performance matches/exceeds original or physical test data to support the change. Note that a brake system compressor pump fitted with an electric drive motor will also require EMC assessment.
Increase in vehicle Mass In Running Order or Gross Vehicle Mass	Likely that track test results are required to show that performance requirements continue to be met.
Change of brake disc/drum size and/or shoe/pad material	Likely that track test results are required to show that performance requirements continue to be met. This may include ABS tests.

Annex 2

Technical requirements: Static Stability (Tilt)

1. Target Standard: UN ECE Regulation 107.09 Annex 3 section 7.4 or UK Certificate of Initial Fitness as applicable to the base vehicle
2. Technical requirements

Evidence is required to confirm continuing compliance with the Target Standard.

This evidence could be calculations to show that the Centre of Gravity height for the re-powered vehicle is no higher or is not significantly changed left to right than for the vehicle pre-repower. If this calculation is not available, or if the Centre of Gravity height has increased then a tilt test will be required to demonstrate continued compliance with the Target Standard.

The exact test requirement will be as agreed with Zemo Partnership / EST in conjunction, where appropriate, with the repower manufacturer and a suitable independent test facility.

Vehicles approved to UK COIF standards shall be assessed against the original vehicle requirements as defined by COIF.

Annex 3

Technical requirements: Acoustic Vehicle Alerting System (AVAS)

1. Target Standard: UN ECE Regulation 138.01
2. Technical requirements

Evidence is required to confirm compliance with the Target Standard.

This evidence could be confirmation of the fitting of a 3rd party AVAS device that meets the required standard.

It should be noted that UN ECE Reg138 is a vehicle standard and so the placement of the AVAS device relative to surrounding components and bodywork is important to ensure a clear sound is emitted. In case of any doubt and/or if no “approved” AVAS device is fitted then a vehicle assessment will be completed. Noise tests at an accredited facility may be required.

Annex 4

Technical requirements: Steering Effort

1. Target Standard: UN ECE Regulation 79.04 or base vehicle approval standard.
2. Technical requirements

Changing of any components in the vehicle steering system or an increase of mass on a steered axle will require evidence to confirm continuing compliance with the Target Standard.

The exact test requirement will be as agreed with Zemo Partnership / EST in conjunction, where appropriate, with the repower manufacturer and a suitable independent test facility.

3. The following is given as a guide to the type of evidence likely to be required for example changes to vehicle specification:

Vehicle change	Type of evidence
Increase in steered axle maximum mass	Track test data to demonstrate compliance with the Target standard. Tests should include powered and un-powered steering effort tests.
Retention of existing power steering pump but with new electric drive motor	Specification comparison showing speed and flow rates of original installation, and speed and flow rates of new installation with electric drive. Note that new electric drive will also require EMC assessment.
Change of power steering pump	New/old pump specification comparison to show that new system performance matches/exceeds original or physical test data to support the change. Note that new electric drive will also require EMC assessment.

Annex 5

Technical requirements: Masses and Dimensions

1. Target Standard: EU Regulation 1230/2012 and Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 48
2. Technical requirements

Overall length of the repowered vehicle should not exceed the original vehicle length.

Overall width of the repowered vehicle should not exceed the original vehicle width.

Overall height may be increased but should be compliant with the Target Standard.

Technically Permissible Maximum Laden Mass (TPMLM) of the repowered vehicle shall not exceed the plated figure for the original vehicle. If this is not possible then:

- a) a new plate should be added in accordance with Annex 17 of this Code of Practice,
- b) an engineering assessment of the vehicle's ability to cope with the additional mass shall be completed. This assessment should cover the entire load path from vehicle to ground, ie it should cover at least:
 - vehicle chassis and structure,
 - suspension
 - axle
 - wheels
 - tyres
- c) testing in specific subject areas shall be completed to ensure compliance with this Code of Practice and other legal requirements at the increased mass.

The mass on each axle of the repowered vehicle shall not exceed the relevant manufacturer's design axle mass/tyre/wheel rating.



In relation to tyres, specific attention is drawn to the allowances within the Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 46. Specifically, tyre speed and load rating may take into account any restrictions on vehicle operating speed.

Annex 6

Technical requirements: Power / Torque

1. Target Standard: UN ECE Regulation 85.00
2. Technical requirements

Quoted power and torque of the repowered vehicle should not exceed the power and torque of the original vehicle.

Power and torque do not need to be determined by a full UN ECE Regulation 85 approval however officially declared manufacturers stated figures are acceptable. In the case of any doubt, a UN ECE Regulation 85 standard test may be required.

It is recognised that the layout of the EV powertrain may differ considerably from that of the base vehicle powertrain. It is also recognised that torque control systems are widely available in EV powertrains. As a result, different gearing and torque control strategies may make a direct pre-post repower torque comparison less meaningful. To allow for this, and with agreement of Zemo Partnership / EST, the torque comparison may be made by considering the calculated torque at the driving wheels.

If, for technical reasons, it is not possible to keep repowered power and/or torque within limit of the pre-repower figures then additional discussion with Zemo Partnership / EST shall take place to agree further measures that may be required. These further measures may include vehicle stability function as defined by ECE Regulation 13.11.

Annex 7

Technical requirements: Identification of Controls

1. Target Standard: UN ECE Regulation 121.01
2. Technical requirements

All controls and warning devices added that are within scope of the Target Standard shall be compliant with that standard.

It is not a requirement to upgrade any existing controls or warning devices fitted to the original vehicle, however any that are upgraded shall be compliant with the Target standard.

Any existing warnings and controls that continue to function after the repower must not be obscured or obstructed by any components fitted as a part of the repower.

Annex 8

Technical requirements: Heating, Ventilation and Air Conditioning (HVAC) systems

1. Target Standard: UN ECE Regulation 122.00 and Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 36

2. Technical requirements

Only zero emission HVAC systems are allowed.

Heaters shall comply with the requirements of the Target Standard.

Annex 9

Technical requirements: Defrost / Demist

1. Target Standard: Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 34
2. Technical requirements

The vehicle must be fitted with a system capable of defrosting / demisting at least the swept area of the windscreen (see Note 1)

A system using warm air to clear the screen must employ fan assistance and ducting to direct the air onto the screen, to ensure effective operation of the defrosting system under cold weather conditions.

An electrically heated screen must provide adequate heat and distribution to ensure effective operation.

If the system uses warm air, only zero emission heaters are allowed.

Note 1: The IVA standards states: The fitting of a device not permanently incorporated into the vehicle structure ie. adhered to the windscreen or body surface shall not be considered as a “system fitted to the vehicle.”

Annex 10

Technical requirements: Speedometer and Reverse Gear

1. Target Standard: UN ECE Regulation 39.01 and Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 17
2. Technical requirements

If the existing speedometer is retained in its entirety including the existing speed pick-up then no further evidence is required.

If the existing speedometer is retained but with a new speed pickup then evidence is required to show the source and any modifications to the speed signal, how this compares to the original vehicle and that this signal is correctly interpreted by the speedometer to ensure continued compliance with the target standard. If adequate evidence is not available then track tests at an agreed facility may be required.

If a new speedometer with a new speed pickup is fitted then evidence is required to show compliance with the target standard. If adequate evidence is not available then track tests at an agreed facility may be required.

The speedometer must operate based on vehicle systems alone. The speedometer shall not rely on GPS or similar systems.

The speedometer shall be capable of displaying the vehicle speed in both km/h and mph.

All vehicles shall have the ability to reverse.

Annex 11

Technical requirements: Speed Limiter

1. Target Standard: UN ECE Regulation 89.00 and Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 47
2. Technical requirements

Evidence is required to demonstrate that the repowered vehicle continues to comply with the Target standard.

Evidence may either demonstrate that the repowered vehicle is incapable of achieving the 100km/h or that a suitable speed limiter is fitted.

If a vehicle is incapable of achieving 100km/h then that claim shall be supported by either:

- a) Documentary evidence from the manufacturer/converter that the vehicle is unable to reach the speed due to the overall gearing of the drive train, or
- b) Documentary evidence from a speed limiter or Tachograph calibration centre, or
- c) Evidence to show that the finished vehicle will be exempt by nature of its use, (vehicles used by the emergency services)

If a speed limiter is fitted then evidence should show at least:

- a) How the speed limiter control is achieved including speed pick-up, set speed, speed control methodology including interaction with regenerative brakes and/or service brakes,
- b) Security precautions to prevent unauthorised adjustments or tampering,
- c) If and how the speed limiter plate is updated.

If adequate evidence is not available then track tests at an agreed facility may be required. Note that if track tests are required it is expected that only the overall maximum speed is assessed and not the full speed v time profiles detailed in UN ECE Regulation 89.

As per paragraph 8.6 of this document, attention is drawn to the requirements for speed limiters to be assessed by a Speed Limiter Centre. Whilst this is the ultimate responsibility of the vehicle operator, repower manufacturers should ensure that fitted systems are designed in accordance with the specification above so that they will meet the assessment criteria.

Annex 12

Technical requirements: Lighting Installation

1. Target Standard: UN ECE Regulation 48.08 and Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 20
2. Technical requirements

Evidence is required to demonstrate that the repowered vehicle continues to comply with the Target standard

Note that this section is only applicable if lighting modifications are **required** as part of the vehicle repower process, eg to ensure compliance with contracted range declarations.

If updates to the vehicle lighting are made for other reasons, eg aesthetics, then evidence is not required in order to meet this ZEVRAS requirement.

Annex 13

Technical requirements: Electromagnetic Compatibility (EMC)

1. Target Standard: UN ECE Regulation 10.05 or 10.06
2. Technical requirements

Evidence is required to demonstrate that components fitted to the vehicle as part of the repowered process comply with the Target Standard.

Evidence shall include a combination of:

- a) component specifications, approvals or accreditations,
- b) a full vehicle EMC chamber test,
- c) justification for read across from previous EMC tests, if applicable.

Final test specifications and scope will be as agreed with Zemo Partnership / EST.

Final test specification and scope will be determined allowing for read across from previously approved repower systems. It should be noted that read across will be based predominantly on the specification of the repower system rather than the base vehicle however significant differences in base vehicle types may also affect the level of read across permitted.

Read across of results from previous tests relating to susceptibility should take into account any protections and/or mitigations in place in the repower systems. Data from previous tests being referenced shall be available for review.

EMC test facilities used will be independent, accredited to ISO 17025 and hold a Technical Service accreditation from a Type Approval authority.

It should be noted that the aim of this requirement is to assess the compliance of systems and components on the repowered vehicle that are directly related to the repower and the safe operation of the vehicle. If EMC emissions exceeding the specified limits are detected then the source of those emissions should be determined. If it is determined that the emissions emanate from a system or component that is not part of the repower and which do not have a

direct effect on the safe operation of the vehicle, then these emissions may be discounted.

Although, in general, legacy parts fitted to a vehicle may be discounted during EMC testing, legacy parts will need to be considered if emissions from those parts have a detrimental effect on the repower systems. Likewise, legacy parts shall be considered if they lead to failures of the repower system during immunity tests because they act to feed test signals into the repower system which then causes a detrimental effect on (ref ECE Reg 10.06 para 2.12):

- the driver's control of the vehicle,
- functions related to driver, passenger and other road user protection,
- functions which, when disturbed, cause confusion to the driver or other road users,
- functions related to vehicle data bus functionality,
- functions which when disturbed affect vehicle statutory data: e.g. tachograph, odometer,
- Function related to charging mode when coupled to the power grid.

EMC testing should also take account of UK Health and Safety Executive Guidance, eg The Control of Electromagnetic Fields at Work Regulations 2016, and ICNIRP 1998 and 2010 Guidelines on the limitation of Human Exposure to Electromagnetic Fields.

In the case of vehicles fitted with inductive charging systems, additional EMC tests, both immunity and emissions, may be required to determine any effect on the vehicle and vehicle occupants during inductive charging. These additional tests are covered within the scope ECE Regulation 10 and attention is also drawn to the requirements of IEC 61980.

Testing requirements for hydrogen powered vehicles must take into account the prevailing limitations on testing vehicles in a chamber. Health and Safety restrictions must take precedence. Testing of hydrogen vehicles is to be as agreed with Zemo Partnership / EST. It is expected that testing of hydrogen powered vehicles will place a larger reliance on component level tests until suitable EMC chamber facilities are available.



Annex 14

Technical requirements: Electrical Safety

1. Target Standard: UN ECE Regulation 100.02 or later.
2. Technical requirements

Evidence is required to demonstrate that the repowered vehicle, including components fitted to the vehicle as part of the repower process, complies with the Target Standard. Evidence is required to demonstrate full compliance with all relevant section of the Target Standard.

Evidence of compliance with the Target Standard could, but does not need to be, a full Type Approval. However attention is drawn to the requirements in section 6 of this document and specifically the need for test facilities to be independent from manufactures.

For clarity it should be noted that this requirement includes both Part I (Vehicle requirements) and Part II (Battery/REESS safety requirements).

For clarity it should be noted that read across of test results from one system to another will be allowed where appropriate to reduce testing requirements. Read across will be as agreed with Zemo Partnership / EST.

Due to the safety critical and complex nature traction battery (REESS) approval testing, attention is brought to section 6 of this document and the requirements for the independence of test facilities.

Annex 15

Technical requirements: Hydrogen and Fuel Cell Safety

1. Target Standard: UN ECE Regulation 134.01 and Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 62
2. Technical requirements

Evidence is required to demonstrate that the repowered vehicle, including components fitted to the vehicle as part of the repower process, complies with the Target Standard.

It should be noted that UN ECE Regulation 134 covers compressed hydrogen systems only. Testing requirements for hydrogen systems involving liquid hydrogen shall be agreed with Zemo Partnership / EST.

Annex 16

Technical requirements: Charging

1. Technical requirements

Vehicles with charging connectors shall be fitted with at least one of the following types:

- a) DC CCS 2
- b) AC Type 2

Connector communication protocols shall be in accordance with IEC 62196:2014.

Other opportunity charging solutions, including but not limited to inductive charging and conductive pantographs, shall be as agreed in advance with Zemo Partnership / EST and with the local authority of the vehicle operation area.

Annex 17

Technical requirements: Statutory Plates

1. Target Standard: Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 18
2. Technical requirements

Any changes to the details shown on the base vehicle statutory plate must be shown on an additional plate attached next to the existing plate.

Details on the new statutory plate should be as agreed in advance with Zemo Partnership / EST.

Annex 18

Technical requirements: Telematics

1. Technical requirements

Every vehicle shall be fitted with a telematics system.

The telematics system shall make the following minimum data available to the vehicle operator, the contracting authorities, Zemo Partnership / EST and EST:

- a) Supplier
- b) Date
- c) Vehicle Fleet / Asset Number
- d) Vehicle Registration Number
- e) Operator
- f) Depot
- g) GPS track of location¹
- h) 24hour (00:00am to 23:59pm) average energy consumption (kWh/km)
- i) Number of recharges in 24 hours (00:00am to 23:59pm)
- j) Energy added per recharge (kW/h)
- k) Average charge rate per recharge (kW)
- l) 24hour (00:00am to 23:59pm) Distance Travelled (km)
- m) Distance travelled between each recharge (km)
- n) 24hour (00:00am to 23:59pm) total operation time (nearest minute)
- o) Fault Codes with time stamp
- p) Date and time last Seen

¹ minimum update frequency: 1 minute

Data shall be made freely available via a single online portal for a minimum of 5 years. Data shall be made freely available by the repower manufacturer upon request in a raw data format (for instance csv) to local authorities or their representatives.

Data shall be freely available for a minimum of 5 years with the actual period being agreed between the repower manufacturer and the local authority responsible for the vehicle contract.

Additional data may be available to the repower manufacturer.

Annex 19

Technical requirements: End of Life

1. Technical requirements

Repower manufacturers shall outline the processes that have been put in place and/or will be put in place to ensure the correct end-of-life handling of components fitted during vehicle repowers.

Repower manufacturer's are reminded of their obligations under the following UK Statutory Instruments:

- The Waste Batteries and Accumulators Regulations 2009
SI, 2009 No. 890
- The End-of-life Vehicles (Producer Responsibility) Regulations 2005
SI 2005 No. 263

Annex 20

Technical requirements: Fire suppression

1. Target Standard: Individual Vehicle Approval (IVA) inspection manual, Buses and Coaches (M2 and M3), Section 52E and UN ECE Regulation 107.09 Annex 3 Paragraph 7.5 excluding 7.5.7 (unless already fitted).

2. Technical requirements

Evidence is required to demonstrate that the repowered vehicle, including components fitted to the vehicle as part of the repower process, complies with the Target Standard.

These requirements only apply to systems and components fitted as part of the vehicle repower and areas in which repower components are fitted. With regards the requirements in UN ECE Regulation 107.09 the term “engine compartment” should be taken to include compartments housing major EV powertrain components eg batteries, motor, power electronics, fuel cell.

UN ECE Regulation 107.09 Annex 3 Paragraph 7.5.6 (covering fire detection in toilets etc) and 7.5.7 (covering emergency lighting and door operation in the event of a fire) is excluded because this requires vehicle integration of a system that is outside of the scope of a Zero Emission Repower. However, if such a system is fitted then measures should be taken to ensure its continued operation.

Repower manufacturers shall provide a full fire risk assessment relevant to each repowered vehicle.

Annex 21

Technical requirements: Bus safety information standard

1. Target Standard: ISO 17840:2
2. Technical requirements

Vehicle information Datasheets are required in accordance with the Target Standard.

Datasheets will be made freely available to appropriate stakeholders eg:

- a) Test facilities
- b) Local authorities
- c) Emergency services

Annex 22

Technical requirements: Labelling of fill ports

1. Technical requirements

All fluid fill ports that are modified or added during the repower process shall be labelled with the type and specification of the relevant fluid.

Labels shall be clear, durable, impervious to any substance with which they are likely to come in contact and shall not deteriorate due to any normal in-service activity such as vehicle washing.

Annex 23

Technical requirements: Energy Efficiency

1. Target Standard: Zemo Zero Emission Bus Certificate
2. Technical requirements

Each vehicle type shall undergo an efficiency test / range test in accordance with the relevant requirements of the Zemo ZEB Certification standard.

Test conditions are to be agreed with Zemo Partnership / EST in advance of testing.

Note that within the current ZEB Certification standard separate drive cycles are applied to bus and coach operations.

During the ZEB Certification test the vehicle efficiency will be determined and claimed range validated.