

Railway Group Standard

GM/RT2132

Issue One

Date September 2010

On-board Energy Metering for Billing Purposes

Synopsis

This document sets out the energy metering requirements when electric traction units are fitted with an energy measuring system that provides data to be used by the infrastructure manager for billing purposes.

This document contains one or more pages which contain colour

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Superseded documents

This Railway Group Standard does not supersede any other Railway Group documents.

Supply

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Part 1 Purpose and Introduction

1.1 Purpose

- 1.1.1 This document sets out the energy metering and data handling requirements for electric traction units when fitted with an energy measuring system.
- 1.1.2 The on-board energy measuring system will provide (via a on-ground data collection service) data to be used by the infrastructure manager to produce a bill which is invoiced to the railway undertakings.

1.2 Introduction

1.2.1 Background

- 1.2.1.1 Track access contracts will be amended to allow for billing on the basis of metered readings. In support of this, the Office of Rail Regulation (ORR) determined that metered billing for traction energy electricity must be facilitated by Network Rail. Whilst other specifications / standards are being developed (the Conventional Rail Locomotives and Passenger TSI (CR LOC & PAS TSI) [draft version 4.0] and revised version of BS EN 50463:2007) they are not anticipated to be available until circa 2011/2 and are primarily focussed on new rolling stock entering service.
- 1.2.1.2 This document facilitates early adoption of the on-board energy measuring system which provides data suitable for subsequent use in the billing system prior to the publication of the CR LOC & PAS TSI and ongoing work to produce a revised issue of BS EN 50463:2007. In addition, this document will also be needed once the TSI is in force, to address:
 - a) Those vehicles not covered by the TSI.
 - b) Associated aspects falling outside the TSI's scope such as the transfer of data from on-board systems to on-ground systems.
- 1.2.1.3 An on-board energy measuring system fitted to a traction unit measures the energy taken from / returned (during regenerative braking) to the contact line. It is specifically used to acquire energy data suitable for billing purposes.

1.2.2 Principles

- 1.2.2.1 The requirements set out in this document are based on the CR LOC & PAS TSI [draft version 4.0] and ongoing work to produce a revised issue of BS EN 50463:2007.
- 1.2.2.2 This document sets out those requirements that involve cooperation between railway undertakings and infrastructure managers in order to enable data from an on-board energy measuring system to be used when participating in the billing system.

1.3 Approval and authorisation of this document

- 1.3.1 The content of this document was approved by Rolling Stock Standards Committee on 30 June 2010.
- 1.3.2 This document was authorised by RSSB on 20 July 2010.

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Part 2 Requirements for an On-board Energy Measuring System

2.1 On-board energy measuring system

- 2.1.1 The energy measuring system shall consist of:
- a) An energy measurement function that includes:
 - i) Voltage and current measurement.
 - ii) Calculation of energy consumed (and where applicable regenerated).
 - b) A data handling system that compiles data from the energy measuring function with time data and geographical position, producing and storing the complete series of data with true energy values (in kWh / kvarh) ready to be sent by a communication service.
 - c) An on-board location function, that gives geographical position of the traction unit.
 - d) An on-board to ground communications service that supports the transfer of compiled data suitable for billing purposes.
- 2.1.2 It is permissible for the functions set out in 2.1.1 to be performed by individual devices or combined into one or more integrated assemblies. Devices provided for other purposes may be used (within the energy measuring system), provided that compliance with the requirements of this standard are achieved.
- 2.1.3 The on-board energy measuring system and associated on-ground aspects are shown in Appendix D.
- 2.1.4 The requirements for recording the fitment of an energy measuring system to a traction unit in the rolling stock register are set out in GM/RT2453 issue two, currently in draft.

2.2 Energy measuring function

- 2.2.1 The energy measuring function (EMF) shall measure all the energy consumed from the contact line and, where applicable, the energy returned to the contact line during regeneration, when using any electric traction power supply system (overhead, third and fourth rail) for which the traction unit is designed.
- 2.2.2 The energy measuring function shall be connected in such a way that all energy (traction and auxiliary) supplied to the traction unit from the contact line and all energy returned to the contact line during regeneration is recorded. For a.c. on-board energy measuring systems the energy measuring function shall also have the capability of recording the reactive energy component.
- 2.2.3 The energy measuring function shall measure the energy if the primary current is equal to or greater than 0.4% of the rated primary current and the primary voltage is at the lowest non-permanent voltage (U_{min2} as set out in BS EN 50163:2004 clause 4.1, Table 1, including special national conditions where applicable) or above. It is permissible for the on-board energy measurement measuring system to record a zero value when the primary current is below the minimum value and the energy measuring function ceases to measure.

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2.2.4 Guidance on the selection of suitable measuring points for traction units designed to operate using the 750 V d.c. traction power supply system is set out in Appendix C.

2.2.5 The energy measuring function shall have a total accuracy of at least:

- a) 1.5% for a.c. for active energy.
- b) 2.0% for d.c.

2.2.6 The accuracies of the energy measuring function set out in 2.2.5 shall be calculated in accordance with the following formula:

$$\varepsilon_{EMF} = \sqrt{\varepsilon_{VMF}^2 + \varepsilon_{CMF}^2 + \varepsilon_{ECF}^2}$$

Where:

- ε_{EMF} = Total accuracy of energy measuring function
- ε_{VMF} = The maximum percentage error of the voltage measurement function
- ε_{CMF} = The maximum percentage error of the current measurement function
- ε_{ECF} = The maximum percentage error of the energy calculation function

2.2.7 The maximum percentage errors of the individual functions set out in 2.2.6 shall be fulfilled under the following reference conditions:

- a) Any voltage in between lowest permanent voltage U_{min1} and highest non-permanent voltage U_{max2} , (with U_{min1} and U_{max2} as defined in BS EN 50163:2004 clause 4.1, Table 1).
- b) Any current between 10% and 120% of the rated primary current of the energy measuring function.
- c) Frequency 50 Hz $\pm 0.3\%$ (for a.c. measurement only).
- d) Power factor between 0.85 and 1 (for a.c. measurement only).
- e) Ambient temperature of 23°C $\pm 2^\circ\text{C}$.

2.2.8 Those devices containing individual functions for voltage measurement, current measurement and energy calculation used to implement the energy measuring function shall be subject to metrological control. This shall be executed in accordance with the following:

- a) The accuracy of each element shall be tested under the reference conditions set out in 2.2.7, to verify that they are within their declared maximum error.
- b) Each element which complies with a) shall be marked, to indicate metrological control and the declared maximum error limit.
- c) The configuration of each element shall be documented as a part of the metrological control.

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- 2.2.9 Recommendations on the additional error resulting from influence quantities and temperature variation are set out in Appendix B.
- 2.2.10 The energy measuring system rated current and voltage shall be matched to the traction units rated voltage and current. However, on d.c. electric traction units, if multiple measuring points are used (see Appendix C), the rated current of each measuring point shall be matched to its associated load.
- 2.2.11 The energy measuring function shall have a time reference period of 5 minutes defined by the UTC clock time at the end of each reference period. One of the time reference periods shall end each day at midnight (00:00:00). It is permitted to use a shorter time reference if the data can be aggregated into 5 minute reference periods.
- 2.2.12 The energy measuring function shall be protected from non-authorised access to the system and data for example by physical means or by software, such that the integrity of the data produced is not compromised.

2.3 Data handling system

- 2.3.1 The data handling system shall compile the measured energy data with the other data necessary to produce the compiled data without any data corruption.
- 2.3.2 The data handling system shall have the capability to respond to requests for compiled data from the on-ground data collection service.
- 2.3.3 The data handling system shall have the capability to transmit the compiled data to the data collection service within 24 hours, provided that the energy measuring system is energised from its power supply and the communications system is operational.
- 2.3.4 The data handling system shall use, as a time reference, the same source of clock as the energy measuring function.
- 2.3.5 The data handling system shall incorporate data storage with a memory capacity capable of storing the compiled data for at least 60 days (irrespective of the time reference period used) of continuous operation (work) and consisting of consumed / regenerated active and reactive (where appropriate) energy, together with the associated time reference and location data.
- 2.3.6 The data handling system shall have the capability to be interrogated locally by authorised personnel on board the traction unit using the appropriate equipment for example a laptop computer in order to provide:
 - a) An opportunity for audit.
 - b) An alternative method of extracting and recovering data.
 - c) A facility to enable maintenance and fault finding.
- 2.3.7 It is permissible to access / interrogate the data in the data handling system for other purposes, for example feedback to the driver in connection with the efficient operation of the train.
- 2.3.8 Access / interrogation of the data handling system shall not alter / corrupt any of the compiled data.

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- 2.3.9 The compiled data suitable for billing purposes shall be stored ready to be transferred (to the on-ground data collection service) in chronological order according to the end times of each 5 minute time reference period as set out in 2.2.11.
- 2.3.10 The compiled data shall consist of the following:
- a) Unique 13 digit identification number which allows the traction unit and each associated on-board energy measuring system to be unambiguously identified. The format shall be 13 digits, where practicable comprising the 12 digit European Vehicle Number (EVN) (see GM/RT2453 issue two, currently in draft), plus one additional digit to identify each on-board energy measuring system used on the traction unit.
 - b) The end time of each elapsed time reference period for energy measurement, defined as year, month, day, hour, minute and second.
 - c) The on-board location data as set out in 2.4.2 at the end of each time reference period.
 - d) The consumed / regenerated active and reactive (where appropriate) energy in each time reference period.
- 2.3.11 The format of the compiled data and the associated quality flags shall be in accordance with Appendix A.
- 2.3.12 The compiled data set out in 2.3.9 shall be retained even when the energy measuring system is isolated from its power supply.

2.4 On-board location function

- 2.4.1 The data from the on-board location function shall be synchronized in accordance with UTC clock time and time reference period with the on-board energy measuring function (see 2.2.11).
- 2.4.2 The on-board location function shall provide the position expressed in latitude and longitude based on the World Geodetic System and given in decimal degrees.
- 2.4.3 In open air and where the on-board location function can receive a signal, it shall have an accuracy of 250 m or better.

2.5 Data transfer - on-board to ground

- 2.5.1 The compiled data set out in 2.3.9 shall be transmitted from the on-board data handling system to the on-ground based data collection service.
- 2.5.2 The compiled data record transmission format shall be in accordance with Appendix A.
- 2.5.3 It is permitted for other types of data to be transmitted from on-board to ground (for example this could be for energy management purposes). The transmission of other types of data shall not interfere with the transmission of the compiled data.
- 2.5.4 The compiled data shall be packed ready for transmission.