A division of Transnet limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

TELEMETER / END-OF-TRAIN (EoT) EQUIPMENT FOR AIR- AND VACUUM BRAKE TRAINS

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Date: JUNE 2010

Circulation restricted to: Transnet Freight Rail (Technical & Operations)
Relevant third parties

1. SCOPE

1.1 Identification

Telemeter / End-of-Train (EoT) equipment for use on Spoornet's air- and vacuum-braked trains.

1.2 System Overview

The primary function of the telemeter equipment is to

- automatically monitor and display to the train driver, train brake-pipe vacuum or air-pressure at the last vehicle, and to raise an alarm as soon as the reading moves beyond specific levels, in order to enhance safe train handling & operation.

However, additional functionality, such as Emergency Brake Application from the rear of the train, an indication of "Train Complete", automatic logging of performance & alarms, etc, is also required.

1.3 Document Overview

This document defines Transnet Freight Rail's requirements for telemeter equipment (per 1.2 above) on air- and vacuum-brake trains. Additional functionality required (e.g. Emergency Rear-End Braking, Train Status function, etc) is also specified, as well as optional extra functionality (e.g. GPS tracking via GPRS, Repeater function), which is/are to be requested for the specific tender.

2. APPLICABLE DOCUMENTS

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

2.1 Transnet Documents

CSE-1159-001 CAT E48	Standard specification for documentation for signals equipment.
CSE-1154-001 CAT E48	Environmental specification of Transnet Freight Rail railway signalling systems.
BBB0947 (Latest issue)	General Ergonomic Guideline for the Design of Visual Display Man – Machine – Interfaces

2.2 External Documents

Association of American Railroads: Standard S-5701. (Latest issue)	AAR Manual of Standards & Recommended Practices: Railway Electronics: END-OF-TRAIN COMMUNICATIONS (Reaffirmed: 1994; Reprinted: 2000; Revised: 2002, 2007)
Cenelec EN 50121-3-2	Railway Applications: Electromagnetic compatibility, Rolling stock apparatus.
Cenelec EN50155	Railway Applications: Electronic equipment used on Rolling Stock

2.3 Compliance

Certain requirements (e.g. the requirement for a standard "air interface protocol" per AAR Standard S-5701, Emergency Brake Application from the Rear) are *mandatory*, whilst others are *optional* (e.g. GPS Tracking via GPRS), or *desirable* (e.g. 4.2.4: antenna condition). Consequently, *tenderers are required to provide a detailed clause-by-clause Statement of Compliance*, and *preference will be given to offers which comply to the greatest degree with these requirements*.

3. REQUIREMENTS

3.1 System

3.1.1 A system is required to automatically and continuously monitor brake-pipe pressure or vacuum levels measured at the brake pipe of the last vehicle on a train, and to provide the train driver with accurate readings on a regular basis. The system must automatically alert the driver when the pressure (or vacuum) levels move outside the limits as specified elsewhere, and also in case of low battery power and/or other alarms or telemetry system failure of any nature. The basic system is to be composed of two units: A Master- or Rear Unit (RU/EoT) mounted on the rear buffer of the last wagon of a train, and a Display- or Cab Unit (CU/HoT) mounted in the train driver's locomotive cab.

3.1.2 Additional functionalities are also required: Some *mandatory* (e.g. Emergency Brake Application from the Rear Wagon, a "Train Status" function [requiring GPS in the CU and RU], Rear End Illuminated Marker / Beacon, Logging of Performance & Alarms), some *optional* (e.g. a Repeater Function, GPS Tracking via GPRS, etc).

Further details will be provided in the specific tender, where applicable. (Refer: 7. NOTES)

3.2 Interfaces

3.2.1 Over the Air: Between RU & CU

3.2.1.1 In order to enable operation between CUs and RUs from different suppliers, communication between the CU and RU shall be per AAR S-5701, also utilising continuous phase FFSK, except that the transmission frequency shall be 142,0125 MHz, for both Rear-to-Front *and* Front-to-Rear communication. Radio equipment shall transmit 5 Watts maximum, & be I.C.A.S.A. approved.
3.2.1.2 In order to accommodate the additional functionality as discussed in this specification, additional message data blocks need to be transmitted after those per AAR S-5701. The message format / structure is defined in Annexure *A*.
3.2.1.3 Compatibility with previous equipment from the same supplier: Functionality to allow a supplier's CU's to operate with previous "non-AAR" versions from the same supplier, may be requested for specific tenders as an interim phase. In such cases, the previous 4-digit RU ID number should be used to select this functionality.

3.2.2 External: Via Serial and Ethernet Ports

3.2.2.1 External serial ports are required on both cab- and rear units, to facilitate inputs and outputs via a standard international data communication protocol (e.g. the AT command set). Programming, re-programming / configuration of both CU & RU as well as downloading of logged data must be possible via the serial port. On the CU, all controls and outputs must be available on the serial port. If the RU is provided with an external display of vacuum / pressure readings and battery voltage, the serial port is still required for programming purposes, but need not be located externally.

3.2.2.2 Similarly, an Ethernet port is required on the CU for similar functionality as above, via a network on the locomotive.

3.3 Equipment

3.3.1 General

3.3.1.1 The equipment should comprise a complete system that includes two separate units, the cab unit (CU/HoT) and rear unit (RU/EoT) including antennas, connectors, couplings, mounting brackets, power supplies, etc.

3.3.1.2a The CU and RU must be able to communicate with each other, and contain the necessary components including (as applicable) power source, display unit for status and alarm messages, and associated electronic equipment.
3.3.1.2b The RU must also contain antennae, pressure and vacuum transducer/s and associated electronic equipment.

3.3.1.3 The RU must be designed as *portable* equipment, as lightweight and small as possible, which may easily be carried by one person by means of a suitable handle.

3.3.1.4 The CU is required to be available in 3 hardware options:

3.3.1.4a A *portable* version, as lightweight and small as possible, with built-in antenna, which may easily be carried by one person by means of a suitable handle.

3.3.1.4b *A second, "built-in" option is required*, to be powered from the 13,6 V supply available in the loco cab, and to operate with an existing external antenna installed on the locomotive. See 3.2.2 for physical dimensions.

3.3.1.4c *A third, "split built-in" option for the CU is also required*, powered from the 13,6 V supply available in the loco cab, operating with the existing external antenna installed on the locomotive, and with an *extra* display "split" from the rest of the CU, for applications where the mounting space in the loco cab is very limited. This option thus would comprise option 3.3.1.4b above, plus an extra "split/remote" display or "Remote Head". Connections between the two CU components shall cater for cable lengths of up to 10 (ten) metres, and shall be via a standard Ethernet 10/100 Mbit/s TCP/IP connection with RJ-45 connectors. *(Refer to Annexure B).*

3.3.1.4d *A fourth, "external display" option for the CU is also required*, powered from the 13,6 V supply available in the loco cab, operating with the existing external antenna installed on the locomotive, but capable of functioning with a separate external display already installed in the loco cab, also for applications where the mounting space in the loco cab is very limited.. Connection / communication shall be possible via a standard Ethernet connection as above. *This option should preferably be incorporated in the "built-in" option in 3.3.1.4b above, thus allowing the CU to be mounted "out of sight" whilst interfacing with an external display (Refer to Annexure B).*

3.3.1.5 All software must be installed on non-volatile reprogrammable (via the external serial port) media (e.g. "flash RAM"). *Non-reprogrammable media such as EPROM's are NOT acceptable.*

3.3.1.6 The equipment housing must be totally splash-proof and impervious to the ingress of dirt or moisture. The rear unit must water-resistant & be suitable for mounting on the rear couplers / buffers of the train.

3.3.1.7 The equipment must be able to withstand very rough handling and / or tampering and must therefore be robustly constructed, particularly with respect to the outer case, antenna, control knobs, battery plugs and all protruding external fittings.

3.3.1.8 If connectors for charging the internal batteries and for an external DC supply are required, these must be of a high quality military standard. Similarly, antenna connectors are to be of the "TNC", "N" or "UHF" (PL259) type, SMA for GSM. (A 13,6V isolated DC supply from which 1 Ampere is continuously available, is provided in locomotive cabs.)

3.3.1.9 As far as possible, calibration and fault diagnosis on the units must be automated.

3.3.2 Cab unit

3.3.2.1 The CU shall have the following controls and indications: (Refer also to Annexure *B*)

- Three buttons (Scroll Up, Select/Enter, Scroll Down) to enable the following functions:
  Switch cab unit ON or OFF, Scroll through the various menu options: e.g. Display the unit's ID number & software version, pair the CU with a RU and display battery statuses, GPS information, Comm's Test / Status Update, etc.

- In the interests of improved MMI, a graphic display is a requirement, capable of dynamic character size adjustment and displaying of icons, etc. Display size to be 240 x 64 pixels.

3.3.2.2 The display must indicate the brake pipe air pressure or vacuum status received from the rear unit, as well as battery status of both units. Any system failure as mentioned in section 3.3.3.4 and 4.4.3 must be detected and indicated (e.g. by a red indicator light and visible flashing of the display and an audible alarm).

3.3.2.3 The display must be of adequate size to provide characters large enough to ensure good legibility of readings from the locomotive driver's seat position under all cab lighting conditions ranging from direct sunlight to night illumination. If the display is provided with continuous back lighting, its effect on the expected battery operating period must be taken into account in the design. Automatic backlight brightness adjustment is a preferred function, but a facility to manually adjust the display brightness is also required. An adequate viewing angle of at least 45 degrees in all directions is required.

3.3.2.4 Integrity checking of the display (e.g. Flash all segments of the display briefly before each new reading is displayed, to indicate whether a segment has failed) is required.

3.3.2.5 During normal operation the display must indicate 000 kPa when the pressure is zero. Pressure must be displayed as a positive reading (e.g. 500 kPa), while a vacuum reading must be preceded by a minus ("**-**", e.g. **–**55 kPa).

3.3.2.6 The pressure/vacuum reading on the cab unit must not deviate from the pressure measured at the rear of the train by more than 10 kPa (for *pressure*) or 2 kPa (for *vacuum*) at all times, including within the low battery power limits.

3.3.2.7 After being switched on and matched with a rear unit, the cab unit must function automatically as follows:

(a) The rear-end pressure- or vacuum readings must be continuously displayed, and the battery status (number of hours remaining) of both the (portable) cab and rear end units must be displayed continuously.

(b) Pressure/vacuum alarms must be sounded and displayed whenever the air pressure drops below 400 kPa or the vacuum less than –51 kPa.

(c) Communication alarms must be sounded and displayed to indicate loss of radio contact with the rear unit, in the event of this occurring, per AAR S5701.

(d) Low battery alarms must be automatically displayed whenever either of the batteries' remaining life drops below 25% (or less than 10 hours)

(e) The battery must be protected against irreversible damage due to excessively deep discharges.

3.3.2.8 The CU must be able to be installed into a similar space as is currently employed for the standard voice communication train radios in service in TFR locomotives. The dimensions of this space shall be 197 ± 0,25 mm (W) by 67,5 ± 0,25 mm (H) by 250 mm (D). The preferred CU dimensions are thus required to be: 196 ± 0,25 mm (W) by 66,5 ± 0,25 mm (H) by ~165 mm (D).

3.3.2.9 Menu Function: The CU must provide a MENU function, initiated by pressing the Select/Enter button whilst the unit is in its normal state. The following options shall then be available:

- "**Comm's**" : To request a radio transmission from the RU in order to test the communication from the RU, without having to wait for a normal RU transmission.

- "**Alarms**" : This allows low PRESSURE alarms to be *acknowledged* and (audibly) SUPPRESSED, for the same alarm level. *Alarms must re-occur if pressure level changes.*

  The "Train Error" alarm (which is latched ON) may also be acknowledged & suppressed by means of this option.

- "**L.C.D.**" : This is to adjust the display brightness level.

- "**Reset**" : This is to reset or "Re-boot" the system when required.

- "**System**" : "Technician Mode" (Not intended for use by train drivers – If this mode is accessed, to exit it should require rebooting the system by selecting "**Reset**" as above.)

- "**Exit**" : To exit menu when required.

  The menu page should time out after 5 seconds of inactivity.

The sub-menu "**System**" should provide further options (Radio, Power, Display, Exit) for checking radio RF output (TX 15 sec), R to F & F to R comms, Repeater reception, as well as battery voltage and display & push-button tests.

3.3.2.10 The displaying of CU and RU Lat. & Long. Information, as well as train length, speed & trip meter, must also be possible (e.g. by pressing the Scroll Up key).

(Refer also to Annexure "EoT Menu Structure_April_10" for further details)

3.3.2.11 The CU should disable itself after a predefined time (e.g. 2 hrs) if no messages from its RU have been received, and should then de-activate any Emergency Rear Brake arming.

3.3.2.12 External Connections as follows are required:

- RJ-45 for Ethernet
- 2-Pin Molex for 12 V power
- 9-pin D-Type RS-232 male for programming
- PL-259 for VHF radio
- SMA for GPS
- 9-pin D-Type RS-232 female

3.3.3 Rear Unit

3.3.3.1a Further to the preceding requirements, the rear unit must include a suitable housing, as well as pressure transducer/s, associated electronics, integral antenna and an air/vacuum pipe coupling, power supply/batteries, ON/OFF button/switch, *and* visual ON/OFF indication.
3.3.3.1b A illuminated display is also required on the RU, which at switch-on must display *at least* the software version number, followed by battery voltage and then the kPa (Pressure or Vacuum) reading. Subsequent pressing of the ON/OFF button must again display the voltage, followed by the pressure/vacuum, for a few seconds.

3.3.3.2 In addition to 3.3.1.7 the rear end unit must be designed for continuous duty service on the rear of trains where it will be subjected to severe vibration and shock.

3.3.3.3 The transducers of the rear unit must be able to measure a pressure range of 0 kPa to +660 kPa with a maximum error of 10 kPa, and a vacuum range of –77 kPa to 0 kPa with a maximum error of 2 kPa.

3.3.3.4 Any failure of the measurement device must not cause any undesired brake application.

3.3.3.5 The telemeter equipment must be able to withstand pressure levels of up to 1 500 kPa without sustaining any damage.

3.3.3.6 The "matching / pairing" function, i.e. to pair a cab unit with a specific rear unit, should be done as simply as possible. The CU should initially display 5 zero's (00000), and entering the RU ID number should be achieved by use of the Scroll Up & Scroll Down keys. The ID of the last RU matched with, should be retained in memory and displayed on start-up, as an time-saving aid.

3.3.3.7a The RU must incorporate the following 3 power modes:

- Fully "**ON**" – i.e. All functionality available
- "**Sleep Mode**" – i.e. Radio transmission OFF, but Pressure Transducer ON, Radio Receiver ON, GPS ON, and (if equipped) GPRS transmission ON but at limited rate per BBD 5420.
- Fully "**OFF**" – i.e. ALL electronics switched OFF, with no drain on battery.

3.3.3.7b The following "ON/OFF" functionality is required:

1. The RU must only switch **ON** when in the vertical position, irrespective of pressure value.
2. Must switch to **Sleep Mode** (by means of a "tilt-switch") after 15 minutes when moved to the horizontal position, provided that the pressure is zero, *or when connected to a charger*.
3. Whilst upright, and the pressure drops below 10 kPa, OR the vacuum to less than - 5 kPa, the RU must switch to **Sleep Mode** after a 15 minute delay, *but should first update the CU.*
4. When the pressure rises to above 10 kPa or the vacuum to more than - 5 kPa, the rear unit must automatically switch its transmitter **ON** again.
5. Additionally, whilst in "**Sleep Mode**", normal transmission must resume when a button on either the CU or the RU is pressed.
6. However, if the vacuum / pressure continues to remain below the above-mentioned limits, the RU must switch **OFF** completely after 10 hours.
7. When the vacuum or pressure is above the specified limits, it must not be possible to switch the RU off.
8. The RU must protect itself against damage to its battery due to deep discharge by switching itself **OFF** if the battery voltage drops too low (e.g. <11V), but should first send an appropriate message to the CU.

3.3.3.8 The rear unit must be mounted on the last vehicle of the train in a manner such that:

- It can fit any vehicle without adapter brackets for mounting purposes, and by means of a simple procedure without requiring any special tools.
- The risk of theft and vandalism is minimised.

3.3.3.9 The RU must be designed such that it may be locked in place so as to minimise the risk of it being stolen or vandalised while mounted on the last wagon of the train. An integral lock with captive key is the preferred option, to prevent removal by means of readily available tools or spanners. If a separate / loose lock is proposed, the lock, key and attaching chain or cable, etc. must be included as part of the equipment. *The key and lock must be pre-approved by TFR*.

3.3.3.10 The RU must be supplied complete with flexible connecting air/vacuum pipes/hoses, suitable for both air-brake and vacuum trains. The coupling mechanism shall also cater for both air-brake and vacuum connections on TFR wagons, and *loose* components or adapters are not acceptable. The pipe & coupler must be attached to the RU body with a 3/4" BSP thread. It must

also be available as a separate item.

4. SYSTEM CHARACTERISTICS

4.1 Messages

4.1.1 Messages per AAR S-5701 transmitted from the rear end unit to the cab unit must include the following:

- RU Identification code.
- Rear unit battery status.
- Brake pipe pressure/vacuum.

In addition, GPS and other data in 2 additional data blocks, as per Annexure *A.*

4.1.2 Incorrect information must not be displayed when interference is experienced from other telemeters.

4.1.3 Reporting rate

4.1.3.1 Messages from the rear unit must be sent to the cab unit at intervals of 60 seconds (one minute) nominal, randomized by +/- 5 seconds, exactly as per AAR S-5701.

4.1.3.2 Messages must be sent to the cab unit immediately following detection of a change in brake pipe pressure (since the previous transmission) greater than the kPa increments, as indicated in the table below.

Pressure / Vacuum Range	Increments (kPa)
-77 to 0 (Zero)	2
0 to 400	50
400 to 660	10

4.1.3.3 The cab unit must expect automatic pressure updates from the rear unit at 60 second (nominal) randomised intervals as per AAR S-5701, and must provide the Rear-to-Front and Front-to-Rear checking functionality & alarms exactly as specified.

4.2 Alarms

4.2.1 An audible alarm, together with an appropriate flashing message display and red indicator light (for pressure / vacuum, communication failure, battery level or Train Status) must be provided in the cab unit to indicate each time (including updates) when

- the brake pipe pressure drops below 400 kPa (or less than –51 kPa for a vacuum train) OR
- communication tests as in 4.1.3.3 above are unsuccessful
- the cab- or rear unit battery life drops below 25% or 10 hours of normal operation.
- “Train Error”: When the GPS-derived parameters exceed the limits per 5.2.

4.2.2 The *audible alarm* must be of sufficient audio level to be heard in the noisy environment of the locomotive and must sound for a duration of 3 seconds. In the case of “Train Error” the alarm must be latched ON until acknowledged. A facility to adjust the alarm volume above a fixed minimum level, is preferred.

4.2.3 It shall be possible to acknowledge the Pressure and Train Error alarms via the Menu function, options “**Alarms**”. This shall then only suppress the current audible alarm, and not the visual alarm indication. However, if the alarm values change, or the alarm normalises and then re-occurs, then the audible alarm must sound again.

4.2.4 The visual alarm *message display* must continue until the pressures/parameters are within the specified range, or reception is restored or the unit is switched off.

4.2.5 A battery status indication must be provided for both units to continuously indicate the remaining capacity of the batteries in hours. (Refer also to Annexure *B,* 3.2.2) The battery status information transmitted by the RU (% capacity used per AAR S-5701, 3.7.2.3) must be used to determine the remaining hours and display on the Cab Unit, as in 3.3.2.7 (a). The values displayed must be accurate to 10% or better, and should be based on a minimum initial capacity of 40 hours. Optimistic values are to be avoided.

4.2.6 If the CU is powered by the locomotive supply, then the supply voltage, or an appropriate symbol should be displayed.

4.2.7 An indication of antenna quality or an alarm to indicate a poor or disconnected CU antenna / connection would be advantageous.

4.3 Identification of Cab & Rear Units

4.3.1 Rear and Cab units must be uniquely identified by a code or "address" in the range 00000 to 99999, as specified in the relevant Annexure in the tender documents.

4.3.2 The cab unit must be able to match / pair with any other rear unit by means of a "pairing" functionality. This "pairing" function must be such that a specific and simple procedure should be followed in pairing a CU with a specific RU unit as in Section 3.3.3.6 to form a set, whereafter these 2 units shall not communicate or pair with any others, until being un-matched and then re-matched with another RU/CU.

4.4 Reliability & Availability

4.4.1 The system must work reliably on a 200 wagon (2,5 km) train travelling at a speed of up to 120 km/h.

4.4.2 All functions are to be performed with an extremely high degree of reliability, and must not result in unnecessary train delays or stoppages.

4.4.3 The equipment must be extremely reliable, with a minimum mean time between failures (MTBF) of 10 000 hours per system/equipment pair. The integrity of the equipment must be such that the probability of a "Train OK" indication being false is less than one in 10^7.

4.5 Power Supply Requirements

4.5.1 Batteries

- The cab and rear units must be supplied with integrated, rechargeable, sealed batteries, unless otherwise specified in the tender documents.

- The battery capacity must be such that the system can operate continuously for a minimum of 40 hours.

4.5.2 Battery charger

- The charger must be simple to operate from a standard 220V AC supply, and be able to recharge the batteries of both the rear and cab units fully within **5 - 10** hours.
- It must be capable of charging batteries which have been completely discharged, and must switch to "float" once the battery is fully charged, and not cause any damage to the

batteries if left connected.

- Indications must provided on the status of the charger as well as the batteries on charge. At least "Power On", "Battery Charging" and "Battery Fully Charged" are required, and "Fully Charged" may not be indicated if the battery is not connected.
- Connectors of the readily available 2-pin "screw-fasten" type, rugged, *without any components which may easily loosen and become detached, leading to short circuits*, are preferred.
- Leads should preferably not be permanently attached to the charger, but also by means of a "screw-fasten" connector.
- A complete charger, with all plugs, leads, etc. is to be supplied with each Rear Unit and each *battery operated* Cab Unit, *unless otherwise specified in the tender documents.*

5 ADDITIONAL FUNCTIONALITIES REQUIRED

5.1 Rear End Illuminated Marker / Beacon Light

- This facility is required, including automatic switching **ON** when the ambient light level drops to (or below) a "dusk" level, and **OFF** when the level rises again.
- The RU must also be provided with a RED reflective surface in order to be visible to other rail vehicles from the rear.
- Power requirements should have a minimal impact on the battery life of the rear units, and this aspect is to be specified.
- A status indication on the CU is also required, per AAR S-5701. (Marker Light **ON**, or **OFF**/Defective)

5.2 Train Complete Function

5.2.1 A "train complete" function is required, in order to assist the driver in ascertaining / confirming whether the train is "complete" (i.e. has not become "parted"). This may be achieved by employing GPS units in the CU & RU, and by continuously monitoring the speed- and displacement differences between the front & rear of the train.

5.2.2 The following shall be displayed to the driver:

- "**Train OK**" - When the system detects no evidence of the train being parted
- "**Caution**" - In cases where there is (temporary) doubt of train completeness
- "**Train Error**" - When the system detects that the train has become parted
- "**Move**" or "**Stop**" per AAR S-5701.
- **Speed** of the **CU** *and* **Speed** of the **RU**
- "**Length**" / Displacement at start-up, plus relative **Deviation** (**+** or **-**)

5.2.3 The display should therefore preferably be divided into 2 areas: One for the standard pressure/vacuum & battery status information, and the other for the Train Complete, speed, distance, etc. information. (See also Annexure *B*, 3.2.2)

5.2.4 The GPS information (from the RU) to be used for this function is to be transmitted in additional message data blocks after the standard ones per AAR S-5701. The message format / structure is defined in Annexure *A*.

5.2.5 After initial switch-on of the CU, when both CU and RU GPS equipment have satellite fixes, the *displacement* in meters between the front and rear units shall be displayed to the train driver as "**Train Length xxxx m?**", whereupon if acceptable to the driver, the value may be accepted by pressing the Enter/Select button. (If not acceptable, the driver should wait for further updates).This value must then be stored, and used as reference for future displacement readings, which are to be displayed as the stored value, together with a deviation (+/-).

5.2.6 Similarly, the RU and CU *speeds* are to be stored, averaged and compared (10 second *moving averages* are proposed)
5.2.7 The above 2 parameters are to be monitored as follows:

- If speeds differ by **<**10 kph, *AND* displacement deviation **<** 100 meters: **TRAIN OK**
- If speeds differ by **>**10 kph, *OR* displacement deviation **>** 100 meters: **CAUTION**
- If speeds differ by **>**10 kph, *AND* displacement deviation **>** 100 meters: **TRAIN ERROR**

However, for **TRAIN OK**, the Pressure/Vacuum must be above the alarm levels, or else **CAUTION** must be displayed, but **TRAIN ERROR** must be displayed irrespective of the Pressure/Vacuum levels. *The train driver will have to take all factors into account in this case.*

5.2.8 The above indications are to be given with a very high degree of integrity, and a very low incidence of false alarms. Tenderers are to provide full details of their proposed system, as well as its level of integrity.

5.3 Emergency Brake Application from Rear Wagon

This functionality (per AAR S-5701, section 3.0) shall be provided. The Emergency Brake application shall be effected (after the system has been armed) by simultaneously pressing the Scroll Up and Scroll Down buttons, whereafter a screen prompt (e.g. "Emergency Brake?") shall be displayed to the train driver. Subsequent pressing of the Enter button within 10 seconds shall initiate the Emergency Brake procedure.
Arming shall be per AAR S-5701, and it shall be possible to Dis-Arm the system if required, by means of the ID 00000.
AAR S-5701, 3.2.2: If the acknowledgement is not received within 3 seconds, then the front/Cab Unit must repeat the command. 3.2.4: Valve Opening shall be ¾" (i.e. 19 mm) and the internal pipe diameter: 5/8" (at least 15mm).
NOTE: The function is for use as an emergency *backup*, and *not* as a braking *performance improvement* device.

5.4 Repeater Function

In certain situations it may be necessary to repeat the signal between CU and RU, either by means of an On Train repeater, or by means of Track Side (Fixed) repeaters. Both versions are to display at least the following when messages are repeated: RU ID number, and Time (hh:mm:ss) with at least the last 5 messages being continuously displayed. CU ID / numbers need not be displayed.

5.4.1 On-Train Repeater

In this case the CU is to be configured such that during switch-on / powering up, the CU may be switched into "repeater mode". The user shall thus have the option of selecting either normal "EoT" or Repeater" mode, so that a CU may either function as a cab unit, or as a repeater when required. The repeater shall also be "matched" to the RU in the same way as the CU, and shall only repeat *valid* messages from its matched RU or CU, after a delay of 500 milliseconds.
Suppliers are to clearly and in detail indicate how their repeater is to function, so as to ensure that secure and reliable repeated communications are to be effected, without communication collision problems (e.g. between paired CU/RU's, OR with other CU's, RU's or repeaters). The "switch-on / start-up" procedure must also be fully described, and must be easy to perform, bearing in mind the possible logistical problems due to long distances between equipment units.

5.4.2 Track-Side / Fixed Repeater

This repeater function must also be incorporated in the CU software, and only be activated in the workshop when required. In this case, the matching function is not required, but only valid messages from the RU or CU are to be repeated, after a 500 millisecond delay. GSM GPRS tracking functionality is required *as an option*, to allow remote monitoring of operation.

Suppliers are to clearly and in detail indicate how their repeater is to function, so as to ensure that secure and reliable repeated communications are to be effected, without communication collision problems (e.g. between paired CU/RU's, OR with other CU's, RU's or repeaters).

5.5 Logging of Alarms and Performance on both CU and RU

5.5.1 The telemeter performance must be continuously monitored and logged by the RU against time & position [km point] along the line, and stored in memory, so as to be available for down-load at the end of the trip (e.g. via the serial port or other means). This implies that the RU must make use of a GPS unit so as to track its position against real (GPS) time.

5.5.2 All communication messages received by the CU, as well as alarms, are to be logged versus time (and km position if possible). The CU time must be synchronised with that of the RU.

5.5.3 Other data / parameters to be recorded are:

- Start Up / Switch On date & time
- Position and ID/Serial Numbers of CU and RU at start up
- During the trip, periodic readings of pressure, battery voltages and alarms, e.g.
  - Low Battery
  - kPa low
  - Comms Failure. Etc.
- Speed
- Train stopped
- Train moving
- Received signal strength, if possible

NOTE: *Refer also to BBD 5420 (latest version)*

5.6 Tracking Facility by Means of GPRS *(Optional)*

In order to provide a tool for the effective asset management of telemeter / EoT equipment, *this facility is required as an option, and will be specified in the tender documents.* This will of course require that the RU is equipped with a GSM GPRS module, *which introduces an extra operational cost.*

For full details of the tracking requirements, refer to BBD 5420 (latest version).

5.7 Special CU's for use by Inspection Trolleys

On certain TFR lines "Rail Break inspection trolleys" are run behind heavy trains to check for broken rails after the train has passed. In an attempt to increase personnel safety by raising an alarm if the trolley moves too close to a train ahead, a "Trolley CU" with modified CU software is required, to monitor the position & speed of a train ahead. Such units must display the following:

- Telemeter RU I.D. (Number)
- Distance away (km)
- Speed of RU (kph)
- Time (hh:mm:ss)

At least the last 4 readings must be displayed continuously, as well as the Trolley CU speed.
As for the standard CU, this unit must provide a visual and audible alarm each time it receives a valid RU message, since trolley is probably then too close to the train. (Should be > 5 km)

5.8 Further Options Required in Future OR Proposed by Suppliers
(e.g. Air Powered Generators,
Track-Side Repeaters for Use in Tunnels for Emergency Rear End Braking, etc.)

To be offered and described if & where applicable.

6 GENERAL REQUIREMENTS

6.1 Documentation and Software

6.1.1 Detailed operating- and maintenance/workshop manuals in accordance with generally accepted industrial standards, must be supplied with each tender. Detailed technical specifications of the equipment and all components must be included. Specification CSE-1159-001 CAT E48 applies.

6.1.2 All software installed on the equipment shall be provided to Transnet Freight Rail, in order to reload or reprogramme / reconfigure equipment when necessary. *This is a mandatory requirement, and software shall be provided when equipment is supplied for acceptance testing.*

6.1.3 One complete set of documentation per ten sets of units is required, unless otherwise specified in the tender documents.

6.2 Standards and Operating Environment

6.2.1 The equipment, its design, maintainability, quality of material, documentation etc. must be in accordance with generally accepted industrial standards & procedures for high quality equipment, and must meet all relevant SABS and/or Spoornet specifications.

6.2.2 Environmental characteristics must cater for all outdoor conditions as encountered in South Africa, including temperature, altitude, humidity, air pollution and lightning. Specification CSE-1154-001 CAT E48 applies.

6.3 Maintenance and Service

The equipment must be designed so as to facilitate easy maintenance, using readily available components, and requiring a minimum of specialised tools and test equipment to service and repair.

6.4 Guarantee & Support

A minimum guarantee period of one year against design and manufacturing defects, etc. is required, as well as guarantees for the availability all components as well as technical support including training, for a minimum period 10 years.

7. NOTES: Items to be specified in Tender Documents/Addendum

3.3.1.4 Specify options a, b, c, or d. (*portable, built-in, split / remote head, or external display*)

4.3.1 I.D. Numbers' range (To be allocated by TFR Configuration Management section)

4.5.1 Cab Unit Batteries required if CU to be portable as per 3.3.1.4a.

4.5.2 Battery Chargers' quantities (if not one with each portable CU and each RU.)

5.4 Repeater Function required or not, and whether On-Train or Track-Side / Fixed.

5.6 GPRS Tracking Facility required or not.

6.1.3 Documentation quantities. (If not one set per 10 sets)

(See Over for Annexures)