ENGINEERING AND TECHNOLOGY
TECHNOLOGY MANAGEMENT

SPECIFICATION

HOT BEARING EVALUATOR DETECTOR SYSTEM (HBEDS)

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Transnet Freight Rail
Transnet and Relevant third parties

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TABLE OF CONTENTS

REVISION SHEET

REV	Section	Description	Date	Approved
1	ALL	First release	Aug 2000	Dr B. Steyn
2	1.3	Added document overview	Sept 2001	Dr B. Steyn
	3.3	Updated interface definition		
	6.1	Updated performance characteristics		
	6.3	Updated system availability factors		
	8.0	Major component characteristics removed		
3	3.3.1	Updated Spoornet ITCMS interface	Aug 2004	Dr B. Steyn
6	3.3.1	Updated ITCMS interface	June 2013	Dr B Steyn
	3.3.2	Updated maintenance technician interface		
	3.3.5	Removed train driver communication system interface		
	3.3.6	Updated vehicle bearing interface		
	6.1	Updated perfomance characteristics		
	6.2	Updated physical characteristics		
7	1.2	Updated system overview	Aug 2020	N. Gobhozi
	2.1	Updated and added systems specification documents and requirements		
	2.2	Added SOW document requirement		
	3.2	Updated context diagram interfaces		
	3.3.1	Removed and updated TFR communication & ITCMS requirements		
	3.3.2	Added multimedia requirements		
	3.3.3	Updated human machine interface		
	3.3.5	Updated train interface		
	4.0	Updated Transnet Freight Rail supplied property list		
	6.1.1	Update detect train		
	6.1.2	Updated identifying and measure the vehicle wheel bearings		
	6.1.4	Added obtain RFID tag information		
	6.1.10	Updated store bearing data		
	6.2	Updated physical characteristics		
	7.0	Updated and added new description of requirements from section 7.1 – 7.6		
	7.7	Updated mandatory requirement to tender		
	7.8.5	Updated interchangeable		
	7.8.6	Updated safety		
	7.14	Updated supplying system spares		
	8.0	Updated quality assurance		
	9.0	Added preparation for delivery		
	10.0	Added acceptance testing: Phase 1 - 4		
	11.0	Added mandatory requirements for tests		
	12	Added mandatory: WTMS acceptance into TFR		

1 Scope

1.1 Identification

Hot Bearing Evaluator Detector System (HBEDS).

1.2 System overview

The Hot Bearing Evaluator and Detector System shall measure the temperature of the wheel bearings of the vehicles in the train consist as the train moves over the system. The wheels on the wagon/locomotive must be uniquely identified in order to associate the measured wheel bearing data with a specific wheel. The measurement and relevant files shall be sent and stored in a Transnet Enterprise System (i.e. Integrated Train Condition Monitoring System and Transnet data server). These measurements shall be compared against pre-set alarm levels. If a measurement is evaluated to be above the alarm limits the system shall raise an alarm via the communication channels. The system shall also gather information on the bearing temperatures for statistical analysis and trending studies and communicate this via the communication channels.

1.3 Abbreviations/glossary

HBEDS – Hot Bearing Evaluator Detector System
TFR – Transnet Freight Rail
TM – Technology Management
TE – Transnet Engineering
GFB – General Freight Business
RN – Rail Network
PM – Project Manager
SOW – Scope of Work
ITCMS – Integrated Train Condition Monitoring System
TCO OAT – Train Control Office Operational Alarm Terminal
FCS – Field Concentrator System
ICD – Interface Control Document
MTBF – Mean Time Between Failure
MTTR – Mean Time To Repair
OEM – Original Equipment Manufacturer

2 Applicable Transnet technical documents

The following technical documents are mandatory references and shall be adhered to by the Transnet Project Manager and the supplier of a technology to Transnet Freight Rail.

2.1 Documents

All the listed documents below are stored in the Transnet Documentation Office. The documentation officer shall issue the documents once the requester has filled in the necessary application forms

Transnet specification/instruction documents

The following specifications, standards and drawings of the exact issue shown form a part of this specification to the extent shown herein. In the event of conflict between the referenced document and this specification, the contents of this specification shall be considered a superseding requirement.

BBB4207	HBED site specification
CSE1154	Environmental & signalling and equipment specification
CSE1159	Standard specification for documentation for Signal equipment
BBH1870	Interface requirement between the ITCMS and Condition

	Monitoring System(ICD document)
BBC1040	Installation of earthing and lightning protection in relay room & signalling enclosures (NOTE: Applicable to any track side enclosures)
BBC5665	Single phase UPS specification 3 – 10KVA
BBG7982	Specification for a typical train condition measurement site
BBB0481	Manual for track maintenance (sleeper spacing etc)
BBH3553	Transnet Freight Rail vehicle footprint: locomotive & wagon
BBD6353	Radio Frequency Identification tag fitted to Transnet rail bound vehicles
BBF1353	Container specification
BBF3244	HBED alarm limits
BBH1359	Scope of Work document (see below)
BBG9365	Changing of wheel temperature alarms
BBH2201	Specification for Training Requirements (School of Rail)
BBH2202	Minimum guidelines on maintenance activities for Condition Assessment Measurement Systems
BBH2203	Specification Communication Mediums (Rail Network Telecommunication office)
BBH2204	Guideline for Condition Measurement System site security

2.2 SCOPE OF WORK document (Contact Technology Management technology owner)

The SCOPE OF WORK (SOW) document shall be drafted after the first site tender meeting discussion has been finalised by relevant parties. Once all the related queries and questions from the interested suppliers are resolved and signed off the document shall be finalised. Technology Management shall obtain a document number and issue this document to the Transnet Project Manager to send to all the suppliers interested in submitting a tender bid inclusive of all the SOW requirements.

NOTE: SCOPE OF WORK document shall cover the following: site location, power and communication requirements, system spares, integration software into TFR, container and security requirements.

3 Requirements

3.1 System definition

The technology shall consist of a wayside measuring system and required processing equipment to:

- Measure the temperature of the wheel bearings on all the wheels of a passing train
- Obtain the vehicle information from the fitted RFID tag
- Store the bearing temperature measurements for alarm and trending purposes
- Generate condition data messages
- Generate alarm messages
- Generate component failure messages

3.2 Context diagram

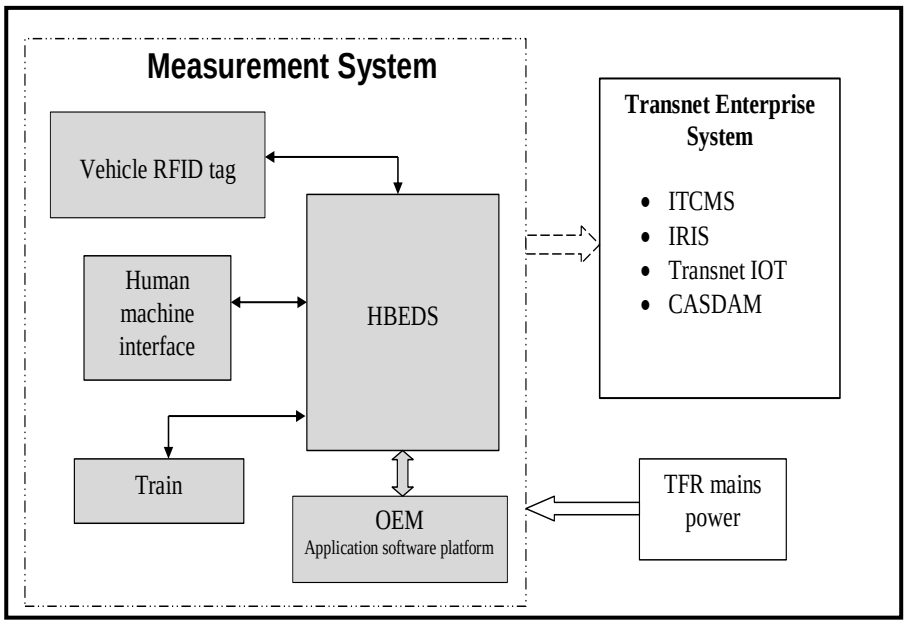


Figure 1: Context Diagram

3.3 HBEDS required Interfaces

3.3.1 HBEDS shall communicate to the ITCMS server (wheel Bearing condition data)

3.3.1.1 The exact message structure and protocol is not specified in this specification document as it shall be compiled in joint collaboration with the system supplier once the contract has been awarded. The interface document BBH1870 once finalised shall prescribe the interface requirements detailing the protocol and the message structures agreed by the OEM and TFR for the required condition measured data, maintenance messages and the alarms that shall be communicated to the ITCMS.

3.3.1.2 The document BBH 2203 shall be adhered to for any telecommunication mediums the measurement system uses in the communication of condition data, maintenance messages and alarms sent by the system to the TFR database server.

3.3.1.3 The following parameters and messages shall be a minimum requirement:

3.3.1.3.1 The HBEDS shall communicate all the bearing temperature measurements to the ITCMS.

3.3.1.3.2 The HBEDS shall communicate all bearing temperature alarms notification messages to the ITCMS.

3.3.1.3.3 The HBEDS shall communicate all maintenance notification messages to the ITCMS.

3.3.1.3.4 The HBED shall communicate all component failures notification messages to the ITCMS. (Examples: shutter failer, temp sensor failed etc)

3.3.2 HBED to the Transnet database server (store multi-media files)

3.3.2.1 The HBEDS system shall be able to send multimedia files (sound/video/images) available (for transfer or local access) to the Transnet Data Server, and separated as follows:

3.3.2.1.1 Alarm Multimedia (for alarm verification if applicable)

3.3.2.1.2 All multimedia (for Transnet to trend/process/learn)

3.3.2.2 The multimedia files (sound/video/images) sent to the TFR database shall have its alarm limits configurable on the system.

3.3.2.3 All types of multimedia (sound/video/images) shall be required by TFR to be stored on the system for at least 90 days.

3.3.2.4 Any supplier providing TFR with a system shall provide TFR with the multimedia message file size, the protocol format immediately once the contract to supply TFR with a measurement system is awarded.

3.3.2.5 The Transnet Database communication protocol shall be TBD1.

****TBD1: During the final phase of drafting the SCOPE OF WORK document the Suppliers shall be notified on the type of server, available transmission line speed (e.g.1 Mb/sec) and the operating platform that the Transnet ICT department shall be using for the database server.*

3.3.3 HBEDS to human machine interface

3.3.3.1 The HBEDS shall provide a human machine interface for the system maintenance technician. This access shall allow the technician to access the wheel bearing condition information, bearing temperature alarm information and the configuration parameters. The interface shall consist of a visual display of the system operational programs, calibration procedures and any system diagnostic views. These facilities shall enable the maintenance technician to perform the required maintenance and assist the technician with fault finding

3.3.3.2 The interface shall provide facilities to allow the technician to modify configuration parameters in the HBEDS. The minimum configuration parameters which should be under control of the technician should be:

- Date and time
- Alarm levels for each of the measurements
- The communication settings of the communication interfaces.
- Any other configurable system parameters which have an impact on the wheel bearing temperature measurements.
- System shall log any configuration change made by the technician.

3.3.4 HBEDS to the Vehicle Tag interface (See document BBD6353)

3.3.4.1 The RFID tag types fitted to the locomotives and the wagons used by Transnet shall be found in the document BBD6353 section 1.0.

3.3.4.2 The RFID tagging configuration for locomotives and wagons shall be found in the document BBD6353 section 3.0.

3.3.4.3 The RFID tag containing the locomotive and wagon information and configuration shall be found in the document BBD6353 section 4.0.

3.3.5 HBEDS to train interface

3.3.5.1 The system shall be able to measure the bearing temperature accurately for all trains travelling over the site up to a speed of 100km/h.

3.3.5.2 The HBEDS shall be activated by a train entering the measurement site.

3.3.5.3 The HBEDS shall be deactivated by a train leaving the measurement site.

3.3.5.4 The system shall interface to the train to determine train composition.

3.3.5.5 The system shall identify the vehicle type (reading fitted tag) for all vehicles irrespective of their position in the train.

3.3.5.6 The wagon orientation is deduced from the information in the tag. If a "01" tag is read from the left side of the train when looking in the direction of travel then the orientation shall be "Front". If a "02" tag is read from the left side of the train when looking in the direction of travel then the orientation shall be "Rear".

3.3.5.7 The system shall be able to handle a vehicle with a missing tag.

3.3.5.8 The system shall be capable of identifying all the various types of vehicles passing the system by using the Transnet Freight Rail vehicle axle spacing pattern found in document BBH3553.

3.3.5.9 The train length can be from a single vehicle to train lengths of more than 400 vehicles per train consist.

3.3.5.10 The system shall accurately measure each vehicle position starting from the first locomotive entering the site until the last vehicle leaving the site of the same train consists.

3.3.5.11 The system shall correctly associate the measured bearing temperature measurements to the correct vehicle position, axle and wheel position.

3.3.5.12 The system shall be able to correctly identify a locomotive position anywhere in the entire train consist.

3.3.5.13 Train movements at a measurement site can be bi-directional.

3.3.5.14 A train entering the site can stop for a period of time, rollback and then move forward over the measurement system.

3.3.5.15 The system shall be able to accommodate train acceleration / deceleration over the measurement site.

3.3.5.16 Wheel sensors installed on the rail shall comply with the Signalling maintenance document BBB0481 (sleeper spacing).

3.3.5.17 Wheels sensors shall be immune to rail traction current surges (i.e. wheel pulse induced when no vehicles wheel is on the sensor).

3.3.5.18 The supplier shall provide heavy duty galvanised steel deflector plates fitted on both sides of the wheel sensors and securely mounted to the rail.

3.3.6 HBEDS to wheel bearing temperature interface

3.3.6.1 The HBEDS system shall interface to the bearings on the vehicle to determine the bearing temperature.

3.3.6.2 The position of the centre line of different types of roller bearings in relation to the rail is shown in section 13 Appendix A Figure 1 for all the roller bearings used by Transnet Freight Rail. The surface area to be measured on the roller and friction bearing is indicated in section 13 Appendix A Figure 2. The geometry of the track relative to the roller bearings is shown in section 13 Appendix A Figure 3.

3.3.6.3 The train's lateral movement can be up to 98 millimetres relative to the rail (GFB wagons).

3.3.6.4 Some of the bogie types employed in Transnet Freight Rail might obscure the effective measurement area of the bearing, especially if the measurement is made at an angle to the vertical centre line.

3.3.6.5 The bearings temperature can be between ambient temperature and 1000 Degrees Celsius.

4 Transnet Freight Rail supplied property list

4.1 Site location

4.1.1 See the SCOPE OF WORKS document shall cover the exact location where the system shall be installed.

4.1.2 Technology Management and Rail Network shall provide the Project Manager with a signed letter once the correct site location & container position meets the site specification requirement.

4.1.3 Technology Management and Rail Network reserve the right to immediately reject the system should there be a deviation on the agreed location. No changes to the SOW location shall be allowed unless all parties agreed to the new position and a sign off indicating such a decision was made.

4.2 Site power

4.2.1 The supplier shall provide TFR the systems power requirements. The power requirements shall be discussed in the first site tender meeting and once an agreement between parties is reached, the SOW shall be drafted.

4.2.2 TFR shall provide a UPS for the container power requirements. See SOW.

5 Transnet Freight Rail loaned property list

Not applicable.

6 System characteristics

6.1 Performance characteristics

6.1.1 Detect train

6.1.1.1 The system shall only be initialised and measure wheel bearing temperatures if a train is present at the measuring site.

6.1.1.2 The system shall be able to detect all vehicles travelling over the site in bi-direction.

6.1.1.3 The system shall not lose track of the train consist when a train stops over the system.

6.1.1.4 The system shall timeout after a configurable set amount of time should the train remain stationary over the site for an extended period.

6.1.1.5 The system shall commence measuring once the train starts moving again.

6.1.1.6 The system shall provide a warning message with the sent bearing temperature information to the ITCMS that the train had stopped and train consist is incomplete. See BBH1870.

6.1.2 Identify & measure the vehicle wheel bearings

6.1.2.1 The system shall identify at least 98% of the vehicle types (i.e. obtain vehicle type from fitted vehicle tag) for all vehicles irrespective of their position in the train. If a vehicle cannot be identified it shall be marked accordingly. The different classifications are:

- Locomotive (4 axle & 6 axle)
- Wagon
- Coach
- Trolley (2 axle)

- Track maintenance vehicle (8 axles or more)
- Unidentified vehicle

6.1.2.2 The system shall 100% accurately measure each vehicle wheel bearings starting from the first locomotive entering the site for the entire train consist.

6.1.2.3 The system shall 100% correctly associate the measured bearing temperature measurements to the correct vehicle position, axle and wheel causing the alarm as well as inserting the correct vehicle number to vehicle.

6.1.3 System train monitor

6.1.3.1 The system shall be able to provide a warning message to the TFR database (ITCMS) as well as to the maintenance technician should the system not measure a train for a certain defined configurable time period (e.g. 6 or 12 hours).

6.1.4 Obtain RFID tag information

6.1.4.1 The HBEDS system shall obtain the vehicle identification information directly from the fitted vehicle tag.

6.1.4.2 The system supplier shall supply an approved RFID tag reader with every measurement system installed in Transnet.

6.1.4.3 The RFID tag reader shall have an ICASA approved seal.

6.1.4.4 The system shall measure every vehicle with a fitted tag for the entire train consist.

6.1.4.5 The system shall be able to cater for missing vehicle tags within the train consist. The system shall uniquely mark this missed vehicle as “U = unknown” if the vehicle footprint to distinguish whether the vehicle is a locomotive or a wagon is not possible.

6.1.4.6 The system shall only read one fitted tag per vehicle (left or right side) at any given time.

6.1.4.7 The system shall correctly insert the vehicle number (read from tag) to the correct vehicle position in the entire train consist. Mandatory accuracy for this association is 100 %.

6.1.4.8 The system shall send the following tag information included in the data being sent to the TFR database. See the BBH1870 interface document.

- Vehicle number
- Owner code
- Vehicle type
- Orientation

See BBD6353 for the configured tag information.

6.1.5 Determine train speed

6.1.5.1 The system shall be able to determine the speed of the train passing over the site in either direction with a speed accuracy of ±1km/h.

6.1.6 Measure and process bearing temperature information

6.1.6.1 The system shall be able to accurately measure, store and process bearing temperature information for all trains passing the site.

6.1.6.2 The system shall be able to determine the bearing temperature of all the train

wheels. The total number of wheel axles on the train shall not exceed two thousand.

6.1.6.3 The HBEDS shall measure the temperature of all the bearings on passing trains with an accuracy of ± 3.5 degrees Celsius.

6.1.6.4 The measurement shall be presented in degrees Celsius.

6.1.6.5 The ambient temperature shall not influence the bearing temperature measurements adversely.

6.1.6.6 The HBEDS shall obtain and process temperature measurements for each bearing on the train within the following constraints:

- Irrespective of the direction of travel.
- For train speeds up to 100km/h.
- Irrespective of train acceleration or deceleration up to 2m/s².
- Changes in train direction whilst the train is still detected on site.

6.1.6.7 The measurement result shall be immune to the train's lateral movement and vertical movement.

6.1.6.8 The system shall compare the measured temperature values against pre-set alarm temperature limits on site.

6.1.6.9 An alarm condition shall be raised immediately if the measured value is found to be outside the alarm limits.

6.1.6.10 Alarm limits shall only be configured by an authorised system manager/technician. If the alarm limits are changed on site i.e. locally on the technician terminal, the system shall communicate a message to the Transnet Database (ITCMS) notifying of the alarm limit changes.

6.1.7 Identify bearing types

6.1.7.1 The system shall identify the bearing type of each axle passing the measurement site.

6.1.7.2 Classification shall be either a “roller” bearing and if possible a “friction” bearing Note: Identifying or measuring a friction bearing is not mandatory.

6.1.7.3 A bearing type that cannot be identified shall be indicated as “U=unknown”.

6.1.7.4 The classification of the bearing type can be done using the average running temperature of the two bearing types. In the case of a friction bearing the average running temperature is 40 degrees Celsius and for the roller bearing this value is 75 degrees Celsius at an ambient temperature of 25 Degrees Celsius.

6.1.7.5 The average running temperature of the different bearing types shall be configurable.

6.1.8 Vehicle axle bearing position on a vehicle

6.1.8.1 The following reference shall be used for providing the position of the individual bearings as shown in the figure 2 when a tag is fitted.

6.1.8.2 The system shall combine the bearing temperature information with the train composition. A measurement shall have the following associated with it:

- Vehicle position in the train consist where the measurement was taken.
- Vehicle number where the measurement was taken.
- Vehicle orientation “1 = F” or “2 = R” read from the tag number.
- If a missing tag occurs a “W = wagon or L = locomotive” shall be inserted in the message sent to the ITCMS as identified by the vehicle footprint. If the vehicle footprint cannot be measured correctly or no match found in the

footprint table provided by Transnet the system shall use a "U = unknown" to indicate data is not usable.

- The system shall number every passing vehicle axle in the train consist starting from the first locomotive vehicle entering the site.
- HBEDS data sent to the ITCMS shall follow the absolute referencing as shown in this document as seen below in 6.1.8.3. See vehicle diagrams shown below as referenced by document BBD6353.
- Direction of travel “UP” or Down” Note: shall be configurable.
- Date and time the measurement was taken.

6.1.8.3 An absolute reference shall be used for providing the actual wheel position where the measurement was taken as shown in the figure 2 if tag information is available. See document BBD6353 for the configuration.

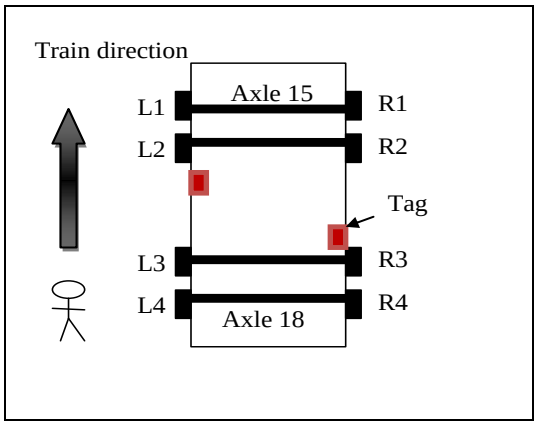


Figure 2: Absolute referencing

6.1.8.4 If no vehicle tag is fitted and can be used in identifying the type of vehicle the axle shall be numbered from 1st vehicle entering site i.e. axle 1. The axle wheels will be numbered from the side facing the front of the train and left and right will be left and right when looking towards the front of the train (leading locomotive).

6.1.9 Generate alarms to be sent to TFR database (See BBH1870 - ITCMS)

Alarms shall be generated as follows:

6.1.9.1 Absolute alarm level - The measured value of the bearing is compared against the absolute alarm value. An alarm is generated when the measured value reaches the configured absolute alarm value.

6.1.9.2 Differential alarm level - The measured value of the left bearing is compared against the measured value of the right bearing. An alarm is generated when the difference between the two measured values exceeds the configured differential alarm value.

6.1.9.3 Average Deviation Alarm Level - The measured value of each bearing is compared against the average of all the bearings on the train. An alarm is raised when the difference between the measured value and the average value exceeds the configured average deviation alarm value.

6.1.9.4 The HBEDS shall not generate hot bearing alarms if it detects heat sources other than the target area of the bearing.

6.1.10 Store bearing temperature data

6.1.10.1 The HBEDS shall store alarm and bearing temperature measurement information.

6.1.10.2 The information shall be sent to ITCMS as per BBH1870 specification.

6.1.10.3 The HBEDS shall make provision to store information for a configurable amount

of trains up to a 1000 trains. The principle of a “ring buffer” shall be used to store and replace data.

6.1.10.4 The HBEDS shall retain the stored information on site and using a ring buffer system, only keep the last 90 days wheel bearing temperature data.

6.1.11 Communicate bearing temperature information and bearing temperature alarms to the ITCMS (as per document BBH1870 exact message format)

6.1.11.1 The system shall communicate bearing temperature information, vehicle information and bearing temperature alarms to the ITCMS immediately after completion of analysis of the train. The bearing temperature alarms shall have the highest priority and be communicated first.

6.1.11.2 The system shall provide the measurements for every train irrespective of whether vehicle identification information is available or not.

6.1.11.3 The system shall ensure that the sent bearing temperature and alarm message was delivered and received by the ITCMS. The system shall continue sending the data until the ITCMS has acknowledged receipt thereof.

6.1.12 HBEDS date and time (as per document BBH1870)

6.1.12.1 The HBEDS system shall be able to keep an accurate date and time (±30 second drift allowed) calendar for real time communication of data and alarms to the Transnet data servers (ITCMS & TFR database).

6.1.13 HBEDS self-check

See BBH1870 for the self-check message requirements.

6.2 Physical characteristics

6.2.1 Track side and enclosure equipment requirements. (See BBB 0481 track equipment installation and maintenance processes in Transnet)

6.2.1.1 “A” boards shall be provided and mounted by the supplier on either side of the tracks to indicate to track maintenance vehicles and to train drivers that they are approaching a measurement system site.

6.2.1.2 The computer equipment shall be housed in an IP rated 65 secured equipment container with suitable cooling equipment to prevent the inside temperature of the container exceeding 30° Celsius.

6.2.1.3 The equipment in the container or room of the HBEDS shall not exceed 1 metre deep by 1.5 metres wide by 2 metres high.

6.2.1.4 The HBEDS shall be installed in a suitable cabinet with lockable castors.

6.2.1.5 The cabinet shall be accessible from the front and back with hinged doors.

6.2.1.6 The supplier shall ensure that all track mounted equipment and trackside equipment shall be clear of the minimum structure gauge as defined in the Permanent Way Instruction manual. See Section 13 Appendix B.

6.2.1.7 The supplier shall ensure all equipment mounted on the sleepers or attached to the rails shall be level or below the rail crown i.e. wheel running surface.

6.2.1.8 The supplier shall supply suitable deflector plates, galvanised piping and trunking to protect any rail mounted equipment and cabling against damage and theft

6.2.1.9 The three sleepers on either side of the measurement system rail mounted equipment shall be painted using durable quality “yellow” 2K paint.

6.2.1.10 The supplier shall provide track side equipment that is securely mounted and lockable. Suppliers providing sleeper type housing enclosures shall be preferred above module enclosures that are bolted to the rails.

6.3 System availability factors

The supplier shall provide guaranteed spares or materials to ensure system repairs and system outages are minimised.

6.4 Environmental conditions

6.4.1 All trackside equipment shall comply with the Signals standard specification document CSE 1154-001-CAT E48 Version 2.

6.4.1.1 Adherences to the following South Africa environmental conditions are critical for the system to perform as per requirements:

- Temperature
- Vibration
- Corrosion
- Pollution i.e mist, chemical spillage, coal & ore dust
- Surges in rail track (electric locomotives, high theft on rail bonding cables)
- Lightning (SA has a high amount of lightning strikes)
- Altitude (0m to 1980m above sea level)
- Humidity (As high as 85%)

6.4.2 The IP rating of all track side enclosures shall be at least IP 65 compliant.

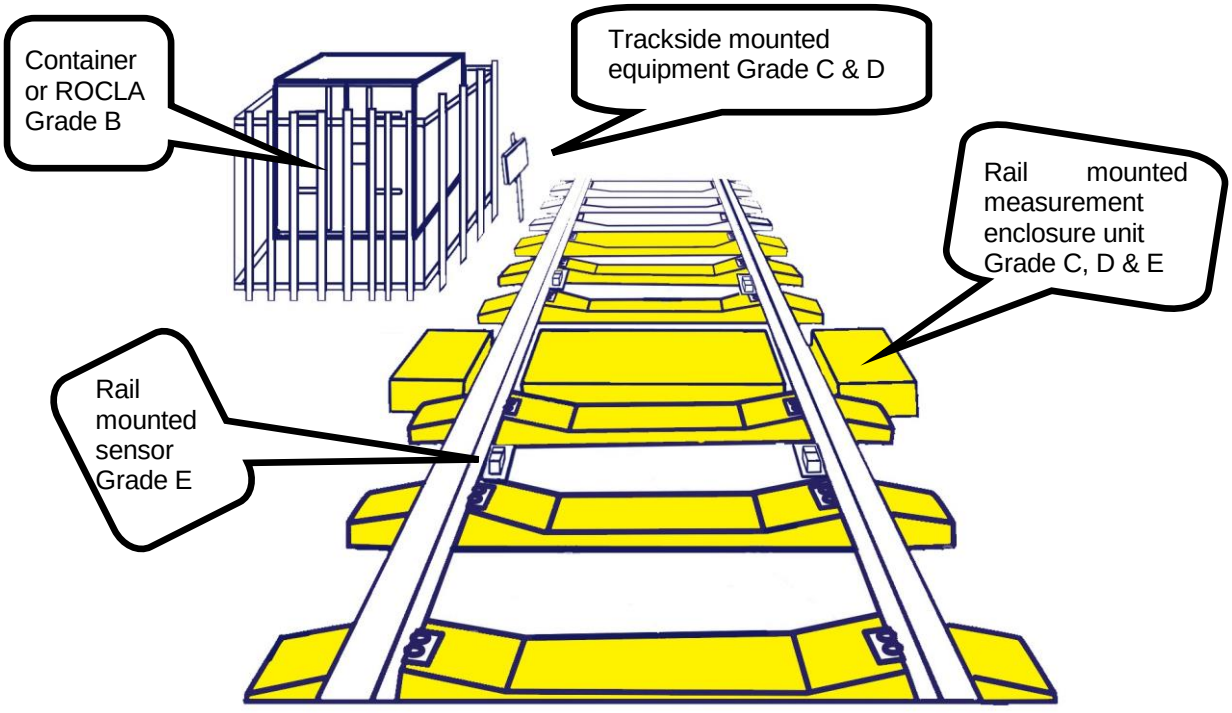


Figure 3: Typical system layout (Graded as per CSE 1154)

6.5 Portability

6.5.1 System equipment

All spare replacement modules shall be small enough to be handled by one technician. If special packaging is required for any module in the rail environment, it shall be supplied as part of the system.

6.6 Transportability

All spare replacement modules shall be small enough so that it can be transported to site in the boot of a car or on the back of a one ton truck (bakkie) with a canopy on a service road.

6.7 Fail-safety requirements

The system is viewed as a fail-safe system, the mission of the system is critical in the operations of Transnet to ensure the bearings are kept in check and removed when due wear or damage.

7 General system implementation requirements and adherence

7.1 Power, communication, interface software, security & container requirements shall be provided by the supplier at the first site meeting. These requirements shall be documented and signed off by the responsible parties after the first site meeting.

7.2 The supplier shall provide a typical UPS power module that shall be installed in the system cabinet to protect the systems computers by shutting down safely in the advent of a mains power failure. The system shall automatically restart once the power is restored.

7.3 Suppliers shall use electrically/electronically controlled components to operate any moving slides or flaps to open shutter windows.

7.4 Suppliers shall use a blower type apparatus to provide air flow to window openings to keep the rain and dust from contaminating the glass windows.

7.5 Supplies shall use electronic systems (e.g. peltier device) and other cooling systems to maintain the room temperature below 30°Celsius. Water cooling systems should be avoided as far as possible due to TFR water availability along the rail track.

7.6 Suppliers installing track side equipment shall only provide suitable enclosures that have minimal exposure to theft. Preference shall be given to equipment embedded in metal sleeper frames that are not easily detachable from the rails.

NOTE: Preference shall be given to suppliers whose measurement system uses enclosures, components requiring less intensive maintenance intervals and life cycle costs to improve the systems availability and reliability. Higher rating will be given to suppliers who fully comply with section 7.2, 7.3, 7.4, 7.5 & 7.6.

7.7 Mandatory requirement to tender

7.7.1 The supplier shall provide the type of computer operating system used. For example: Windows 10 Enterprise 64 bit.

7.7.2 The system shall be able to measure 100% of all the fitted vehicle tags to obtain the vehicle information i.e. type of vehicle, vehicle number etc.

7.7.3 The system shall be able to measure 100% of all the vehicle axles of the train passing the measurement site.

7.7.4 The system shall be able to correctly configure (at least 98%) the placement and position of the locomotives and the wagons in the complete train consist. TFR have mixed train consists. For example: Ore line uses 3 rakes of 114 wagons with loco’s in the front, middle and at the end of the train consist.

7.7.5 The system shall measure all the bearing temperature for at least 95 % of all the vehicles in a train consist over a 3 month window period.

7.7.6 The supplier shall provide a complete set of system documentation including relevant proof/examples of other railway operators HBEDS bearing condition data for the technical review evaluation.

7.7.7 The supplier shall be able to provide further technical information or provide a presentation on request by the review specialists.

7.7.8 The supplier shall include the following costing in their tender bid:

7.7.8.1 Transport/shipping equipment to TFR site

7.7.8.2 Supplied critical spares for system (See SOW)

7.7.8.3 Container (cost shall including concrete plinth & earth grid)

7.7.8.4 Security (minimum 2m high galvanised steel fence & gate)

7.7.8.5 System interfacing costs into the Transnet Freight Rail Enterprise network.

7.7.8.6 OEM application software (OEM tools - trending & data analysis etc.)

7.7.8.7 OEM & their local suppliers full installation of the system

7.7.8.8 Total system cost.

7.7.9 The SOW signed document shall clearly state the required items as listed above that all the suppliers shall provide in their tender bid to TFR. Suppliers delivering all the items required by TFR shall be given a higher rating. TFR reserves the right to nominate the supplier best suiting their budget requirements.

7.8 Design and construction

7.8.1 Nameplates and markings

7.8.1.1 All hardware and wiring looms shall be equipped with durable manufacturer's nameplates baring at least unit identification, the manufacturer's name, date of manufacture, a serial number, revision number with the current revision status marked, operating voltage and power requirements.

7.8.2 Materials, processes and parts

See document BBH 2202.

7.8.3 Availability and Reliability (See document BBH 2202)

7.8.3.1 Availability

7.8.3.1.1 The HBEDS shall be available to measure all vehicles passing the site to at least 96% of the total number of vehicles rolling by the system over a 3 month cycle period.

7.8.3.2 Reliability

7.8.3.2.1 The HBEDS shall require a MTBF of not less than 3 months in a 3 month roll by system cycle.

7.8.3.2.2 The HBEDS MTTR shall not exceed 48 hours.

7.8.4 Workmanship

See document BBH 2202.

7.8.5 Interchangeable

The supplier shall provide all spares or parts that are interchangeable where the case of

obsolescence of a component or part has occurred. The supplier shall issue a letter to guarantee that the new component or part still meets the systems functionality and performance.

7.8.6 Safety

- All work shall be conducted within the regulations stipulated in Act 85 of 1993 (Occupational Safety Act) or the latest revision.
- All trackside work shall be done in accordance with safety procedures laid down by the by local TFR depot manager.
- Supplier shall adhere to TFR train working rules.
- Supplier shall undergo TFR induction training.

7.9 System Documentation (See CSE 1159, BBH2201 & BBH2202)

7.9.1 The supplier shall request the PM to provide a batch of TFR documentation numbers for the systems document that shall be supplied to TFR. i.e. all the relevant technical drawings, wiring diagram etc. that make up the system.

7.9.2 All documentation supplied to TFR shall be in English. See CSE 1159.

7.9.3 The supplier of the system shall provide the following system documentation to Technology Management for review (See document CSE1159 section 3 for items listed below):

7.9.3.1 System wiring diagram with test points and values (e.g. voltage)

7.9.3.2 Installation manual (section 3.2)

7.9.3.3 Operations manual (section 3.3)

7.9.3.4 Maintenance manual (section 3.4)

7.9.3.5 Training manual (can be provided on training session) (See BBH 2201)

7.9.3.6 Calibration manual (See BBH 2202)

7.9.3.7 Field enclosure drawings (section 6.0)

7.9.3.8 System diagnostic fault finding guideline (See BBH 2202)

7.9.3.9 Complete system overview block diagram showing connecting sub systems and major component inputs and outputs (See BBH 2202)

7.9.4 “As Built” set of drawings shall be delivered for each installed HBEDS site**.**

7.9.5 Technology Management shall reserve the right not begin the Acceptance Test Procedure Phase 1 cycle if the full complement of the required documentation is not made available. Training documentation (as per BBH 2201) can be provided during the training session.

7.9.6 The supplier shall track and update all documents with any functional changes made during the 12 month test period.

7.10 System Technician

7.10.1 Transnet Freight Rail i.e. Rail Network depot shall ensure that a responsible technician is appointed (or employed in TFR) to permanently provide the daily, weekly required support to the system to ensure the system is operational and measuring train bearing temperature.

7.10.2 The TFR system technician shall be at least computer literate, relevant electronic and mechanical skills to be able to repair and capably calibrate the system when required.

7.11 Maintenance

See document BBH 2202.

7.12 Facilities/Spares/equipment

See document BBH 2202.

7.13 Personnel and training

See documents BBH 2201 & BBH 2202.

7.14 Supplying system spares

7.14.1 During the first site tender meeting with the suppliers the amount of critical parts required for the system shall be discussed and the amount thereof shall be documented in the SOW.

Note: These supplied spares shall not to be used in the 12 month guarantee period. All failed components during the 12 month guarantee period before final handover to TFR shall be replaced by the supplier on their own costs.

7.14.2 The supplier shall provide an inventory of all the system spares as well as the part numbers including any OEM in-house manufactured printed circuit boards and peripheral cards.

7.14.3 The supplier shall guarantee continued local availability of all components of the system, as well as frequently used spares of the components, for a contractually specified period of at least 10 years. The supplier shall provide TFR a certificate indicating this guarantee period.

7.14.4 The supplier shall guarantee delivery of all critical spares within 2 weeks of placed order. The supplier shall provide TFR a certificate to guarantee their commitment.

7.14.5 The supplier shall provide TFR with a repair and refurbishment option of its in-house developed embedded printed circuit boards. Refurbished and repaired printed circuit boards to be charged at market related prices.

7.14.6 A “cloned” hard drive disk/disks of the measurement system shall be delivered with each installed HBEDS to enable the system technician to repair the HBEDS after a catastrophic failure, for example hard disk crash.

8 Quality assurance

8.1 Transnet reserves the right to accept or reject the installation of the equipment, the installed cables, measurement equipment, equipment paintwork, the galvanising of metal materials where any of the above items fail to meet Transnet Freight Rail quality specifications standards.

9 Preparation for delivery

9.1 Acceptance Test Procedure (ATP)

9.1.1 The test procedure shall be drawn up and documented by the supplier in an ACCEPTANCE TEST PROCEDURE (ATP) document. Technology Management and Rail Network shall approve the ATP document. Note: section 10.2 shall also be included in the ATP where a test train with adjusted hand brake to cause bearing to heat up slightly by 10 – 15 degrees shall be used to test the bearing temperature system. The data shall be verified against calibrated bearing temperature target. NOTE: No diesel locomotive shall be used for the test train. A 15E or a 22E electric locomotive shall be used to verify that the rail traction current & the incremental speed notching does not influence the systems performance i.e. wheel sensor etc.

9.2 Responsibility for tests

9.2.1 The suppliers shall be responsible for the execution of the tests to prove their system meets the HBEDS specification requirements.

9.2.2 The minimum tests to be performed shall be those determined by mutual consent

between Project Manager/Technology Management/Rail Network and the supplier.

9.3 Site Access

9.3.1 The successful tenderer shall obtain site permits 6 weeks ahead of scheduled installation of the system by contacting the appointed PM to organise these permits.

9.3.2 The successful tenderer shall be required to do an Induction course before they shall be allowed access to work near the railway lines and power overheads within TFR.

9.3.3 The Supplier of the measurement system shall not be allowed on TFR property (railway line or service road) without prior arrangement with the local depot technician or a TFR representative to be on site.

10 Acceptance testing: Phase 1 – Phase 4

Note: TM & RN shall not approve the system until the system has performed Phase 1 – Phase 4 in the Transnet Freight Rail railway environment for a fixed period of 12 months i.e. 4 seasons

10.1 Phase 1: Site audit by TM & RN [1 ≤ 2 days]

10.1.1 Technology Management (TM) and Rail Network (RN) shall visit the first/pilot site to determine if the supplied system meets the Scope of Work document requirements (agreed by parties at tender site meeting).

10.1.2 Main incoming power: TM shall check that the Earth spike, Surge protection and Phase protection modules are correctly installed.

10.1.3 Communication: TM shall check the integration communication software between the first/pilot system and the ITCMS. Proof of verified messages between the systems shall be shown that it is operational and working. Self-check messages acknowledge and ITCMS indicating the system is working.

10.1.4 Electrical rail bonding: TM shall do an inspection to validate all electrical bonding and shall be signed off by TM & RN.

10.1.5 System installation in the section shall be signed off by TM & RN that it does not interfere with train operations and correct operation of the signalling installed systems.

10.1.6 TM shall notify the Project Manager that the site is now ready for a functional system measurement test.

10.1.7 Test train shall be arranged by the Project Manager and a notification of at least 6 weeks shall be required. Secondly a 21 day notification is required to arrange an occupation to work on the line.

10.2 Phase 2: Testing system as per specification [1 ≤ 3 days]

10.2.1 The supplier shall be responsible for the execution of the functional tests.

10.2.2 The minimum tests to be performed shall be those determined by mutual consent between Technology Management and the supplier (local supplier and the OEM).

10.2.3 The responsibility for proving the test results shall reside with the supplier.

10.2.4 The supplier shall document the test results and thereafter the result shall be made available to Technology Management VIT/Transnet Engineering Wagon VIT.

10.2.5 TM reserves the right not to continue any further testing and evaluation of the system until the measured temperature measurements provided by the supplier is acceptable to Transnet Engineering & Wagon Maintenance Engineer.

10.2.6 TM shall provide the Transnet Project Manager with a letter stating whether the bearing temperature measurements are accepted by Transnet Wagon Maintenance engineer or if further evidence to validate the accuracy and reliability of the system shall be required. The Project Manager shall notify the supplier on the acceptance or rejection

of the temperature results.

10.2.7 Phase 2 shall be completed once TM has notified the Project Manager that the measured bearing temperature accuracy is accepted. The Project Manager shall notify the supplier.

10.3 Phase 3: System approval period [12 ≤ 18 months]

10.3.1 After completion of phase 2 the 12 month cycle period begins for the system to measure and provide a 95% yield of measured trains with all wheels bearing temperature data stored in the ITCMS.

10.3.2 The Project Manager shall set the beginning date and the end date of the 12 months evaluation period.

10.3.3 If any system defects occur or the system fails, the evaluation period shall be reset and a new end date for approval shall be put into effect.

10.3.4 The time period for the new approval date shall be limited to 18 months and after this period Transnet shall reserve the right to cancel the contract for the system.

10.3.5 TM and RN shall evaluate the measured data during the test period and if all the requirements have been met and passed (end of day 5 of phase 2), the system shall become operational and all bearing temperature data, maintenance and alarm messages shall be sent to the ITCMS.

10.3.6 All system training shall be as per specification document BBH2201 & BBH2202 requirements.

10.3.7 The depot shall be informed that the system is operational and under the final testing 12 month phase. The depot shall prepare for the takeover of the maintenance cycle of the system as well as to plan a budget for the required critical spares of the system.

10.4 Phase 4: 12 months cycle – approval of the pilot/system technology [1 ≤ 3 days]

10.4.1 Once the system has performed and met Transnet specification requirements and the measured data has met the clients requirements Technology Management/Rail Network shall sign and approve the technology that it has met the prescribe performance requirements.

10.4.2 If the system failed a number of times Technology Management shall instruct the PM to withhold any further payments to the supplier. The supplier shall be liable to replace all faulty components at their own costs during the guarantee 12 month period.

10.4.3 The supplier shall provide all the documents and required information and the executable “cloned” disk/disks before the system shall be approved. See CSE1159.

10.4.4 Rail Network shall test the supplier’s executable “cloned” disk to validate whether the executable disk actually works before the system shall be approved.

10.4.5 All quoted tender spares shall be in the possession of Transnet before the approval of the system shall be signed. See list of examples of critical spares required.

- Cloned measurement system hard drive disk
- Peripheral pc cards (e.g. OEM embedded pc boards, data acquisition boards etc.)

11 Mandatory Requirements for tests

11.1 All tests shall be observed and signed-off by the duly appointed representative of Transnet Engineering, Rail Network and Technology Management.

11.2 Any tests requiring the use of rolling stock shall be arranged by Transnet Freight Rail given sufficient notice by the supplier.

11.3 The tests shall be executed step by step to validate conformance with the specification document.

11.4 The tests shall firstly verify the correct operation under normal conditions of operational trains. Provide evidence of a complete train consist (i.e. 400 vehicle) bearing temperature data for trains passing the system.

11.5 The tests shall then be repeated using a test train by adjusting the hand brake on a single wagon to cause the bearings to heat up slightly by 10 – 15 °C. This will assist in verifying the system accuracy to detect the correct wagon and the wheel bearing measurements of the system.

11.6 Rail Network depots shall take ownership after Phase 2 is completed during which the system performance shall continuously comply with the requirements.

11.7 The supplier shall stay responsible for all routine maintenance/repairs to the system during the 12 month guarantee and approval period.

Note: Errors, calibration requirements, failures and related occurrences that are not covered by the routine maintenance schedule during this time shall be deemed as “faults” and shall reset the fault free evaluation measurement 12 month cycle.

12 Mandatory: HBEDS acceptance into TFR

The following TFR department representative shall be required at the end of 12 month evaluation period for final handover:

- Technology Management
- Rail Network
- Transnet Engineering
- School of Rail
- Operational Readiness
- Corporate safety

13 Appendix A

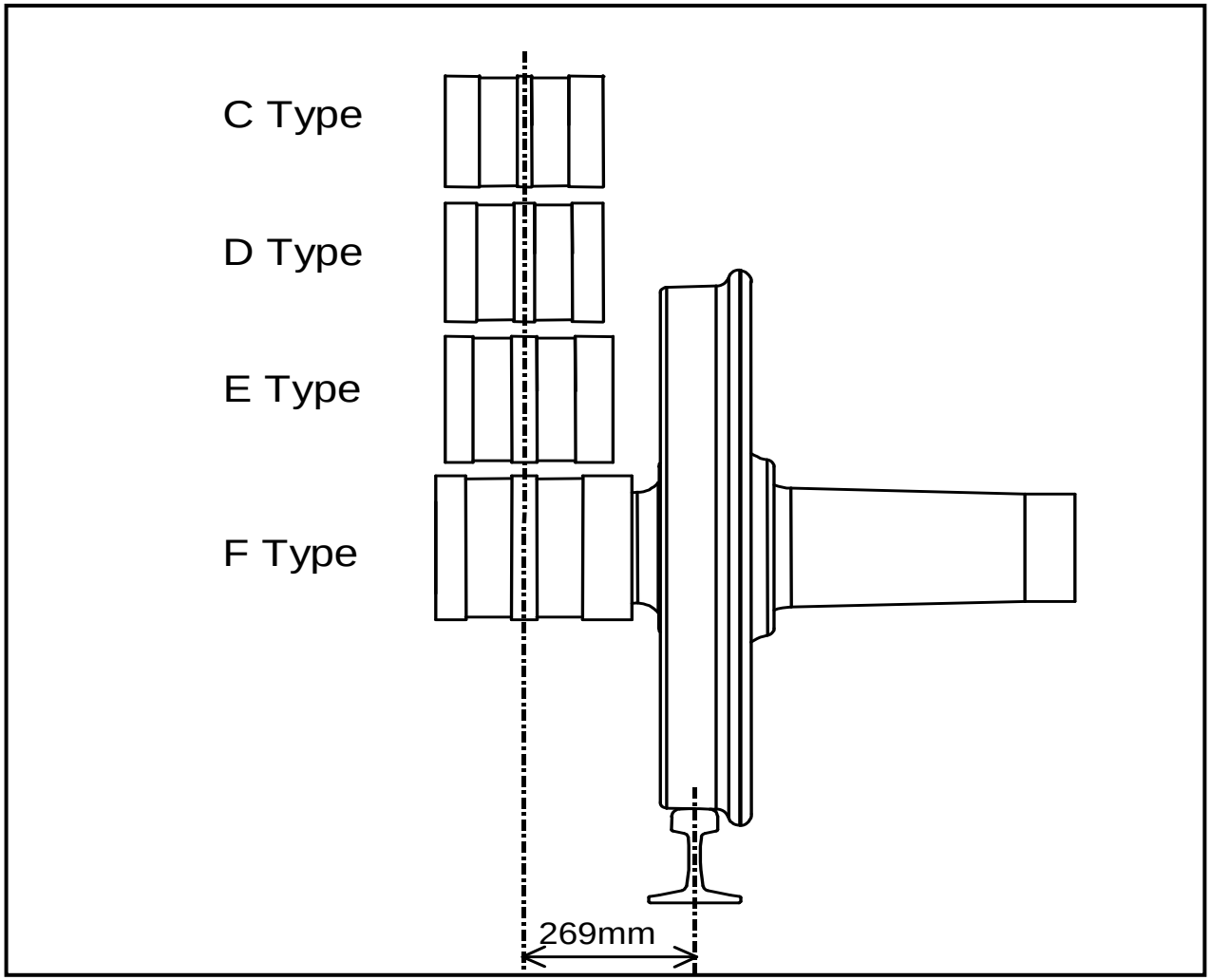


Figure 1: Position of the bearing centre lines for the different bearing types.

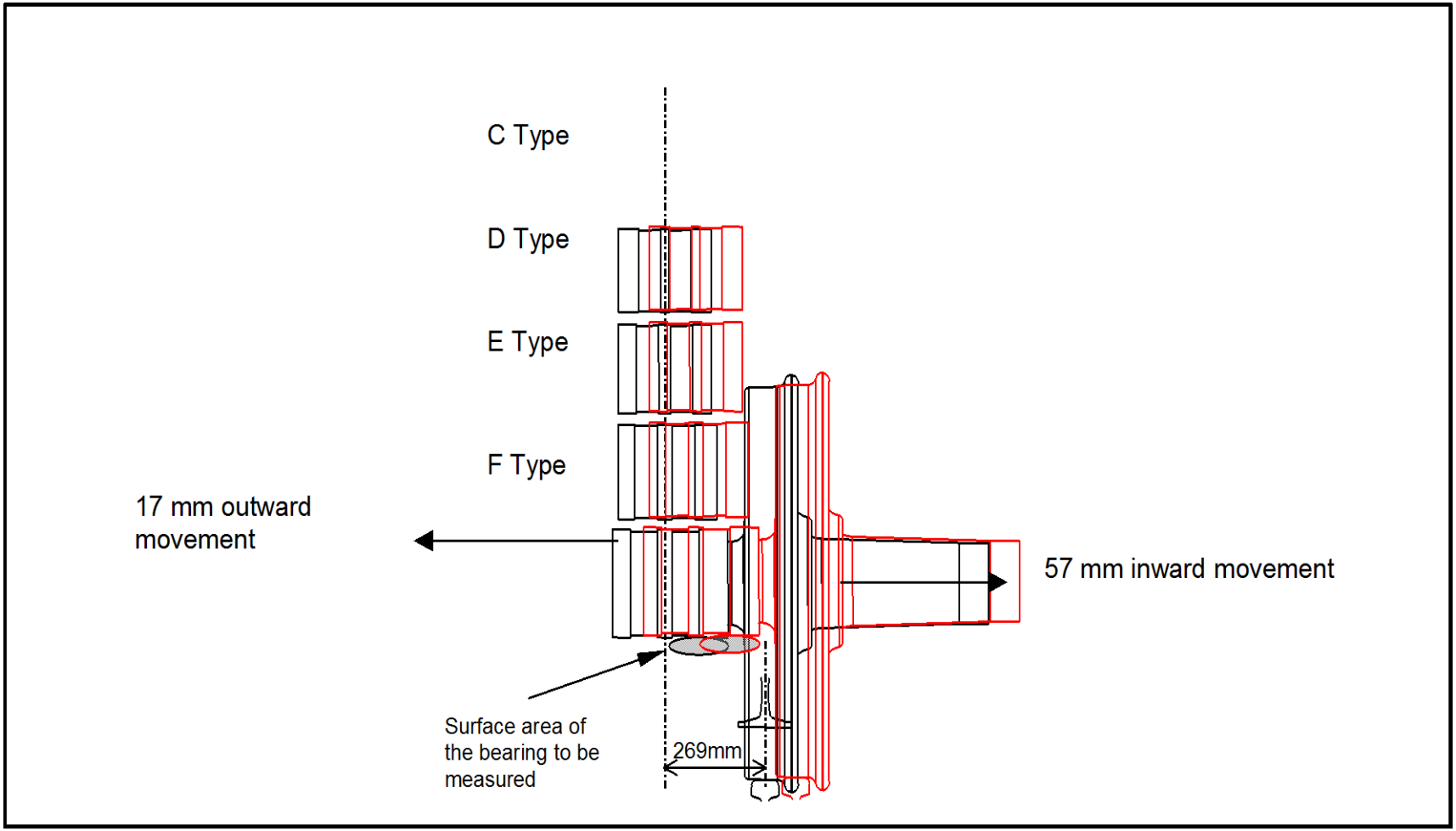


Figure 2: Measuring position on roller bearings, showing inward and outward lateral movement possible

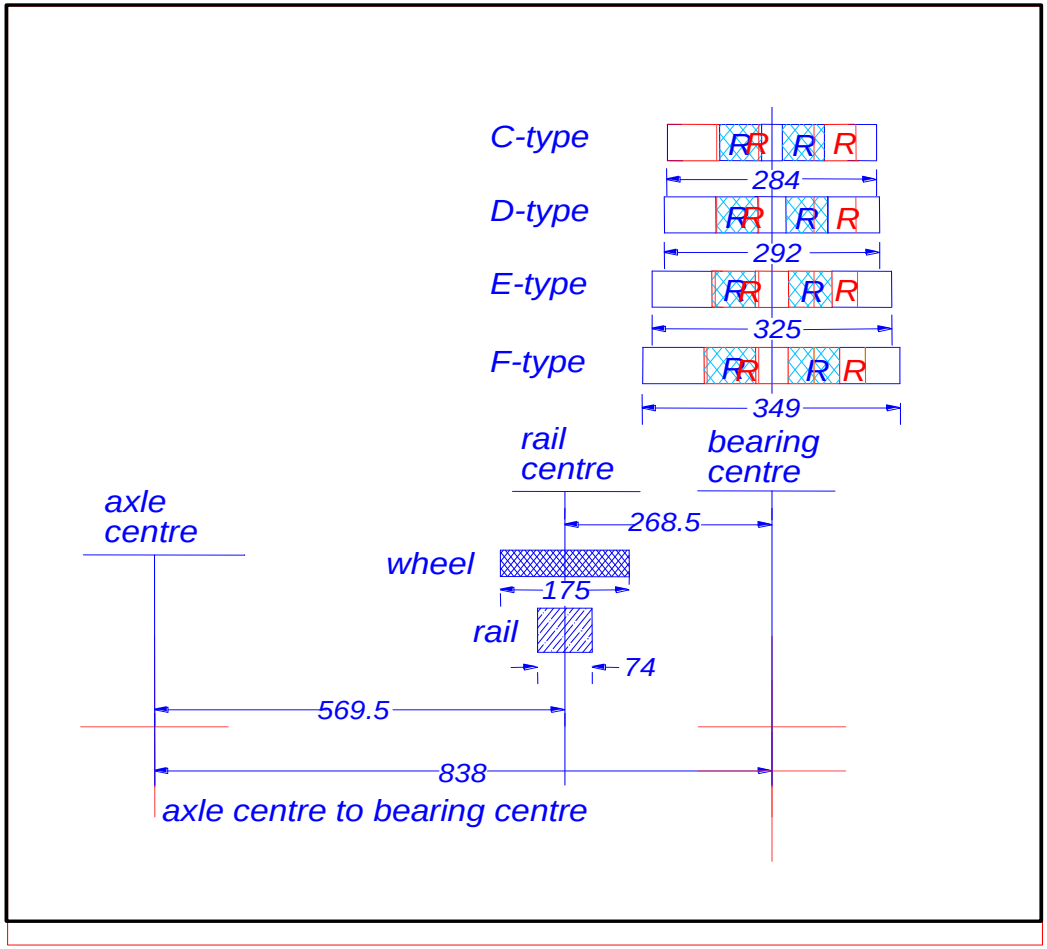
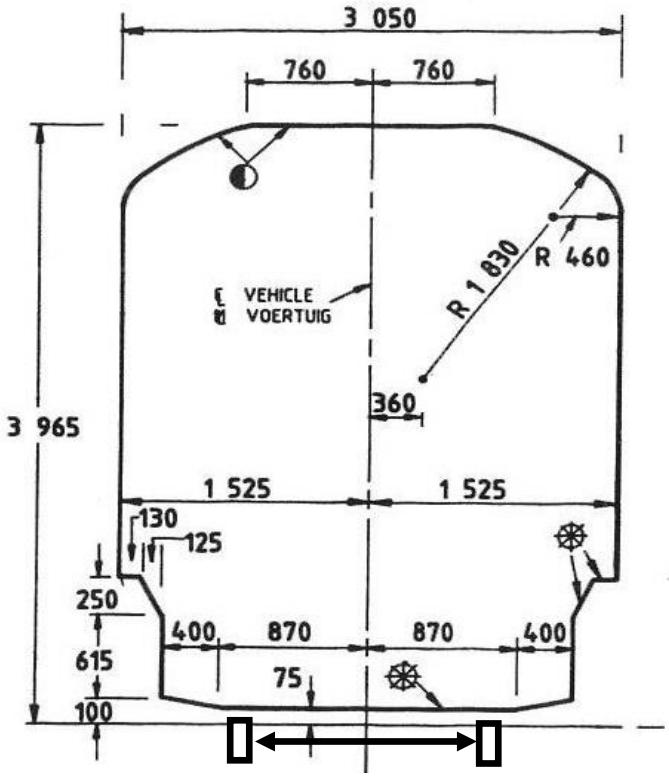


Figure 3: Measurement position for bearing types used by Transnet relative to rail geometry

Appendix B

Transnet Freight Rail structure gauge



Rail gauge1065mm