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Railway applications — Axlebox condition monitoring — Interface and design requirements

Part 2: Performance and design requirements of on-board systems for temperature monitoring

National foreword

This British Standard is the UK implementation of EN 15437-2:2012.

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A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Bahnanwendungen - Zustandsüberwachung von Radsatzlagern - Leistungsanforderungen - Teil 2: Leistungs- und Konstruktionsanforderungen von fahrzeugbasierten Systemen für Temperaturüberwachung

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Foreword

This document (EN 15437-2:2012) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2013, and conflicting national standards shall be withdrawn at the latest by March 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

EN 15437 "*Railway applications - Axlebox condition monitoring - Interface and design requirements*” is comprised of the following parts:

— *Part 1: Track side equipment and rolling stock axlebox*;

— *Part 2: Performance and design requirements of on-board systems for temperature monitoring* (the present document).

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Failed wheelset bearings on rolling stock create a hazard to the safe operation of the railway. If a bearing fails while rolling stock is in service there is the potential for a catastrophic event. A catastrophic event may result in fatalities, severe damage to rolling stock and/or the infrastructure and a risk that rolling stock may derail and/or a fire may develop.

One indication that a bearing is about to fail is a rise in the heat generated by the bearing. Bearings that are about to fail may, therefore, be detected by monitoring their temperature to identify an unacceptable rise.

This part of EN 15437 covers the monitoring of axlebox bearing temperature by on-board monitoring systems. According to the application, these may be considered to be basic systems or advanced systems.

In most cases, rolling stock axleboxes continue to be monitored by trackside Hot AxleBox Detectors [HABD] which is the subject of Part 1 of EN 15437. The monitoring system is fitted on the rolling stock and is able to function autonomously from trackside monitoring systems which are ground-based.

In contrast to trackside monitoring systems, the detection characteristic may be adapted to the particular vehicle design, such that the alarm levels employed are configured depending on the bearing properties, sensor arrangement, vehicle type, network characteristics, etc.

The use of on-board monitoring may also provide a solution for overcoming constraints related to bogie design or other aspects of vehicle design or operation which may prevent effective monitoring by means of the track-side monitoring systems.

Other devices which apply functionally equivalent alternatives (for example based on the principle of vibration monitoring) may be available and normalized elsewhere, such as in other parts of this series of European Standards.

1 Scope

This European Standard defines the minimum performance requirements of on-board monitoring systems for axlebox condition monitoring by means of temperature measurements.

This European Standard refers to temperature monitoring of the axlebox. However, the design may be such that the rolling bearing itself is monitored directly.

The requirements of this European Standard are intended to apply equally to basic monitoring systems for monitoring the axlebox temperature through to more technically complex systems that may employ a combination of mechatronics.

To ensure the compatibility of monitoring systems and the effective monitoring functions, this European Standard defines the requirements in the following areas:

— equipment and characteristics;

— monitoring performance;

— operation and interface.

This part of EN 15437 does not include:

— systems that do not give an indication to the driver;

— how an on-board monitoring system is structured and how it measures the temperature and identifies axlebox position. This is considered part of equipment design and not part of the functional requirements set out in this standard;

— operational requirements for acting on the information reported by the on-board monitoring system;

— operational requirements for conflict of information between trackside monitoring systems and on-board monitoring systems;

— maintenance requirements for on-board temperature monitoring systems.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50121-2, *Railway applications — Electromagnetic compatibility — Part 2: Emission of the whole railway system to the outside world*

EN 50125-1, *Railway applications — Environmental conditions for equipment — Part 1: Equipment on board rolling stock*

EN 50126-1, *Railway applications — The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) — Part 1: Basic requirements and generic process*

EN 50128, *Railway applications — Communications, signalling and processing systems — Software for railway control and protection systems*

EN 50129, *Railway applications — Communication, signalling and processing systems — Safety related electronic systems for signalling*

EN 50155, *Railway applications — Electronic equipment used on rolling stock*

EN 61373, *Railway applications — Rolling stock equipment — Shock and vibration tests (IEC 61373)*

EN 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508 (all parts))*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
axlebox
assembly of box housing, rolling bearings, sealing and grease

3.2
bearing
axle journal bearing or bearing assembly on a rail vehicle axle that transmits a proportion of the weight of the rail vehicle directly to the wheel set

3.3
rolling bearing
bearing operating with rolling motion between the parts, supporting load and moving in relation to each other

3.4
on-board monitoring system
system that is capable of detecting a temperature of an axlebox that is indicative of the health of that axlebox and indicates when acceptable temperature conditions have been exceeded

3.5
Safety Integrity Level (SIL)
one of a number of defined discrete levels to specify the safety integrity requirements of the safety functions to be allocated to the safety related systems

Note 1 to entry: The Safety Integrity Level with the highest figure has the highest level of safety integrity.

4 Equipment and characteristics

4.1 Design requirements

The equipment shall respect the applicable requirements regarding the environmental conditions for equipment on-board rolling stock as set out in EN 50125-1. In particular, vibration design of electrical and electronic equipment, as well as their fixing, associated with the measurements on the bearing unit or on the axle box shall respect the requirements set out in EN 61373.

The equipment shall respect the applicable requirements regarding electronic equipment as set out in EN 50155.

On-board monitoring systems shall not interfere or influence the behaviour of trackside equipment or other train-borne equipment.

NOTE This document does not set out the architecture of the environment in which an on-board temperature monitoring system may be installed. The range of architectures may differ significantly (from a freight wagon to a high

speed EMU) and therefore the level of protection required for each installation may be quite different. It is the responsibility of the system installer to establish if the specification of an on-board temperature monitoring system (including any protection for interference from external sources such as electricity or heat) is suitable for the architecture in which it is to be installed and to perform.

4.2 Reliability

The reliability of the on-board monitoring system shall be expressed according to the methods set out in EN 50129. This is to enable the Railway Undertaking (or other responsible entity) to satisfy their requirements when making a risk analysis (concerning rolling stock running with an undetected hot axlebox), for example as described in EN 50126-1.

4.3 Description of alarm levels

Temperature limits shall be determined for alarm levels depending on the bearing properties, sensor arrangement, vehicle type, network characteristics, etc. as follows:

— Alarm level 1 (“hot” alarm): The temperature limit, indicative of the condition of a bearing, above which damage will occur to the bearing and/or its functionality, with the potential to lead to a hazardous event.

— Alarm level 2 (“warm” alarm): The temperature limit, indicative of the condition of a bearing, above which accelerated deterioration of its serviceability is anticipated to occur.

The axle box tests undertaken as part of the requirements set out in EN 12082 can provide an indication of the values to which the alarm levels should be set. However, the range of operational conditions can be different (grease, loads, speeds, forces, etc.) to those of the tests and therefore the final choice of values should account for operational condition.

NOTE The design and function of trackside HABDs means that the differential alarm is required. However, because the on-board monitoring system is specific to an axlebox, a differential alarm is not required. This does not prevent installing an on-board system that includes a differential alarm.

5 Monitoring performance

5.1 General

To cater for different requirements, this standard sets out requirements for both basic and advanced on-board monitoring systems.

The essential requirement is that the on-board monitoring system shall determine the temperature condition of the axlebox and indicate that acceptable temperature conditions have been exceeded. Advanced on-board monitoring systems shall determine the temperature condition of the axlebox and deliver information on the temperature condition ready for further communication and diagnosis.

5.2 Required information

5.2.1 Basic

Essential information for a basic on-board monitoring system is:

— status that the temperature of the bearing has exceeded Alarm level 1.

5.2.2 Advanced

Essential information for an advanced on-board monitoring system is:

— status that the temperature of the bearing has exceeded Alarm level 1;

— status that the temperature of the bearing has exceeded Alarm level 2;

— position on the train of the bearing which has caused an alarm. This can be done by providing detail of the longitudinal and transverse positions, the axlebox identification number, or identification on the axlebox;

— status that the detection equipment is faulty.

NOTE 1 On some systems, the alarm level 1 and the alarm level 2 can be identical.

Each item of this essential information shall include unique identification of the source of the information (equipment or axlebox position in the train).

NOTE 2 Optional information can include for example: time and date stamp, temperature values, rates of change of temperature, trends, differential comparisons, status indicator for bearing OK, status indicator for equipment OK.

5.3 Monitoring capability

5.3.1 Basic on-board monitoring system

A basic on-board monitoring system shall be capable of determining that an acceptable axlebox temperature has been exceeded.

The tolerance on the temperature at which a basic on-board monitoring system is set to indicate that an unacceptable temperature has been exceeded shall be not worse than ± 5 °C.

For a basic on-board monitoring system based on a fusible plug, where the plug is designed to be activated by an axlebox temperature exceeding 95 °C, it should be activated by an axlebox temperature between 90 °C and 100 °C.

5.3.2 Advanced on-board monitoring system

The temperature sensor and monitoring equipment shall determine and evaluate a temperature that is representative of the condition of the axlebox bearing.

The minimum temperature measuring accuracy (maximum deviation of the measured temperature from the actual temperature in the sensor position) shall be no more than ± 5 °C over the temperature range 16 °C to 150 °C.

The registered temperatures shall be evaluated against the alarm levels set out in 4.3 to establish if an alarm threshold temperature has been exceeded.

The maximum time between the alarm threshold being exceeded and delivery of that information to the interface shall be defined in the specification for the on-board monitoring system. Factors that shall be taken into account when specifying the maximum time are the type and maximum speed of the rolling stock and the safety level that is to be achieved.

A risk assessment shall provide guidance for setting the maximum time and demonstrating the safety level to be achieved.

NOTE This standard does not propose how the measurements are made, the time in which the measurements are made and how the data are evaluated or prepared for the interface. These parameters are at the discretion of the system designer.

5.4 Functional Safety

A Safety Integrity Level (SIL) shall be specified for both the hardware and the software for the on-board monitoring system. The SILs shall be defined using the procedures set out in EN 50126-1 or EN 61508 that are appropriate to its application.

The hardware of the on-board monitoring system shall be developed in accordance with the requirements set out in EN 50129 or EN 61508 for the determined SIL.

The software for the on-board monitoring system shall be developed in accordance with the requirements set out in EN 50128 for the determined SIL.

6 Operation and interface

6.1 Operation

6.1.1 Basic on-board monitoring systems

A basic on-board monitoring system shall:

— be active at all times when rolling stock is in operational service;

— detect the temperature of all axleboxes to which it is fitted.

NOTE There may be situations where not all axleboxes of a train need to be monitored by an on-board monitoring system. Two examples are:

— a freight train with a mixture of outboard axleboxes (monitored by trackside monitoring systems) and inboard axleboxes that require monitoring by an on-board monitoring system;

— a train which has only some axleboxes that trackside monitoring systems are unable to monitor and therefore have on-board monitoring systems fitted to those specific axleboxes.

6.1.2 Advanced on-board monitoring systems

An advanced on-board monitoring system shall:

— detect the temperature of all axleboxes to which it is fitted;

— self-start when commanded;

— be operational within 1 min of self-start;

— be operational at all times when in service;

— perform automatic checks that the system is functioning correctly, that is it is monitoring axleboxes and performing to requirements;

— report a malfunction or degraded state;

— respond to interrogation for information on demand;

— provide the monitoring capability set out in 5.2;

— allow verification of its functionality.

6.2 Interface

6.2.1 Basic on-board monitoring system

A basic on-board monitoring system shall:

— deliver the essential information set out in 5.2.1;

— provide an indication to the driver that the temperature of an axlebox has exceeded an acceptable level.

NOTE An indication that the temperature of an axlebox has exceeded an acceptable level can be achieved by partially venting the brake pipe, by integration of a fusible plug into the brake system design, to give a warning indication to the driver in the event of an axlebox overheating.

6.2.2 Advanced on-board monitoring system

An advanced on-board monitoring system shall:

— deliver the essential information set out in 5.2.2;

— provide an indication to the driver that the temperature of an axlebox has exceeded an acceptable level;

NOTE 1 Where an infrastructure manager and/or the regulatory authority agree that the safety target for the monitoring of axleboxes is met by trackside monitoring systems they may authorise the inhibiting of the indication to the driver.

— include an interface that facilitates connection and communication with a diagnosis system where such a system is fitted.

NOTE 2 This part of EN 15437 does not specify protocol syntax, protocol semantics or electrical characteristics of the on-board monitoring system communication interface.

NOTE 3 The interface may include communication to an on-board recorder unit to record an indicator for the condition “activated alarm for axlebox”, if data recording for regulatory purposes is required by a Technical Specification for Interoperability.

7 Assessment methods and criteria

The table below sets out the criteria to be assessed:

NOTE Some criteria may only apply to advance on-board monitoring systems.

Table 1 — Assessment methods and criteria

Criteria	Assessment	Result
Testing of temperature alarms	Provide demonstration that the relevant alarm level status as set out in 5.2 is generated at the interfaces of the system when relevant temperatures are measured by the on-board monitoring system.	Pass/Fail
Testing of equipment faulty alarms (based on failure mode effect criticality analysis – FMECA):	Provide demonstration that the equipment health status is generated or becomes evident at the interfaces of the system for the failure modes declared in the FMECA analysis.	Pass/Fail
Testing of location information	Provide demonstration that the correct localisation information is generated or is evident at the interfaces of the system when either temperature alarm level 1 or temperature alarm level 2 is exceeded or the system is in failure. No specific requirement to test optional information of 5.2.2.	Pass/Fail
Measuring accuracy across the range of temperature quoted:	Demonstration that the temperature, which is measured by the on-board monitoring system, is within the tolerance set out in 5.3.	Pass/Fail
Safety target levels have been determined (SIL):	Provide evidence that a proper safety target level has been determined for the on-board monitoring system for its given application as set out in 5.4.	Pass/Fail
Hardware built and tested to the SIL identified:	Provide evidence that the hardware of the on-board monitoring system has been designed and tested according to the identified safety level as set out in 5.4.	Pass/Fail
Software implemented and tested to the SIL identified:	Provide evidence that the software of the on-board monitoring system has been designed and tested according to the identified safety level as set out in 5.4.	Pass/Fail
Axleboxes fitted with on-board monitoring systems:	Provide evidence that all axleboxes of a train that are designed to be fitted with an on-board monitoring system are fitted with an on-board system.	Pass/Fail
Activation and functionality	Demonstrate that the system is activated and functional in accordance with the applicable requirements set out in 6.1.	Pass/Fail
If the system has the facility to respond to interrogation then verify that a request for information receives the expected response.	Demonstrate that a request for information is responded to in accordance with the requirements set out in 6.1.	Pass/Fail
Verify that the system self-checks and sends a message to confirm its functionality.	Demonstrate that the system is performing self-checks and reports a malfunction or degradation needing maintenance as set out in 6.1.	Pass/Fail
Interface check	Demonstrate that the system delivers the essential information at the interface and provides an indication to the driver as set out in 6.2.	Pass/Fail
Electrical interference	Demonstrate protection from electrical interference in accordance with the requirements set out in EN 50121-2 and EN 50121-3.	Pass/Fail

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Directive 2008/57/EC[1].

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 for HS Rolling Stock, Table ZA.2 for CR Freight Wagons and Table ZA.3 for CR Locomotives and Passenger Rolling Stock confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations

Table ZA.1 — Correspondence between this European Standard, the HS TSI RST published in the OJEU dated 26 March 2008 and Directive 2008/57/EC

Clause/subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4. Characterisation of the subsystem 4.2 Functional and technical specification of the subsystem 4.2.3 Track interaction and gauging 4.2.3.3 Rolling Stock parameters which influence ground based train monitoring systems 4.2.3.3.2 Axle bearing health monitoring	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3 1.2. Reliability and availability 1.5 Technical compatibility §1 2 Requirements specific to each subsystem 2.3 Control-command and signalling 2.3.2 Technical compatibility §1 2.4 Rolling stock 2.4.2 Reliability and availability	Specification and assessment method for on board detection equipment are an open point in the TSI

[1] This Directive 2008/57/EC adopted on 17th June 2008 is a recast of the previous Directives 96/48/EC 'Interoperability of the trans-European high-speed rail system' and 2001/16/EC 'Interoperability of the trans-European conventional rail system' and revisions thereof by 2004/50/EC 'Corrigendum to Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system'.

Table ZA.2 — Correspondence between this European Standard, the CR TSI RST Freight Wagons (ERA IU-WAG TSI-Final draft 1.0, dated 7.11.2011) and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4.Characterisation of the subsystem 4.2. Functional and technical specifications of the subsystem 4.2.3 Gauging and track interaction §4.2.3.4 Axle bearing condition monitoring	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3 1.2. Reliability and availability 1.5 Technical compatibility §1 2 Requirements specific to each subsystem 2.3 Control-command and signalling 2.3.2 Technical compatibility §1 2.4 Rolling stock 2.4.2 Reliability and availability 2.4.3 Technical compatibility §3	The specifications of the design and the verification of on-board equipment is an open point in this TSI

Table ZA.3 — Correspondence between this European Standard, the CR TSI Locomotive and Passenger Rolling Stocks published in the Official Journal on 26 May 2011, and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4.Characterisation of the Rolling stock subsystem 4.2 Functional and technical specifications of the subsystem 4.2.3 Track interaction and gauging 4.2.3.3 Rolling Stock parameters which influence ground based systems §4.2.3.3.2 Axle bearing condition monitoring	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3 1.2. Reliability and availability 1.5 Technical compatibility §1 2 Requirements specific to each subsystem 2.3 Control-command and signalling 2.3.2 Technical compatibility §1 2.4 Rolling stock 2.4.2 Reliability and availability	The requirement for on board equipment is an open point in this TSI

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 12082, *Railway applications — Axleboxes — Performance testing*

[2] EN 15437-1, *Railway applications — Axlebox condition monitoring — Interface and design requirements — Part 1: Track side equipment and rolling stock axlebox*

[3] EN 50121-3-1, *Railway applications — Electromagnetic compatibility — Part 3-1: Rolling stock — Train and complete vehicle*

[4] EN 50121-3-2, *Railway applications — Electromagnetic compatibility — Part 3-2: Rolling stock — Apparatus*

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