Operational Concept for ERTMS

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1 Introduction

1.1 Background

1.1.1 The Great Britain (GB) rail industry’s long-term vision is predicated on the strategic challenges identified within the 2007 Rail White Paper ‘Delivering a Sustainable Railway’, which addresses the need to increase customer satisfaction and capacity, while decreasing cost and carbon emissions. These challenges, more commonly referred to as the ‘4Cs’, underpin the work undertaken on behalf of the industry by the Technical Strategy Leadership Group (TSLG).

1.1.2 TSLG is a cross-industry expert body made up of senior executive staff that develops and champions the implementation of the 2012 Rail Technical Strategy (RTS, see (RD22)), which supports national policy for the development of the railway over a 30-year planning horizon.

1.1.3 The RTS sets out the technical strategies in six themes to support the transformation of the railway and deliver rewards over the next 30 years. The control, command and communication theme includes an objective to maximise the benefits associated with the introduction of the European Rail Traffic Management System (ERTMS).

1.1.4 ERTMS is a signalling and operation management system using the European Train Control System (ETCS) for automatic train protection, the Global System for Mobile Communications – Railway (GSM-R) system for voice and data transmission, the harmonised set of European operating rules and the European Traffic Management (TM) layer.

1.1.5 The RTS identifies the following as potential benefits associated with the deployment of ERTMS:

a) Lower capital costs for signalling systems.

b) Less need for, and maintenance of, expensive track-based infrastructure.

c) Optimised network capacity that is more flexible than conventional lineside signalling systems.

d) Easier deployment of other technologies including intelligent traffic management systems and automatic train operation (ATO).

1.1.6 If the benefits discussed in the RTS are to be realised nationally then there is a need for the industry to work collaboratively to develop a generic ERTMS system design that satisfies not only the immediate needs of the industry, but also those that can be anticipated in the future, including potential future interactions with European applications. To this end the national application of ERTMS is being developed by a cross-industry team led by Network Rail, which includes representation from the Association of Train Operating Companies (ATOC), train operators (freight and passenger) and RSSB.
1.1.7 Note that the abbreviation ‘ERTMS’ has been used throughout this document for simplicity. It is acknowledged that in some instances the term ‘ERTMS’ should strictly be ‘ETCS’ but this distinction is not considered significant for the operational concept. The difference between ERTMS and ETCS is more important for lower level specifications and will be used correctly in these, as appropriate.

1.2 Purpose

1.2.1 The National ERTMS Programme has developed the ERTMS Operational Concept to provide the rail industry with a vision of how ERTMS will be operated once deployed on the GB rail network, thus complementing the work being undertaken by TSLG and the long-term vision set out in the RTS.

1.2.2 The document incorporates learning from the Cambrian ERTMS Early Deployment Scheme, and from European implementations via information available in the form of European Rail Agency (ERA) and European User’s Group Engineering Support Group (EUG ESG) engineering guidelines.

1.2.3 The content of the ERTMS Operational Concept should not be regarded as mandatory; it provides a high-level view that reflects the current understanding of how the ERTMS system should operate in GB. The content is intended to influence the generic ERTMS system design and support the realisation of associated benefits on a national basis through the development of a National ERTMS requirements suite that conforms to, and complements, European legislation and which will subsequently form the basis of specifications in the form of National Technical Rules (NTRs) and National Safety Rules (NSRs), Rail Industry Standards (RISs) and company standards.

1.2.4 The document identifies a number of open points that require further work to resolve. These will be progressed as part of the ERTMS programme works through their issues management (RD12) and reference design (RD36) processes.

1.2.5 The publication of the ERTMS Operational Concept as a relevant strategy is beneficial to the National ERTMS Programme and the wider rail industry, as it provides an effective mechanism to engage with the industry and consult on the high-level view of how ERTMS should operate when applied to the GB rail network.

1.3 Scope

1.3.1 The scope of the ERTMS Operational Concept is based upon the Control, Command and Signalling (CCS) Technical Specification for Interoperability (TSI) (RD4) and the Operations and Traffic Management (OPE) TSI (RD18). The following ERTMS application levels and implementations are within scope of the ERTMS Operational Concept:

a) ERTMS Level 0.

b) ERTMS Level NTC (National Train Control).
c) ERTMS Level 1 (with lineside signals).
d) ERTMS Level 2 (with lineside signals).
e) ERTMS Level 2 (without lineside signals).

1.3.2 The structure of the document provides a brief explanation of the ERTMS system architecture, application levels, operating modes and supervision, before describing how the ERTMS system should operate within the context of GB’s rail network. The description of how the ERTMS system should be operated is articulated using the familiar and methodical day-in-the-life-of-a-train approach, whereby train operations are considered in normal, degraded and emergency situations.

1.4 Exclusions from scope

1.4.1 This document does not explicitly describe transitions between ERTMS and other onboard protection systems such as mechanical trainstops, GW-ATP, Chiltern-ATP, Communication Based Train Control (CBTC), KVB or TVM. However, the general national train control systems (Class B systems) concepts detailed in sections 20 and 21 are considered to be applicable to these systems as well.

1.4.2 The use of Limited Supervision mode (LS, section 5.3) is also excluded from the scope of this document, as its use within the context of the GB application of ERTMS is currently being evaluated by research project T1043 - Viability of ETCS limited supervision for GB application.

1.5 Conventions

1.5.1 Where reference is made to functionality mandated by European specifications principally the System Requirement Specification (SRS) (RD6), the word ‘WILL’ is used to identify the requirement. This means that there is no need for this to be considered from a national perspective (for example, RGSs, company standards, operational process / procedures, training material etc.).

1.5.2 The term 'MUST' is used throughout this document to identify a requirement that needs to be considered from a national perspective. This is because these requirements are not mandated in the European specifications such as the SRS.

1.5.3 The requirements in this document that need to be considered nationally are not mandatory, although they are likely to influence the content of the National ERTMS Requirements suite and subsequently NTRs and NSRs, RISs and company standards.

1.6 Whole life management

1.6.1 It is envisaged that the content of the ERTMS Operational Concept will eventually be incorporated by the system design as it matures into NTRs, NSRs, Rail Industry Standards and company standards.
2 Principles

2.1 The following operating and implementation principles have been applied during the development of the concepts set out in the document:

a) Fundamental operating principles as defined in the Operational Concept for the Great Britain Mainline Railway (see (RD21)).

b) Principles that relate to the RTS objectives and potential benefits, that is, the operational design should seek to:

i) Reduce whole life costs through the reduction of trackside equipment.

ii) Increase network capacity, flexibility and capability.

iii) Avoid the imposition of unnecessary system constraints that may prevent future evolution of the system through integration with other systems, for example traffic management, ATO, and Driver Advisory Systems (DAS).

c) Specific ERTMS related implementation and operating principles as follows:

i) The implementation of ERTMS should seek to exploit opportunities to improve safety on the railways.

ii) The ‘normal method of signalling’ for a fitted train operating with an ERTMS movement authority (MA) must be via the ERTMS Driver Machine Interface (DMI). On overlay schemes if a driver observes a signal at danger ahead and has an ERTMS MA to pass that signal the driver must either stop the train at the signal (if the braking distance is available) or stop the train immediately.

iii) Regardless of the operating level or mode, drivers of fitted trains must continue to maintain vigilance and an awareness of events or information outside of the train cab (‘heads-up’ driving), as ERTMS might not provide or detect all of the information required to operate the train safely and efficiently (for example, station stops, external hazards etc.).

iv) In normal operation, the implementation and operation of ERTMS must not constrain current railway capability, or impose any additional performance constraints on the timetable or on other train movements and, where reasonably practicable, should improve performance, compared with the current method of operation.

v) The implementation of ERTMS must be designed, maintained and operated to provide the highest level of supervision practicable considering the safety and operational requirements for the type of operation being undertaken.

vi) The normal method of authorising an ERTMS fitted train operating in Levels 1 or 2 to move must be through the issuing of an ERTMS MA.
vii) Divergence between lineside signalling information and information displayed on the ERTMS DMI must be minimised.

viii) Divergence between lineside signalling information and information displayed on the ERTMS DMI must form part of the system design and be tolerable from a safety perspective.

ix) Signallers and other non-driving staff must not be required to make a decision on which signalling control or operational rule to use or apply in a given situation based on the fitted/unfitted status of a train.

x) An ERTMS MA must not be granted to pass a signal at danger.
3 System Architecture

3.1 General

3.1.1 The control/command and signalling element of ERTMS is divided into two subsystems, the ERTMS onboard equipment and the ERTMS trackside equipment.

3.1.2 Supporting equipment is also required to form a complete signalling system and, in some applications, to transfer data between the ERTMS trackside equipment, the ERTMS onboard equipment, and other systems.

3.1.3 The European specifications primarily define:

a) The messages passed between the ERTMS trackside equipment and the ERTMS onboard equipment and vice versa.

b) When the ERTMS onboard equipment is required to send a message to the ERTMS trackside equipment.

c) Some of the messages that the ERTMS trackside equipment is required to send to the ERTMS onboard equipment in a specific scenario (for example, the establishment of a communication session).

3.1.4 The remainder of the system is undefined and hence the functionality may be achieved in a variety of ways.

3.2 Trackside equipment

3.2.1 General arrangements

3.2.1.1 The principal elements of ERTMS trackside equipment are shown in the example architecture in Figure 1 and are discussed in the following paragraphs. Note that the figure is simplified; when implemented there will certainly be more than one of each piece of equipment indicated, or some elements may be combined into a single item of equipment, for example, the Radio Block Centre (RBC) and interlocking.
ERTMS trackside equipment shown in green.

Dashed lines indicate equipment and/or interfaces that may not be required for all ERTMS implementations.

1 – Warning of start of cab signalling board
2 – Indication of start of cab signalling board
3 – ERTMS stop marker board
4 – Shunt entry board
5 – Indication of end of cab signalling board

Figure 1   ERTMS trackside equipment
3.2.2 Radio Block Centre

3.2.2.1 The RBC is a computer-based system that generates messages to be sent to the train on the basis of information received from external systems, for example the interlocking, or the ERTMS onboard equipment. These messages are comprised of a series of data packets which contain information to support the operation of fitted trains.

3.2.2.2 The main objective of these messages is to provide ERTMS MAs to allow the safe movement of trains on the railway infrastructure area under the responsibility of the RBC. These messages are transmitted via GSM-R data radio using the Fixed Telecommunications Network (FTN) and the GSM-R network.

3.2.2.3 The RBC is required for ERTMS Application Levels 2 and 3 only.

3.2.2.4 The RBC generates ERTMS MAs based on train position and interlocking states. An ERTMS MA may only be sent once a route has been set, all locking is in place and the conditions for the train movement have been satisfied and the RBC is in communication with a train that is to enter that route.

3.2.2.5 The RBC is configured with data that describes the route and speed restrictions that will be encountered (gradient and speed restriction data). This data is not contained in the interlocking but is necessary for the train to comply with the speed profile.

3.2.2.6 The RBC will also receive information from the train, such as the train’s location and status.

3.2.3 Balise

3.2.3.1 The balise (or to give it its full title, Eurobalise), is a data configurable transponder that is mounted in the four-foot. The balise is required for all ERTMS Application Levels. However, for ERTMS Application Levels 0/NTC its use is limited to announcing and commanding level transitions. The balise needs no external power supply as it is energised by the passing train. Once energised, the balise transmits a telegram back to the train.
3.2.3.2 Although trackside balises provide a means for transmitting telegrams to the train, they are not just a messaging medium. The ERTMS onboard equipment, and in Level 2 the ERTMS trackside equipment, use trackside balises as location references. The ERTMS onboard equipment manages its distance monitoring to end of authorities (EoAs) and supervised locations (SvLs), and other critical locations such as speed changes, start and end of speed restrictions etc., according to defined balise locations. In Level 2 and 3 operation, the RBC uses trackside balise locations to determine train location from received position reports, and to calculate safety critical data such as ERTMS MA information. The infrastructure manager (IM) must therefore ensure that balises are installed and maintained in the correct designed position (in accordance with the relevant TSIs and national values) and that balise data used by the RBC is accurate and managed appropriately.

3.2.3.3 The content of the telegram will vary depending on its purpose. Furthermore, a balise can either send the same telegram in each transmission or it can be connected to a Lineside Electronic Unit (LEU) to enable it to transmit a different telegram according to the inputs received by the LEU.

3.2.3.4 A balise group consists of one to eight balises. Each balise is uniquely identifiable within each balise group and each balise group can be uniquely identified.

3.2.3.5 Balise groups enable the train to determine its direction of travel and orientation in relation to the balise group orientation (nominal or reverse).

3.2.3.6 Balise telegrams are made up of individual packets which contain data to support the operation of fitted trains. As fitted trains can pass over balise groups in either direction, individual packets can be made valid for either or both directions of travel.

3.2.3.7 Multiple balises, within a balise group, permit the transmission of more data. This also allows for redundancy as the same telegram application information can be transmitted from more than one balise. If one balise fails to be read for whatever reason, the other balise may be read thereby ensuring delivery of the application information. Together, the telegrams from each balise in a balise group form a balise group message.

3.2.4 Trackside data recording

3.2.4.1 The status of trackside systems (including but not necessarily limited to the interlocking, RBC and signaller’s control and display equipment) must be recorded to support incident investigation.

GN4 Recording the status of trackside equipment may be beneficial for maintenance and diagnostic purposes as well.

3.2.5 Lineside signage

3.2.5.1 The ERTMS trackside system architecture may include the following lineside signs (see Figure 1):
a) A shunt entry board, which indicates the entry of a shunt route. This only applies to ERTMS without lineside signals areas.

b) An ERTMS stop marker, a harmonised trackside ERTMS marker which can be used to mark EoAs used for degraded operation and where stopping positions are critical on the ERTMS railway. ERTMS stop markers will be clearly and unambiguously identified to enable the driver to refer to a specific ERTMS stop marker (see (RD29)).

c) An ERTMS identification plate, which displays the identity of an ERTMS stop marker, a cab signalling shunt entry board or an indication of the start of cab signalling board.

3.2.5.2 Section 21.3.4 sets out the information to be provided at transitions.

The ERTMS system architecture may include lineside signs to facilitate degraded operating conditions, for example, to indicate at the lineside some speed restrictions that fall below the Staff Responsible (SR) ceiling speed (see section 6.3.9 of this document).

3.2.5.3 Any additional lineside signage required to facilitate the operation of ERTMS must only be provided or retained where there is a business, safety or operational need.

3.2.6 Signaller’s workstation

3.2.6.1 Wherever practicable, the workstation controls and indications must be the same for fitted and unfitted trains on ERTMS overlay implementations.

There will be controls and indications that are only applicable to ERTMS, for example, controls to manage temporary speed restrictions for fitted trains.

3.2.6.2 The signaller's workstation must provide the necessary information and controls to enable the signaller to safely and efficiently monitor and control trains within the signaller's area of control.

3.2.6.3 Where necessary, the workstation must facilitate the management of fitted and unfitted trains operating over the same infrastructure.

3.2.7 Technician’s terminal

3.2.7.1 The technician’s terminal must facilitate real time fault diagnosis and rectification, by continually monitoring the health of the ERTMS system and interfaces.

3.2.7.2 While the technician’s terminal is likely to be a fixed installation, consideration must be given to the provision of a remote access capability to provide flexibility in the future as ERTMS is rolled out across the network.

It may also be necessary to provide a portable technician’s unit in order to facilitate maintenance activities and improve response times. The design of remote access systems should consider cyber-security issues.
3.3 ERTMS onboard equipment

3.3.1 General arrangements

3.3.1.1 The principal elements of ERTMS onboard equipment are shown in the example architecture in Figure 2 and are discussed in the following paragraphs. Note that the figure is simplified; there may be more than one of each piece of equipment fitted.

![ERTMS onboard equipment diagram](image)

**Figure 2** ERTMS onboard equipment

3.3.1.2 Each driving cab will be connected to a set of ERTMS onboard equipment.
For locomotives and fixed formation multiple units, each driving cab could be provided with a dedicated set of ERTMS onboard equipment, or the driving cabs could share a single set.

Where locomotives or multiple units work in multiple or tandem, ERTMS supervision appropriate to the operating level and mode (see sections 4, 5, and 6) will be provided in the active driving cab(s), i.e. those from which the train is being controlled, only.

In normal operation, the active driving cab would be the leading cab, but this may not be the case where propelling, shunting or reversing moves are being undertaken.

The train is equipped with a computer, the European Vital Computer (EVC). It is the EVC that provides the supervision of the train’s movements against all the inputs received from the trackside equipment, onboard odometry, the driver and other stored information. The EVC provides outputs to the driver through the ERTMS DMI, to other train systems and functions through the Train Interface Unit (TIU) and transmits information back to the RBC.

The TIU is the means by which ERTMS interfaces to other train systems, such as:

a) Train function control systems. For example, ERTMS is able to provide information for the command of the change of traction systems, the raising/lowering of an overhead pantograph and command the air tightness function to activate/deactivate where certain trackside data has been received.

b) Traction control systems. An interface is provided to command a cut in traction power.

c) Master controller to determine the position of the direction controller and whether the cab desk is open or closed.

d) Train braking systems. An interface is provided to command service and/or emergency brake applications.

The interface between the ERTMS onboard equipment and other train systems is likely to be unique to a class of train.

Fitted trains are equipped with a balise reader. It energises the balise, enabling the balise to transmit messages to the train. The balise reader then receives the message and passes it on to the EVC via a Balise Transmission Module (BTM).

The ERTMS DMI:
a) Provides the means for the driver to enter data into the onboard system (see section 7.5 of this document).

b) Displays actual train speed (a speedometer).

c) Displays supervised speed and changes ordered by the ERTMS trackside equipment.

d) Displays information about the route ahead (the “planning information”).

e) Alerts the driver to changes in supervision, errors and other warnings (visually and audibly), including text messages.

3.3.5.2 For speed indication, normally the speedometer on the ERTMS DMI driven by the ERTMS onboard equipment must be used; however; in order to meet reliability targets, facilitate degraded operation, or to facilitate migration, an additional speedometer function might be considered.

3.3.5.3 Providing that reliability targets can be met with the display device, it is permissible for the additional speedometer function to be displayed on the:

a) ERTMS DMI.

b) TMS screen.

c) Other available DMIs.

3.3.5.4 If an additional speedometer function is provided and it is visible under normal operation, it must either:

a) Be calibrated with the ERTMS-driven speed display DMI so that they both display synchronised information, or

b) Be disabled when the ERTMS DMI is active.

3.3.5.5 Where a decision regarding the availability of optionally displayed information or information that can be activated or deactivated on the ERTMS DMI is required, it must be assessed for suitability to the driving task.

3.3.5.6 Depending on the operational mode and supervision status (for example ceiling speed supervision), the information presented to the driver will include the following:

a) The speed limit that ERTMS is currently supervising to.

b) Target speed.

c) Actual speed.

d) Distance to target, for example a zero or non-zero speed target.

e) Geographical position information.

f) Actual mode and level.

g) Future maximum permitted speed(s) relative to their position.
h) Pre-indication point.

i) Indication point.

j) Alerts to the receipt of more restrictive information.

k) Warnings when ERTMS is close to intervention.

l) Text messages.

m) Indications when ERTMS has intervened (and control may be regained by the driver when the speed has reduced sufficiently).

n) Indications when ERTMS has tripped (and the train will be brought to a stand before the driver can regain control).

o) Available track condition information.

p) Planning information.

**GN11** Where a ‘Set Speed’ automatic speed control function is fitted to the train and is active, the set speed point should be displayed on the ERTMS DMI speed dial.

![Figure 3 Typical ERTMS driver machine interface display](image)

**3.3.6 Planning Information**

3.3.6.1 The display of planning information on the ERTMS DMI must be available, that is the onboard must be configured such that the objects of the planning information are not permanently disabled.

**GN12** Planning information is only available in FS, and includes the following objects:

a) Distance scale.
b) Orders and announcements of track conditions:
   i) Close/open air conditioning intake, and whether to be automatically or manually executed.
   ii) Lower/raise pantograph, and whether to be automatically or manually executed.
   iii) Start and end of neutral sections, and whether automatic or manual reaction required.
   iv) Non stopping areas.
   v) Radio holes.
   vi) Inhibition of special brakes, and whether to be automatically or manually executed.
   vii) Sound horn.
   viii) Change of traction system (various), and whether to be automatically or manually executed.

c) Gradient profile.

d) Speed profile discontinuities.

e) Planning area speed profile.

f) Indication marker.

g) Control buttons allowing the driver to hide or show the planning information, or to adjust the displayed distance range.

3.3.6.2 The Railway Undertaking (RU) must define within its procedures whether it is acceptable for a driver to be allowed to hide the planning information.

3.3.6.3 The trackside implementation must support the display of track condition information where required.

3.3.7 Text messages

GN13 The ERTMS onboard equipment will automatically generate system status messages and display these as text messages for the driver to indicate changes of the state of the system. ERTMS will also support the display of additional text messages received from balises or the RBC.

3.3.7.1 Text messages, in addition to the automatically generated system status messages, must only be provided where there is a safety, performance or operational need.

GN14 Text messages can, for example, be used to support routing information (see section 10 of this document) and locally monitored level crossings (see section 15.2 of this document).

3.3.7.2 Risk assessments on the provision of additional text messages must consider the hazard of driver distraction.
3.3.8 Fault and failure indications

3.3.8.1 The ERTMS onboard equipment must present real time information to the driver when a fault or failure is detected or is present that requires immediate attention. This includes on completion of power up (see section 7.2) and during train operation (see section 17.2).

3.3.8.2 Any error codes or messages presented to the driver as part of the fault or failure indication must be simple to interpret, unambiguous, and standardised across the network, to facilitate ease of fault reporting and determination of response.

3.3.8.3 Fault and failure indications must support the driver in determining the impact on train operations (service affecting fault, or not) and the appropriate rules to be applied.

3.3.9 Odometry

3.3.9.1 The odometry system on board the train provides ERTMS with both speed and distance travelled information. This has to be high integrity and so is usually provided by more than one measurement. Typically, the EVC receives input from tachometers and also from a Doppler radar mounted underneath the train. The EVC uses this information to calculate the train’s speed and position so that it can supervise the train effectively.

The EVC can also use this information to periodically report its position to the ERTMS trackside equipment.

3.3.10 Juridical recording

3.3.10.1 The ERTMS onboard equipment provides an interface for the provision of juridical data related to ERTMS operation, including ERTMS DMI events such as warnings and alarms, and the use of the isolation switch, to an onboard data recorder. The juridical data can be used to support investigation into incidents and for routine system monitoring.

GN15 Subset-027 (RD26) sets out the functional information to be transmitted to the onboard data recorder.

3.3.10.2 Where an independent onboard data recorder is provided for the recording of ERTMS juridical data, it must be possible for recorded ERTMS events to be synchronised 'off line' with events recorded by other onboard and trackside data recording devices.

GN16 The ERTMS specifications do not mandate the provision of a single onboard data recorder to record all train system data, including ERTMS juridical, nor do they mandate the provision of a separate and unique recorder for ERTMS juridical data alone. The synchronisation of data off line could be achieved through the recording of common data by separate data recorders.

3.3.10.3 Where the ERTMS functional interface is to be included in an existing onboard data recorder, the requirements for each must be satisfied.
Subset-027 (RD26) sets out the functional information to be transmitted to an onboard data recorder, GM/RT2472 (RD27) sets out the requirements for onboard data recording.

GSM-R status and traffic information can also be recorded onboard and could be used to support incident investigation and routine monitoring.

Functionality to remotely download data stored on the onboard data recorder must be provided to support incident investigation and routine monitoring, and to avoid the need for personnel to attend the vehicle. This capability must be available while the train is in service.

### 3.3.11 Specific Transmission Module

3.3.11.1 Onboard national train control systems, for example Automatic Warning System (AWS) and Train Protection and Warning System (TPWS), can be integrated with the ERTMS onboard equipment if implemented as a Specific Transmission Module (STM).

Integration of national train control systems and the ERTMS onboard equipment is not dependent on them being implemented as an STM.

The integration between an STM and the ERTMS onboard equipment is via the STM interface defined in (RD17).

Implementation of national train control systems as an STM presents an opportunity to improve the tones and alerts associated with the related national train control systems, and enables the industry to realise additional safety benefits. It may be possible, for example, to improve the tones and alerts associated with TPWS and late to acknowledge AWS caution brake demands, and the brake release action following these events. Implementing these changes should reduce the probability of a ‘reset and continue’ event occurring.

Railway Group Standard GE/RT8075 (RD15) mandates the requirements for AWS/TPWS.

Information from national train control systems implemented as an STM may be presented on the ERTMS DMI, on a supplementary screen connected to the ERTMS onboard equipment or in a manner that is consistent with unfitted trains.

The provision of a supplementary screen in some driving cabs may not always be practicable due to space constraints, thus resulting in the national train control information being presented on the ERTMS DMI. In these circumstances careful consideration should be given to the reliability and availability of the ERTMS DMI, as a failure of the ERTMS DMI may result in the traction unit being taken out of service.

### 3.3.12 ERTMS isolation switch

3.3.12.1 The ERTMS onboard equipment must incorporate a control that enables it to be physically isolated from the traction unit’s braking system and, where required, other onboard systems.
This control should be physically separate from the ERTMS onboard equipment so that the train is not totally immobilised by failure/removal of ERTMS.

3.3.12.2 Operation of the ERTMS isolation switch must be clearly indicated in affected driving cabs. The indication must be visible from the train driver’s normal seated position.

3.3.12.3 Operation of the ERTMS isolation switch must cause the ERTMS onboard equipment to enter Isolation mode (IS, see section 5.9).

3.3.12.4 The ERTMS isolation switch must be protected against routine or accidental use.

3.3.12.5 The ERTMS isolation switch must be located outside the reach zone of the train driver’s normal seated position.

3.3.12.6 Once the ERTMS isolation switch has been operated it must not be possible for the ERTMS onboard equipment to be placed back into service without intervention by a competent person once it has been proven that the ERTMS onboard equipment is safe for operation.

3.3.12.7 Operation of the ERTMS isolation switch must remove any ERTMS suppression of onboard Class B safety systems (see section 20 of this document).

3.3.12.8 The use of the ERTMS isolation switch must be defined in the national operational rules and maintenance procedures for the traction unit.

3.3.12.9 The operation of the ERTMS isolation switch is included in the juridical data provided by the ERTMS onboard equipment (see section 3.3.10 of this document).

3.3.13 ERTMS reset

3.3.13.1 The ERTMS onboard equipment must incorporate a control (ERTMS reset) that enables an authorised user to temporarily interrupt the power supply to the ERTMS onboard equipment (that is, invoke a transition to and out of No Power mode (NP)) without interrupting the power supply to other onboard systems.

3.3.13.2 The ERTMS reset must be protected against routine or accidental use.

3.3.13.3 The ERTMS reset must be located within each driving cab, but outside the reach zone of the train driver’s normal seated position.

3.3.13.4 The use of the ERTMS reset must be defined in the user and maintenance procedures for the traction unit.

3.3.13.5 The operation of the ERTMS reset must be recorded on the traction unit’s data recorder.
3.3.14 Cold Movement Detection

3.3.14.1 Cold Movement Detection (CMD) allows for the detection and recording of vehicle movements while the ERTMS onboard equipment is in NP (see section 5.17 of this document).

3.3.14.2 CMD facilitates the revalidation of the onboard train position, and other information, which is invalidated following a transition to NP.

**GN24** Other onboard information affected by the provision of cold movement detection includes End of Loop Marker (EOLM), ERTMS Level, table of trackside supported levels (see section 21 of this document), and RBC ID/Phone number information (see section 7.5.4).

3.3.14.3 CMD will only be available when the ERTMS onboard equipment is in NP.

3.3.14.4 If cold movement is detected, or if the CMD is or becomes unavailable, then the invalidated data stored in the ERTMS onboard equipment will remain invalid and the affected train will start with an invalid position (see sections 8.2.3 and 8.3 of this document).

3.3.14.5 If no cold movement is detected, then the invalidated data stored in the ERTMS onboard equipment will be revalidated when the ERTMS onboard equipment is powered and the affected train will start with a valid position (see section 8.2.2 of this document).

**GN25** The provision of CMD should significantly reduce the occurrence of performing start of mission with an invalid position on trains that regularly transition to NP.

3.3.14.6 CMD must be provided for Level 2 applications in GB.

3.3.14.7 CMD must be available for a period after entry into NP appropriate to the safety and operational requirements of the particular train/locomotive and the particular types, and frequency, of train movements undertaken.

**GN26** (RD6) specifies that CMD will be provided in NP for a period of at least 72 hours. The specifications for ERTMS assembly procurement should consider whether there is a need for CMD to be available for longer than 72 hours to satisfy the operational needs of a particular train/locomotive.

3.3.14.8 It must not be possible for a train to exit from IS or SF with a valid position.

3.3.15 Driver Reminder Appliance

3.3.15.1 The Driver Reminder Appliance (DRA) is a system that was implemented to mitigate SPAD (Signal Passed at Danger) risk. It is recommended that DRA is not used when operating in ERTMS Levels 1 and 2.

**GN27** For fitted trains provided with DRA, the risk of exceeding the limit of the authorised movement is not always managed by the ERTMS functionality, for example where release speeds are provided, but the risk of passing an associated danger point is managed, therefore additional DRA functionality is considered unnecessary.
However, it is permissible for a railway undertaking to continue to use the DRA to maintain consistent procedures. For example, a railway undertaking may consider it to be appropriate for a driver on a fitted train to apply the DRA on both fitted and unfitted infrastructure to maintain operational consistency. This decision should consider the risk of drivers becoming conditioned to using DRA operating in ERTMS Levels NTC, 1 and 2 during the implementation of ERTMS.

For Level 0 and Level NTC operation the use of DRA is covered by existing national rules. These are currently specified in Rule Book module TW1, section 10 (RD10).

Railway Group Standard GM/RT2491 (RD1) defines the design requirements for the provision and functionality of a DRA. There is no requirement for DRA to be provided on ERTMS fitted trains providing the trains are confined to operating on ERTMS operated lines only.

3.3.16 Driver Advisory Systems

The National ERTMS Programme must consider the integration of the onboard DAS and ERTMS to facilitate the sharing of data common to both systems (see section 7.5.1 of this document) and the consolidation of displayed information and/or displays.

The provision of driver advisory information requires a similar data set to that required to be entered for ERTMS operations, for example Driver ID, Train Running Number, braking parameters, and maximum train speed (see (RD31) and (RD32)). Providing an interface for this common information to be shared by DAS and ERTMS may reduce train preparation and driver handover time, and reduce the risk of data entry errors.

The consolidation of information and/or displays will minimise the number of DMIs and sources of information in the driving cab.

The level of potential integration between DAS and ERTMS onboard equipment may vary according to whether the equipment is to be retrofitted to existing stock or fitted to new stock. There may be trade-offs required between the lower costs of an entirely independent application, and benefits resulting from sharing services, data or equipment with other existing or future applications.

The ERTMS specifications do not currently support the provision of driver advisory information, nor do they define a means to convey that information via the ERTMS DMI. However, the ERTMS DMI Specification (RD14) can be interpreted to permit the display of advisory information via the ERTMS DMI as long as it does not affect or interfere with the specified display of ERTMS information.
4 ERTMS application levels

4.1 Level 0

4.1.1 Level 0 enables fitted trains to operate on infrastructure not fitted with ERTMS, and where there is no alternative train protection or warning system.

4.1.2 While operating in Level 0 the ERTMS onboard equipment will supervise train speed against a maximum permissible speed calculated from:

- a) Pre-configured maximum train speed information.
- b) ERTMS operating mode related speed information (national value).
- c) STM related speed information (on the approach to a transition to Level NTC).
- d) TSR information received from a balise group.

4.1.3 Rollaway protection (see section 6.1.2) will also be provided in Level 0.

4.1.4 There will be no supervisory information displayed on the ERTMS DMI - only current train speed will be displayed.

4.2 Level NTC

4.2.1 Level NTC enables ERTMS fitted trains to operate on infrastructure not fitted with ERTMS, or on overlay implementations, where the safe movement of the train is controlled by the underlying national train control (Class B) system which may be integrated with the ERTMS onboard equipment using:

- a) A Specific Transmission Module compliant with (RD17) (see section 3.3.11 of this document), or
- b) A bespoke interface, or
- c) A combination of (RD17) compliant and bespoke interfaces.

*Class B systems are those national legacy train protection systems listed in (RD20).*

4.2.2 Where the national train control system has been integrated with the ERTMS onboard equipment it is possible to display related information on the ERTMS DMI. However, the information displayed will be dependent on the functionality of the underlying national train control system (for example, it may be possible to present the tones and alerts associated with AWS and TPWS on the ERTMS DMI).

4.3 Level 1

4.3.1 Level 1 is designed to be used as an overlay on an underlying signalling system, whereby ERTMS MAs are generated trackside and transmitted to ERTMS fitted trains using balises (see section 3.2.3 of this document).

4.3.2 Level 1 ERTMS MAs can apply to one or more consecutive predetermined block sections delineated by train detection boundaries.
4.3.3 An ERTMS fitted train operating in Level 1 will need to pass over a balise in order to receive an MA, which will require the routine use of Staff Responsible mode (SR) at start of mission (see section 5.5 of this document) and/or release speeds (see section 6.4.5 of this document).

4.3.4 If infill is required, then balises must be used. An alternative such as Euroloop or radio infill should only be used if the benefit they bring is greater than the whole life cost.

4.3.5 Fitted trains are not required to be able to read Euroloops or support radio infill; therefore if either of these is implemented on the infrastructure, the infrastructure design must support trains that do not have the capability to read Euroloops or radio infill.

4.4 Level 2

4.4.1 Level 2 is a radio based system that is designed to be used as a standalone, integrated or overlay signalling system.

4.4.2 The reason for implementing Level 2 as an overlay system is so that unfitted trains can operate on the route. Once all trains that use the route are fitted then the system can be updated to a Level 2 without lineside signals route.

4.4.3 Level 2 ERTMS MAs can apply to one or more consecutive predetermined block sections delineated by train detection boundaries, and are generated trackside and transmitted to the ERTMS onboard equipment of a train using the GSM-R network.

4.4.4 The ERTMS system monitors all fitted trains operating within each RBC (see section 3.2.2 of this document) as each fitted train has a unique identity within the system and regularly updates its position automatically.
5 ERTMS operating modes

5.1 General

5.1.1 The ERTMS onboard equipment has 17 different operating modes, each of which offers a different degree of supervision and protection.

5.1.2 Regardless of the operating mode, before a train movement is allowed to start or continue, the driver must have authority to move with a clearly defined limit of authority, and must:
   a) Continue to monitor the speed of the train against the information available.
   b) Stop the train at all defined stopping points when required (for example, stations, End of Authority, ERTMS stop markers etc.).
   c) Maintain a level of awareness that enables them to identify, and respond appropriately to, intermediate stopping points, or potential hazards that would otherwise go undetected by the train systems or that present an immediate danger to the safe operation of the railway (for example, obstructions of the line).

5.1.3 A full list of operating modes and a brief description of each is provided in the following sections.

5.2 Full Supervision

5.2.1 Full Supervision mode (FS) is applicable in ERTMS application Levels 1 and 2.

5.2.2 FS affords the highest level of supervision available within the chosen ERTMS application level and the system design must maximise its use.

5.2.3 To be in FS, the ERTMS onboard equipment will require an ERTMS MA that includes movement authority, speed and gradient information. The following characteristics can be used to make up the movement authority information:
   a) The location of the EoA or Limit of Authority (LoA). If a LoA is defined then a target speed must also be defined.
   b) Location of the danger point associated with the EoA.
   c) Location of the end of an available overlap and an associated release timer.
   d) Release speed associated with the overlap and/or danger point (can be a defined value or instruction to calculate onboard).
   e) MA sections and associated timers.
5.2.4 Should gradient and speed information only be known for part of the train (for example, it only knows the gradient information forwards from a signal or ERTMS stop marker that the train is currently passing), then the train will transition into FS mode, but include a message on the ERTMS DMI indicating that gradient and speed information is not available for the whole length of the train. This message will persist until the train reaches a location where gradient and speed information is available for the whole length of the train.

5.2.5 If the gradient and speed information is only known for part of the train, then the operational rules or procedures must define how the driver is to interpret and respond to the associated message that will be displayed on the ERTMS DMI.

5.2.6 While in FS the ERTMS DMI will display the following information:
   a) Current train speed.
   b) Permitted speed.
   c) Target speed (depending on the supervision status).
   d) Distance to go (depending on the supervision status).

5.2.7 Other information will be displayed on the ERTMS DMI, but this will be conditional, user defined or dependent upon the operational design (for example, the planning area is an optional feature within the ERTMS specifications).

5.2.8 The National ERTMS Programme needs to undertake further analysis concerning the available information that can be displayed on the ERTMS DMI in order to define the system requirements.

5.2.9 If the ERTMS onboard equipment detects that the train is travelling too fast or calculates that it is likely to exceed the EoA or SvL it will intervene (see section 6 of this document).

5.3 Limited Supervision

5.3.1 Limited Supervision mode (LS) is applicable in ERTMS application Levels 1 and 2.

5.3.2 LS was conceived to be used as part of a transitory step where the underlying signalling system is not life expired and hence full ERTMS infrastructure fitment is not cost effective, but where there is an operational benefit in providing some ERTMS supervision and protection at critical locations when ERTMS fitted trains operate over the line concerned. It can be used to replace older train protection systems that provide similar functionality, in particular creating the opportunity to remove this equipment from trains.

5.3.3 LS can provide warnings, overspeed and overrun protection, but need not be fitted to every signal.

5.3.4 LS (where available) will be commanded by the trackside and indicated on the ERTMS DMI.
5.3.5 To avoid a brake intervention the driver will be required to acknowledge a change of mode to LS when transitioning from either of the following modes:

a) Standby mode (SB).
b) FS.
c) On-Sight mode (OS).
d) Staff Responsible mode (SR).
e) Post Trip mode (PT).

5.3.6 When in LS only limited information will normally be displayed on the ERTMS DMI (for example, mode, level, train speed and local time).

5.3.7 Other information may be displayed on the ERTMS DMI, but this will be conditional, user defined or dependent upon the operational design.

5.3.8 When operating in LS the driver must control the train in accordance with the signalling and speed information provided at the trackside.

5.4 On-Sight

5.4.1 On-Sight mode (OS) is applicable in ERTMS application Levels 1 and 2.

5.4.2 OS enables the train to enter into a track section that could be occupied by another train, or obstructed by any kind of obstacle or enter a track section that is unable to be detected as clear.

5.4.3 OS must be used where it is not reasonably practicable to control the movement of a train through the issuing of an FS MA.

5.4.4 The method by which OS is offered will be dependent upon the ERTMS application level and ERTMS system design.

5.4.5 OS cannot be selected by the driver.

5.4.6 In train awakening situations in ERTMS Level 2, OS may be offered to drivers by the RBC if the ERTMS onboard equipment has a valid position (see section 8.2.2 of this document).

5.4.7 In ERTMS Level 1 the change to OS is commanded from balise groups.

5.4.8 The trackside will command a transition to OS at a defined point or within a defined area, the method by which this will be achieved is dependent upon the application level and system design.

5.4.9 Where it is necessary to use OS, the length of the OS MA must be kept to a minimum, with the system design always seeking to issue an FS MA as soon as it is considered safe to do so.

5.4.10 In order to ensure that the driver is aware of an OS MA being offered by the ERTMS system, the transition to OS will be indicated on the ERTMS DMI which the driver must acknowledge.

5.4.11 If the driver fails to acknowledge a transition to OS, the ERTMS system will intervene with a service brake application.
5.4.12 By acknowledging a change of mode to OS, the driver must understand that they are only authorised to move the train forward at a speed that will enable them to stop short of an obstruction or EoA.

5.4.13 The location at which the acknowledgement request is presented must be designed such that:

a) The acknowledgement request does not distract the driver from other priority tasks, for example preparing to stop at a platform, approaching level crossings or traction power changeovers.

b) Acknowledgement requests associated with different functions (for example an acknowledgement for a level transition and for an OS mode change) are not required to be presented to the driver at the same time.

GN36 The ERTMS DMI manages acknowledgement requests on a first in-first out basis, that is, the first acknowledgement request will be displayed to the driver, with subsequent acknowledgement requests displayed one second after the first request is acknowledged (see (RD6)).

5.4.14 OS is associated with a maximum speed limit, which the ERTMS system will supervise the train against (see section 6.3.10 of this document).

5.4.15 The operational design must consider the hazards associated with the displaying of speed and distance information when operating in OS as there is a perceived risk that drivers may interpret the speed and distance information as targets and may be unable to stop short of an obstruction or EoA. These hazards will require mitigation through the application of operational rules and by training.

5.4.16 In order to transition to OS, the ERTMS onboard equipment will require an ERTMS MA, which includes movement authority (see section 5.2 of this document), speed and gradient information and an OS mode profile defining the start location and length of the required OS operation, and the OS mode speed.

5.4.17 The driver must be provided with clear and unambiguous information to support determining when an existing OS authority is extended.

GN37 Due to the limited distance to go information and the planning information not being available in OS mode, drivers may find it difficult to determine when an existing OS authority is extended.

5.4.18 If the gradient and speed information is only known for part of the train, then the operational design must define how the driver is to interpret and respond to the associated message that will be displayed on the ERTMS DMI.
Should gradient and speed information only be known for part of the train (for example, it only knows the gradient information forwards from a signal or ERTMS stop marker that the train is currently passing), then the train will transition into OS, but include a message on the ERTMS DMI indicating that gradient and speed information is not available for the whole length of the train. This message will persist until the train reaches a location where gradient and speed information is available for the whole length of the train (see section 5.2 of this document).

5.5 Staff Responsible

5.5.1 SR is applicable in ERTMS application Levels 1 and 2.

5.5.2 Train movements in SR must only be undertaken when FS and OS are not available, as the ERTMS onboard equipment will supervise the train movement against a nationally defined ceiling speed (see section 6.3.9 of this document) and, if available, a distance to go.

5.5.3 SR will be used in either of the following operational circumstances:

a) To pass an EoA without an ERTMS MA.

b) During start of mission with an invalid or unknown train position, or where a communications session with the RBC cannot be established.

SR might also be authorised by the RBC following a train trip and entry into Post Trip mode (see section 5.12 of this document).

5.5.4 Movements in SR must be authorised by the controlling signaller or the person controlling the move (see section 7.3 of this document) and wherever possible constrained by:

a) Limiting the distance the train is allowed to travel in SR based on data stored onboard, received from the RBC or entered by the driver.

b) The RBC sending a list of expected balise groups.

c) Balises with a ‘Stop if in SR’ message that will trip a train which passes over in SR (unless the balise is contained within a list of expected balise groups, or override is active).

In ERTMS application areas where lineside signals are provided it may be acceptable from a safety, operational and performance perspective for certain train movements in SR to be authorised using the trackside signalling equipment (that is, the clearing of a signal to a proceed aspect). An example of where this might be acceptable is a driver being permitted to move a train up to a signal displaying a proceed aspect following receipt of SR during start of mission in order to validate the onboard position and receive an ERTMS MA (See section 8.2.3 of this document).

5.5.5 If it is necessary to authorise a train to pass consecutive ERTMS stop markers in SR the ERTMS onboard equipment must allow the use of override on the move.
5.5.6 The operational rules and procedures must define how train movements in SR are to be authorised.

5.6 Shunting

5.6.1 Shunting mode (SH) is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.6.2 SH allows train movement in either direction.

5.6.3 The level of supervision available in SH when operating in Levels 0 and NTC includes ceiling speed supervision (see section 6.3.11 of this document). However, when operating in Levels 1 and 2 it is possible to mitigate the risk of overrun by providing automatic stop commands (that is, Danger-for-Shunting packets) within the balises protecting the boundaries of a defined shunt area (see section 8.6 of this document).

5.6.4 The system design, operational rules and procedures must mitigate the risks associated with any shunting movement travelling too far.

5.6.5 When transitioning to SH an existing communication session with the RBC will be terminated. This will result in any information normally transmitted by the ERTMS onboard equipment to the RBC not being available and any emergency controls that rely upon data communications will not be effective.

5.6.6 However, there are occasions when the level of supervision offered by SH may be sufficient to control the risks associated with the movement, for example, when making slow speed movements within a yard, depot, or siding or within an engineering possession.

5.6.7 While operating in SH the driver must obey lineside signals (if provided) and reach a clear understanding with the signaller/shunter before any movement commences.

5.7 Passive Shunting

5.7.1 Passive Shunting mode (PS) is applicable in ERTMS application Levels 0, NTC, 1 and 2, and is provided to:

a) Manage the ERTMS onboard equipment of a running hauled locomotive, neither remote controlled nor providing traction power but mechanically coupled to the leading locomotive.

b) Facilitate the continuation of a shunting movement with a single locomotive or fixed formation multiple unit fitted with one ERTMS onboard equipment and two cabs when the driver has to change the driving cab.

GN41 Regarding point a) above, the hauled locomotive could be located anywhere within the train consist, including at the rear of the train (see section 8.5.2 of this document).
5.7.2 PS is an extension of SH, that when selected by the driver will prevent ERTMS onboard equipment in SH mode transitioning to Standby mode (SB, see section 5.14 of this document) when the driving desk is closed, allowing SH to be available immediately when the cab is reopened for further shunting moves.

\textbf{GN42} The driver enters PS by selecting the ‘maintain shunting’ option on the ERTMS DMI with the ERTMS onboard equipment in SH.

5.7.3 Traction units operating in PS must be prevented from entering SH when the cab is opened in areas where SH operations cannot be safely carried out.

\textbf{GN43} It may not be appropriate or desirable for a locomotive that was authorised to enter SH in one area and then entered PS for a move to a different location, to automatically receive the same ‘authorisation’ on arrival at the new location. It is possible to prevent the entry of ERTMS onboard equipment in PS to SH through the use of the “Stop shunting on desk opening” message transmitted by balise. ERTMS onboard equipment in PS receiving the message will transition to SB rather than SH on cab opening.

5.8 \textbf{Unfitted}

5.8.1 Unfitted mode (UN) is applicable in ERTMS application Level 0.

5.8.2 The level of supervision available in UN includes ceiling speed supervision (see section 6.3.12 of this document).

5.8.3 In addition to ceiling speed supervision it is possible to provide supervision for Temporary Speed Restrictions (TSR, see section 6.3.6 of this document).

\textbf{GN44} TSR supervision in UN is unlikely to be utilised in GB, as this would require additional temporary trackside equipment to be provided (that is, temporary balise groups), when the risk of a train travelling too fast over the affected section of line should be able to be mitigated through conventional arrangements.

5.8.4 When operating in UN, the driver must control the train in accordance with the information provided at the trackside (for example, signal aspects, speed boards etc.).

5.9 \textbf{Isolation}

5.9.1 Isolation mode (IS) is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.9.2 IS will be entered when the ERTMS onboard equipment has been isolated using the ERTMS isolation switch (see section 3.3.12 of this document).

5.9.3 When in IS a traction unit must be capable of being hauled.

5.9.4 The operational rules and procedures must define how a train in IS is to be moved (see section 17 of this document).
5.9.5 The driver must be provided with current train speed information for operations in IS (see section 3.3.5 of this document).

5.10 Non-Leading

5.10.1 Non-Leading mode (NL) is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.10.2 NL is designed to facilitate tandem working and can be used for banking movements (that is, where two or more ERTMS fitted traction units form part of the same train formation but are not electrically connected and require a driver on each traction unit) and is the ERTMS operating mode used by other than the leading traction unit.

5.10.3 The ERTMS onboard equipment requires a ‘non-leading input signal’ from the train interface as a necessary condition to enter NL (see (RD24)).

5.10.4 The ERTMS onboard equipment will not perform any train movement supervision in NL - supervision for an associated train movement being provided by an ERTMS onboard equipment (or onboard Class B systems) elsewhere within the train formation.

5.11 Trip

5.11.1 Trip mode (TR) is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.11.2 A transition to TR will be initiated automatically when:

a) Commanded by the trackside.

b) The ERTMS onboard equipment detects that the train has passed beyond the point to which it was authorised to move.

5.11.3 Upon entering TR the ERTMS onboard equipment will command an emergency brake application. All MA information and track description data held onboard will be deleted and no new data will be accepted.

5.11.4 The emergency brake demand will remain active until the train has come to a standstill and the driver has acknowledged the transition to TR.

5.11.5 The ERTMS onboard equipment will indicate to the driver, via the ERTMS DMI, the reason for the transition to TR.

5.11.6 The information presented to the driver on the ERTMS DMI must be sufficient to enable the cause of the event to be identified.

In order for information presented on the ERTMS DMI to be correctly interpreted, it may be necessary to provide the driver with a full description of the possible ERTMS DMI indications in the traction vehicles fault and failure guide.
5.11.7 In Level 2 operation, where a communication session with the RBC is, or can be established, the ERTMS onboard equipment will automatically report a transition to TR to the RBC which must be indicated to the signaller to make them aware of a potentially hazardous situation.

5.11.8 The driver must interpret a transition to TR as a hazardous situation and take all necessary action to safeguard the train and other users of the railway (including reporting the event to the controlling signaller).

5.11.9 If the signaller becomes aware of a transition to TR, then they must take all necessary action to contain the incident (see section 18 of this document).

Because ERTMS protects the SvL and there is high confidence that the train will stop before the danger point, it is not considered necessary to automatically initiate overrun management. Transition to TR can occur for a number of reasons, not necessarily exceedance of the EoA, therefore unless the system can distinguish an EoA trip it is not reasonable to automatically trigger overrun management for a TR event.

5.11.10 Once the affected train is at a standstill and the driver has acknowledged the transition to TR, the ERTMS onboard equipment will automatically transition to Post Trip mode (PT, see section 5.12 of this document), except when operating in ERTMS application Levels 0 and NTC.

5.11.11 When operating in ERTMS application Level 0 or NTC upon acknowledgement of the transition to TR, the ERTMS onboard equipment will automatically transition to SH, UN or National System mode (SN). The mode to which the ERTMS onboard equipment will transition is dependent on the presence of valid train data and the ERTMS operating mode being used prior to the TR event occurring.

If the ERTMS application Level is 0 or NTC, the ERTMS onboard will transition to UN or SN respectively if valid train data is held, otherwise it will transition to SH.

5.11.12 All transitions to TR must be investigated in order to understand the circumstances surrounding the event.

5.11.13 The national operational rules must define the arrangements for recovering from a transition to TR taking into consideration the risks associated with each of the possible causes.

5.12 Post Trip

5.12.1 PT is applicable in ERTMS application Levels 1 and 2.

5.12.2 A transition to PT will be initiated automatically by the ERTMS onboard equipment when the train is at a stand and the driver has acknowledged the transition to TR.

5.12.3 Following the driver's acknowledgement:
a) In Level 2 the onboard notifies the RBC of the mode change to PT and then waits for the RBC to acknowledge the exit from TR before allowing the driver to select start.

b) In Level 1 the onboard will allow the driver to select start as soon as the mode changes to PT.

**GN48** *In Level 2, if the transition to TR was as a result of receiving an emergency stop order from the RBC, this emergency stop order must first be revoked (or deleted) before the train can continue.*

5.12.4 While in PT it will be possible for the train to be moved backwards for a predefined distance that is determined by a nationally defined value (see section 6.2.2 of this document).

5.12.5 While in PT, the ERTMS onboard equipment performs reverse movement protection against moves in the forward direction according to a nationally defined value (see section 6.1 of this document).

5.12.6 The signaller must not authorise the train to move until all of the following requirements are satisfied:

a) The circumstances surrounding the event are understood.

b) The railway undertaking concerned have authorised the continuation of the train movement using the same driver, where necessary.

c) The signaller is satisfied that the train movement can be made safely.

5.12.7 Once authorised by the signaller, the driver of the affected train must press start on the ERTMS DMI which:

a) In Level 1 it will result in the ERTMS onboard equipment proposing SR to the driver.

b) In Level 2 it will result in a request for a new ERTMS MA being sent to the RBC.

5.12.8 Upon receiving a request for an ERTMS MA, the RBC must issue the highest level of supervision available.

5.12.9 A transition to PT will deactivate the emergency brake demand previously commanded by the transition to TR.

5.13 **Sleeping**

5.13.1 Sleeping mode (SL) is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.13.2 Train movements in SL will be normal where multiple working is required (that is, where two or more fitted traction units are coupled physically and electrically and where only one driver is required to control the train).

5.13.3 Transition to SL will be automatically initiated when the ERTMS onboard equipment detects that a driving desk has been opened that is associated with another ERTMS onboard equipment elsewhere in the train formation (that is, the train is being driven from another ERTMS fitted traction unit within the train formation).
5.13.4 Once an ERTMS assembly has transitioned to SL, it will remain in SL until either the sleeping input signal is lost and the train is at a stand, or the driving desk is opened. The ERTMS onboard equipment will then automatically transition to SB.

5.13.5 As a minimum the sleeping input signal must be lost if the traction unit becomes uncoupled from the rest of the train (for example, during uncoupling activities or divided train scenarios).

**GN49** The ERTMS onboard equipment receives the sleeping input signal via the train interface. Functionality for detection of uncoupling therefore relates to the integration of ERTMS within the vehicle rather than a requirement on the ERTMS onboard equipment.

5.14 **Stand-by**

5.14.1 SB is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.14.2 Transition to SB will be automatically initiated when the ERTMS onboard equipment is powered up. If a fault has been detected it may subsequently transition to System Failure mode (SF, see section 5.15 of this document).

5.14.3 SB will be the default operating mode for the ERTMS onboard equipment and is the initial mode used at the start of mission process (see section 7.5 of this document).

5.14.4 Train movement must be permitted in SB to facilitate coupling and uncoupling activities.

**GN50** Facilitating such movements in SB eliminates the need for any interaction with the ERTMS DMI, as there is no requirement for the driver to select an alternative mode or input any train data, thus providing similar levels of productivity to those experienced when operating unfitted trains. However, safety is improved through the provision of standstill supervision (see section 6.1 of this document).

5.15 **System Failure**

5.15.1 SF is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.15.2 The detection of a safety critical fault by the ERTMS onboard equipment will cause it to transition to SF except, where possible, if the ERTMS onboard equipment is operating in NL, PS, or SL modes.

5.15.3 Transition to SF will cause the ERTMS onboard equipment to automatically command an emergency brake application.

5.15.4 If the affected ERTMS onboard equipment is operating in NL or SL when the safety critical fault is detected, then the system must record and display the details of the fault if possible (see section 3.3.8 of this document) and automatically transition to SF upon exiting NL or SL.
5.15.5 The powering down of the affected ERTMS onboard equipment will cause a transition to NP. Transition to NP might clear an intermittent fault within the ERTMS onboard equipment and therefore remove the need to isolate it (see section 3.3.13 of this document).

5.15.6 The railway undertaking’s contingency plans must describe how transitions to SF are investigated and subsequently managed.

5.16 Reversing

5.16.1 Reversing mode (RV) is applicable in ERTMS application Levels 1 and 2.

5.16.2 There may be occasions when it may be advantageous to make reverse movements without the need to change driving cabs or enter SH (for example, to facilitate routine shunting movements that involve propelling movements).

5.16.3 The application of ERTMS must include all areas where RV is authorised and these areas must be defined in local publications and be indicated on the ERTMS DMI.

5.16.4 The ERTMS trackside equipment will announce an area where RV is authorised in advance to the ERTMS onboard equipment.

5.16.5 The level of supervision available in RV includes ceiling speed supervision (see section 6.3.13 of this document) and distance to go supervision (see section 6.2.3 of this document).

5.16.6 The ERTMS DMI will display the train speed, the permitted speed and remaining distance to go. However, the driver must not regard the permitted speed and distance to go as targets, as it is the driver’s responsibility to limit the distance to be travelled in RV to an absolute minimum and at a speed that enables the train movement to be stopped short of any obstruction, or when instructed to do so by the person controlling the movement.

5.16.7 The national operational rules must define when RV is authorised for use and how exceedance of the distance to go is to be managed.

5.16.8 In addition, the ERTMS National Programme must undertake further analysis to determine whether RV should be used in an emergency to enable drivers to take evasive action if a train movement exceeds an ERTMS movement authority and enters a conflict area.
5.16.9 RV and SH facilitate reverse movement, but distance to go information is not displayed on the ERTMS DMI in SH. Therefore, it may be sensible to authorise RV in some shunting areas in order to gain operational benefits.

5.17 No Power

5.17.1 NP is applicable in ERTMS application Levels 0, NTC, 1 and 2.

5.17.2 A transition to NP will be initiated automatically when the normal power supply to the ERTMS onboard equipment is interrupted (for example, during train disposal duties or by use of the ERTMS reset button (see section 3.3.13 of this document)).

5.17.3 Although a transition to NP will cause all previously entered data to be lost, the ERTMS onboard equipment will monitor train movements through cold movement detection (see section 8 of this document).

5.17.4 When in NP the ERTMS onboard equipment will permanently command an emergency brake application. Therefore, if it is required to move while in NP then the emergency brake command must be overridden by an external means.

5.18 National System

5.18.1 SN is applicable in ERTMS application level NTC (see section 4.2 of this document).

5.18.2 In SN no train supervision functionality is provided by the ERTMS onboard equipment.
6 ERTMS Supervision

6.1 Movement supervision

6.1.1 General

6.1.1.1 The ERTMS onboard equipment is designed to prevent fitted traction units from making unauthorised movements, by intervening with automatic traction cut off and brake interventions when movement is detected that exceeds a defined distance.

6.1.1.2 Table 1 identifies those ERTMS operating modes in which movement supervision is provided and the type of protection/supervision provided.

<table>
<thead>
<tr>
<th></th>
<th>FS</th>
<th>LS</th>
<th>OS</th>
<th>SR</th>
<th>SH</th>
<th>UN</th>
<th>PT</th>
<th>SB</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Table 1  Movement protection/supervision

GN53 * The normal direction of travel for train movement in this ERTMS mode is backwards; therefore the ERTMS onboard equipment will intervene if a train movement is detected in the forward direction if it exceeds the national value for D_NVROLL.

6.1.1.3 The distance at which ERTMS will intervene is dependent upon a nationally defined value (D_NVROLL).

GN54 RSSB report ERTMS National Values - Safety Analysis - D_NVROL (RD16) recommends that D_NVROLL be set to 4 metres to mitigate the risk of interventions due to drivers being unable to accurately and consistently estimate small distances.

6.1.1.4 The ERTMS onboard equipment will indicate an intervention on the ERTMS DMI, by displaying the system status message ‘Runaway movement’ and the brake demand symbol.

6.1.1.5 Once the train movement has stopped, it will be possible to command the release of the train brakes by acknowledging the brake demand on the ERTMS DMI.

6.1.1.6 Depending on the circumstances and the consequences it may be necessary to report the event.
6.1.2 Roll away protection

6.1.2.1 When roll away protection is active (see Table 1) the ERTMS onboard equipment will automatically intervene to stop any train movement that exceeds the national value for D_NVROLL in the opposite direction to that which is selected through the direction controller.

6.1.2.2 If the direction controller is in the neutral position, then any train movement exceeding the national value for D_NVROLL in either direction will be stopped using roll away protection.

6.1.3 Reverse movement protection

6.1.3.1 When reverse movement protection is active (see Table 1) the ERTMS onboard equipment will automatically intervene to stop any train movement that exceeds the national value for D_NVROLL in the opposite direction to that permitted by the currently valid MA, or any mode specific directional data.

6.1.4 Standstill supervision

6.1.4.1 When standstill supervision is active (see Table 1) the ERTMS onboard equipment will automatically intervene to stop any train movement that exceeds the national value for D_NVROLL.

6.2 Distance supervision

6.2.1 Shunting

6.2.1.1 The system must mitigate the risks associated with a train exceeding the limit of a shunting movement.

**GN55** The ERTMS system can mitigate the risk of a train movement being made in SH from exceeding the defined limits of a shunting area through the use of expected balise group lists and/or balise groups containing ‘Danger for Shunting’ packets.

6.2.1.2 If the ERTMS onboard equipment detects that the train has exceeded the limit of shunt area then the onboard will automatically transition to TR (see section 5.11 of this document).

**GN56** The onboard transitioning to TR might not prevent the leading vehicle from exiting the shunt area when propelling because when propelling, the ERTMS onboard equipment does not know where the front of the train is.

6.2.1.3 In ERTMS application levels where signals are provided, the shunter and driver must come to a clear understanding and ensure it is safe for the movement to take place; this includes checking the signal is displaying a proceed aspect. However, the driver of a fitted train must also check the ERTMS DMI to ensure the appropriate ERTMS Level and mode is displayed and where necessary the presence of an ERTMS MA.
6.2.1.4 In ERTMS application levels where signals are not provided, the shunter and driver must come to a clear understanding and ensure it is safe for the movement to take place; this includes checking that an appropriate ERTMS level and mode is displayed on the ERTMS DMI, and where necessary the presence of an ERTMS MA.

6.2.1.5 The ERTMS system must provide all necessary information to facilitate the safe movement of a train in SH. Therefore, if there are speed restrictions that will be encountered during the move that fall below the SH ceiling speed, then the ERTMS system must describe how these will be communicated to the driver in order to control the risks associated with travelling too fast (for example, the speed of the movement could be procedurally restricted throughout, or the driver could be advised of the speed if it were a longer movement, or lineside signage may be required).

6.2.2 Post Trip - maximum distance for reversing

6.2.2.1 While the ERTMS onboard equipment will facilitate a backwards train movement in PT, the distance of the movement is determined by a national value (D_NVPOTRP).

6.2.2.2 The National ERTMS Programme has not currently identified an operational requirement to provide backwards movement following a transition to PT, therefore the national value D_NVPOTRP must be set at zero to prevent backwards movement.

6.2.3 Reversing

6.2.3.1 Train movements in RV must only be permitted where there is an operational or performance requirement for moves in the reverse direction, and where the hazards associated with such a move can be mitigated (see section 5.16 of this document).

6.2.3.2 Unplanned reversing moves may be required in certain situations. The implementation of ERTMS must support these types of moves being undertaken safely and efficiently.

GN57 Examples of unplanned reversing moves that should be supported include reversing part of propelling snow plough operations, or rail grinders reversing to extinguish a lineside fire cause by grinding.

6.3 Speed supervision

6.3.1 Supervision of the maximum permissible speed

6.3.1.1 ERTMS will supervise the maximum permissible speed according to the most restrictive of:

a) The permissible speed of the infrastructure, taking into account differential, permanent, temporary, level crossing and axle load speed restrictions.

b) The maximum speed of the train, taking into account the maximum speed of the traction unit being driven and the maximum speed of the most restrictive vehicle in the train.
c) The ceiling speed (if any) for the ERTMS operating mode in use.
d) ERTMS function related speed restrictions, for example that associated with the override function.

6.3.1.2 The ERTMS onboard equipment will intervene with a brake application if it detects that the train’s speed has exceeded a limit above the maximum permissible speed.

**GN58** ERTMS intervention limits are calculated by the ERTMS onboard equipment considering the actual speed of the train. The ERTMS onboard equipment will intervene (command a brake application) when the train speed exceeds the calculated intervention value, which for emergency brake intervention, can be 7.5km/h or 15km/h, or a linearly calculated limit between them, above the maximum permissible speed. For more information on the calculation of ERTMS warning and intervention limits (see (RD6)).

6.3.1.3 If the emergency brake is used as the first line of intervention, then the brake application must be released when the train speed has been reduced to below the maximum permissible speed.

6.3.1.4 The ERTMS system must mitigate the risk of brake interventions when two consecutive reductions in the maximum permissible speed are located within close proximity to each other, as a short gap can cause the subsequent reduction in speed to be masked.

**GN59** Speed masking can result in the driver of an approaching train experiencing a brake intervention, as they have insufficient time to respond to an upcoming speed restriction having released the brakes upon achieving compliance with the previous speed restriction just a short distance before.

6.3.2 Permissible speeds

6.3.2.1 In Level 0, Level NTC, Level 1 and Level 2 with signals areas, all permissible speeds that are published must be indicated at the lineside to provide drivers of unfitted trains with a definitive point of reference as to where the speed changes.

**GN60** Permissible speeds form part of the ERTMS line speed profile.

6.3.2.2 Where some types of train would be subject to different permissible speeds over the same route, separate line speed profiles must be determined to give optimal performance for all trains using a route.

**GN61** Permissible speed profiles can be defined and allocated to ERTMS train categories which are different from any categorisation currently used on GB conventional lines. Although there may be several possible different speed profiles for ERTMS fitted trains, normally a maximum of three speed profiles are signed at the lineside. It will therefore not be possible to have consistency between the conventional permissible speeds and all the possible ERTMS speed profiles without compromising the performance of ERTMS fitted trains.
GN62  (RD6) requires that a line speed profile be determined for a basic category of train.

GN63  Further work is necessary to determine the most appropriate relationship between vehicle characteristics, limitations imposed by track or structures, and braking capabilities to match these to the criteria for determining permissible speed profiles contained within ERTMS.

GN64  A train will belong to one 'cant deficiency' train category and optionally may belong to one or more 'other international' train categories. The permissible speed profile for a specific train is the most restrictive speed of the 'cant deficiency' speed profile for the category the train is in (or if this is not available, the next lowest that is available) and the lowest of the 'other specific' speed profile for all the 'other international' train categories the train belongs to (if any). An axle load speed profile, defining different speed values and for which minimum axle load category the speed value applies, can also be specified which will be considered by the ERTMS onboard equipment.

GN65  How many, and which specific, line speed profiles are configured into ERTMS might vary from scheme to scheme, being determined by the business benefit gained from optimal performance against the cost and complexity of the design and whole-life management of multiple profiles.

6.3.2.3  The permissible speed profile for ERTMS fitted trains need not necessarily be the same as for unfitted trains that is, it may be higher or possibly lower. In normal operation, the driver of an ERTMS fitted train must therefore follow the speed profile as indicated on the ERTMS DMI which may not necessarily be the same as that indicated by lineside signage for permissible speeds and speed restrictions.

GN66  For trains operating under the supervision of ERTMS on lines equipped with lineside signalling, higher speeds may be permitted by ERTMS irrespective of the constraints signal spacing places on unfitted trains.

GN67  There is no need to manage train speed to provide appropriate braking distance between lineside signals when operating with ERTMS, as ERTMS will supervise speed taking into account the actual braking characteristics of the train. This means that no additional functionality or constraints are required for enhanced permissible speeds or for trains that have poor braking performance (for example light locomotives, see section 6.4.3 of this document).

6.3.2.4  Calculation of the braking capabilities of variable formation trains, or those where potential braking capability is not available (due, for example to isolated vehicles) may be on a more precise basis than on conventionally signalled lines. However, if advantage is taken of this, consideration must be given to possible issues that arise from the maximum speed of a train varying during the journey.
6.3.3 Speed restrictions

GN68 This section describes the occasions when it may be necessary to temporarily restrict the speed of trains, in a similar manner to that which is required on conventional lines through the implementation of emergency and temporary speed restrictions.

6.3.3.1 The introduction of ERTMS must enable speed restrictions to be supervised once they have been entered into the ERTMS system.

6.3.3.2 For ERTMS Level 1 and 2 areas, a means must be provided for speed restriction information to be quickly entered into and withdrawn from the ERTMS system without the need for railway personnel to visit ERTMS equipment located at the lineside.

6.3.3.3 The ERTMS system must mitigate the risks of fitted trains traversing the speed restriction too fast.

6.3.3.4 The IM must communicate details relating to speed restrictions to railway undertakings (for example, time of implementation, severity of restriction, exact location, and the defined commencement and termination points).

6.3.3.5 Railway undertakings must, as a minimum, communicate details relating to speed restrictions to personnel responsible for controlling the safe movement of unfitted trains within their respective organisations.

6.3.3.6 The timing of such communications is important, as the operational rules and procedures must define how speed restrictions are to be communicated when there is insufficient time to plan the implementation of the speed restriction and where the speed restriction has been anticipated and planned.

GN69 Under normal operating conditions on ERTMS fitted infrastructure there is no need for such information to be communicated to the drivers of fitted trains. However, the information may be useful supplementary information during degraded operating conditions.

6.3.3.7 The operational rules and procedures must define how speed restrictions are to be implemented, responded to and withdrawn.

6.3.3.8 If it is necessary to implement a speed restriction immediately (for example: due to a track defect) then all trains (fitted and unfitted) approaching the affected section of line must be made aware of:

a) The location where the speed restriction begins and ends.

b) The speed limit imposed.

6.3.3.9 The driver must control the speed of the train movement and not exceed the speed restriction when traversing the affected section of line.

6.3.3.10 The following controls must be implemented before all trains (fitted and unfitted) approaching a speed restriction no longer have to be made aware of the restriction:
a) The provision of temporary lineside signage and associated AWS equipment (where required).

b) The speed restriction is capable of being supervised by the ERTMS system.

In overlay areas where both fitted and unfitted trains can operate, the need to implement both controls is intended to mitigate the hazards associated with a signaller having to decide which trains to advise and which not based on the fitted status of the train. Subject to risk assessment, the dependency on the provision of lineside furniture may be relaxed where the number of moves over the speed restriction by unfitted trains is limited.

6.3.3.11 Temporary lineside signage and associated AWS equipment (where required) must normally only be provided for speed restrictions on unfitted infrastructure, or on fitted infrastructure where unfitted trains operate.

6.3.3.12 Where temporary lineside signage and associated AWS equipment (where required) is used on fitted infrastructure, it must be consistent with that used on unfitted infrastructure.

6.3.3.13 On fitted infrastructure, the normal method of communicating a speed restriction to drivers of fitted trains will be via the ERTMS DMI. The warning, commencement and termination of a speed restriction that is indicated at the lineside with temporary lineside signage may not be consistent with the information displayed on the ERTMS DMI, as the ERTMS supervision is based upon the actual braking characteristics of the train.

However, in degraded operating conditions, where temporary lineside signage is provided it may be useful supplementary information that could assist the driver of a fitted train to locate the commencement and termination point of a speed restriction, but this cannot be relied upon in the absence of the associated onboard AWS indications.

There are defined locations where it is not necessary for the IM to provide temporary AWS equipment; these are published in the Sectional Appendix associated with the route concerned. In these areas, it might be possible to mitigate the risk of a fitted train operating in degraded mode traversing the speed restriction too fast through operational rules, procedures and the provision of temporary lineside signage.

6.3.3.14 The operational rules and procedures must define how speed restrictions will be communicated to drivers of fitted trains when the speed restriction is not being supervised by ERTMS, including those speed restrictions that fall below an ERTMS mode’s associated ceiling speed.

The supervision of speed restrictions when operating under the control of ERTMS is dependent on the operating mode, for example, speed restrictions are not supervised in SH, PS, NL, SL or RV.
6.3.3.15 In ERTMS Level 2 areas, trains operating in SR must receive speed restriction information entered into the ERTMS system if the train is in communication with the RBC and it is possible for the RBC to send it.

**GN75** If a train in communication with the RBC has an invalid or unknown position it will not be possible for the RBC to send speed restriction information to it.

6.3.3.16 To avoid the confusion of having different operating rules for different situations, all trains in SR mode must still be given speed restriction information as part of the permission to proceed.

6.3.3.17 Signallers must have ready access to information related to speed restrictions and provide this information to drivers as part of the permission to proceed.

**GN76** This information should include the start and end location of the speed restriction and applicable speed/s in suitable units of measurement, and the types of train to which the speed restriction is applicable (see section 6.3.4 of this document). This information could be made available on the signallers control panel on request to support accurate association with the train position.

6.3.3.18 Drivers must be made aware through training and competency that the in-cab display can be different depending on whether the train has received speed restriction information or not.

6.3.3.19 The operational rules and procedures must define the process for withdrawing a speed restriction.

**GN77** It may be possible to remove an ERTMS speed restriction prior to any associated temporary lineside signage being removed. This may be confusing for drivers of fitted trains, as they may experience divergence between the information presented on the ERTMS DMI (the normal method signalling) and the information presented at the lineside.

6.3.3.20 The drivers of fitted trains must be made aware of the possibility of divergence between the speed related information presented on the ERTMS DMI and that provided at the lineside for unfitted trains.

### 6.3.4 Differential speed restrictions

**GN78** This section describes the occasions when it may be necessary to temporarily restrict the speed of trains to different values at the same location depending on the type of train, in a similar manner to the use of differential temporary speed restrictions on the conventional network.

6.3.4.1 Differential speed restriction functionality must be provided for ERTMS Level 2 applications.
On conventionally signalled lines, it is possible to sign only two differential temporary speed restrictions at the same location at the trackside - the higher speed applies to passenger carrying coaching stock (which includes postals) and light locomotives, and the lower speed to everything else. In situations where environmental conditions, for example high winds, lead to a speed restriction being imposed on trains running under OLE, this is nominally imposed as a blanket speed restriction and is advised to drivers by instruction (see section 6.3.5 of this document).

The reason for applying a differential temporary speed restriction may be quite different from any basis on which differential permissible speeds (see section 6.3.2 of this document) are determined, although the ability to optimise performance by applying any more detailed application criteria must be taken advantage of where practicable.

With ERTMS, the train characteristic information available at the trackside potentially allows for a greater differentiation in speed restriction data than is available on a conventional application, but this can only be supported by providing specific functionality within the ERTMS trackside subsystem as differential speed restrictions are not supported within the specified ERTMS TSR packet structure. It is possible that differential speed restrictions could be imposed by the trackside adjustment of the permissible speed profiles for relevant categories of train (see section 6.3.2 of this document) subject to the reason for the imposition of the speed restriction permitting any such variation.

The introduction of ERTMS Level 1 must not affect the management of differential speed restrictions.

Although differential speed restrictions are operationally desirable, it is recognised that this might be a significant change to the ERTMS Level 1 architecture which will be complex and costly. In addition, the GB implementation plan limits the extent of ERTMS Level 1 applications.

The National Operating Strategy needs to undertake further analysis concerning the future management of trains that would currently operate under RT3973 restrictions, as ERTMS alone may not be capable of adequately managing these trains.

Blanket speed restrictions

The operational rules and procedures must define how a blanket speed restriction is to be imposed, taking into consideration the following:

a) Operation of fitted and unfitted trains within the affected area.

b) Whether the speed affects all trains or only certain traction types, classes or categories.
GN83 Where the blanket speed restriction only relates to fitted trains, it might be possible to define it as a speed restriction within the ERTMS system to mitigate the risk of a fitted train traversing the affected area too fast (see section 6.3.6 of this document). However, the reason for implementing the blanket speed restriction and/or the geographic scope of it may cause the implementation of such a speed restriction using ERTMS functionality to be unacceptable from a signaller workload perspective; resulting in existing arrangements being applied.

GN84 It might also be possible to use ERTMS train categories to manage differential blanket speed restrictions.

6.3.6 Managing speed restriction information in the ERTMS system

6.3.6.1 Processes and tools of suitable safety integrity must be developed to ensure that speed restriction information is correctly entered into the ERTMS system.

GN85 As speed restrictions entered into the ERTMS system are less obvious than those signed on the lineside, errors in the entry of speed restriction information, or the failure to enter the speed restriction information, may not be readily detected without suitable procedures in place when they are set up.

6.3.6.2 The ERTMS system must be capable of enabling speed restrictions to be defined across signaller and RBC boundaries.

6.3.6.3 Speed restriction information must be configurable with at least the start and finish points, the speed value/s and trains to which they are applicable, the applicable direction and the effective start time. This can be done in real time, or set up ‘off line’ and activated at the effective start time.

6.3.6.4 It must be possible to configure a speed restriction distance resolution of between one and ten metres.

6.3.6.5 It must be possible to configure a speed restriction speed value to a resolution of 5mph (or 5km/h if metric units of measure are being used).

6.3.6.6 Automatic activation of speed restrictions entered into the ERTMS system must only be implemented if it is possible for the system to prevent drivers of fitted trains within the vicinity of the location where the speed restriction is to be activated from experiencing warnings and/or interventions as a result of the activation. If this is not possible, then the activation of speed restrictions entered into the ERTMS system must be achieved manually.

6.3.6.7 The person responsible for manually activating a speed restriction entered into the ERTMS system must only do so if they are sure it will not cause the driver of a fitted train to experience an ERTMS warning or intervention.
6.3.6.8 The ERTMS system must be capable of providing information to remind the person responsible for activating a speed restriction entered into the ERTMS system. The reminder must be configurable to enable it to be set at a predetermined time.

6.3.6.9 It must be possible to de-activate an activated speed restriction at any time, but the ERTMS system must not adversely affect trains while the speed restriction is being de-activated on the system. 

GN86 This means an ERTMS fitted train entering or traversing the affected area is not subject to unexpected changes in supervised speed that could lead to unsafe situations, for example jumps in release speed values being mistaken for an extension of an ERTMS MA.

6.3.6.10 ERTMS will provide more effective speed supervision than that available to unfitted trains, as the ERTMS system will provide the driver of the train with a braking curve designed to reduce the speed of the train to be compliant with the activated speed restriction prior to reaching the commencement point.

6.3.7 Train related speed restriction

6.3.7.1 The ERTMS onboard equipment will supervise the speed of the train against the maximum speed entered/validated during train data entry (see section 7.5 of this document).

6.3.8 Mode related speed restrictions

6.3.8.1 The RSSB research and development project T093 published in March 2004 (RD11) recommends a baseline set of national values for ERTMS. The recommended values for mode related speed restrictions have been extracted and incorporated within the following sections. Given the age of (RD11) and the level of experience gained across Europe since publication, the recommended values for mode related speed restrictions must be reassessed for suitability to the application of ERTMS on the GB mainline railway.

6.3.8.2 In modes where ceiling speed supervision to a mode related speed value is provided, drivers must not consider that ceiling speed information displayed on the ERTMS DMI is a target speed, or that it changes the driver responsibilities associated with that mode.

6.3.9 Staff responsible ceiling speed

6.3.9.1 (RD11) recommends that the national value for SR ceiling speed \( V_{NVSTFF} \) be set at 25mph (40km/h). This is the ceiling speed at which a fitted train will be supervised while operating in SR.

6.3.9.2 There may be circumstances when it is possible to authorise train movements in SR at a higher speed than that allowed by the national value \( V_{NVSTFF} \). Under these circumstances it will be possible for the SR ceiling speed to be amended temporarily by the driver.
6.3.9.3  The operational design must determine the circumstances under which
the SR ceiling speed may be temporarily amended, taking into
consideration the impact this may have on the system's effectiveness to
prevent a fitted train operating in SR from travelling too far.

6.3.9.4  The operational design must determine how fitted trains should be moved
when it is not possible to issue ERTMS MAs, and where SR is to be used
a risk assessment must be conducted to determine the maximum
permitted speed of the movement.

6.3.9.5  The assessment of risk must consider, as a minimum, all of the following:
   a) Distance to be travelled.
   b) Effectiveness of ‘Stop if in SR’ messages to prevent a train entering a
      conflict point.
   c) Braking characteristics of trains on the route.
   d) Speed profile of the line and how speed restrictions that fall below the
      SR ceiling speed will be communicated.

6.3.9.6  If the risk assessment supports increasing the SR ceiling speed over the
national value, then the driver must manually amend the SR ceiling speed
when authorised to do so.

6.3.9.7  The driver must interpret the SR ceiling speed as a maximum permitted
speed and not a target speed, as they must be able to stop the train within
the distance that can be seen to be free from obstruction and continue to
comply with any speed restriction that falls below the SR ceiling speed.

6.3.9.8  Operational rules and procedures must define how speed restrictions will
be communicated to drivers of fitted trains when any permissible speed or
speed restriction is lower than the SR ceiling speed.

6.3.9.9  In ERTMS areas without lineside signals, lineside speed signage must be
provided where the permissible speed is lower than the SR ceiling speed.

6.3.10  **On-sight mode speed limit (V_NVONSIGHT)**

6.3.10.1  (RD11) recommends that the national value for the OS speed limit
(V_NVONSIGHT) be set at 25mph (40km/h). This is the speed at which a
fitted train will be supervised while operating in OS, unless an amended
OS speed limit is received from the trackside (see section 5.4 of this
document).

6.3.10.2  The driver must interpret the OS speed limit as a maximum permitted
speed and not a target speed, as they must be able to stop the train within
the distance that can be seen to be free from obstruction.

6.3.10.3  There may be circumstances when an OS MA is received during the start
of mission process, in which case the train must not be moved unless the
driver is sure that the line is clear to the next signal or ERTMS stop
marker (see section 8.2 of this document).
6.3.10.4 If the train is travelling at a higher speed than the OS speed limit when the transition to OS occurs, then the ERTMS system will intervene with a brake application (see section 6.3.1 of this document).

6.3.10.5 ERTMS brake interventions during transitions between ERTMS modes are undesirable and wherever possible must be avoided through the ERTMS system design.

6.3.11 Shunting mode speed limit
6.3.11.1 When operating in SH the movement will be restricted to a maximum ceiling speed.

6.3.11.2 (RD11) recommends that the national value for the SH speed limit (V_NVSHUNT) be set at 25mph (40km/h). This is the speed at which a fitted train will be supervised while operating in SH, unless an amended SH speed limit is received from the trackside.

6.3.11.3 The driver must interpret the SH speed limit as a maximum permitted speed and not a target speed, as they must be able to stop the train within the distance that can be seen to be free from obstruction.

6.3.11.4 Operational rules and procedures must define how speed restrictions will be communicated to drivers of fitted trains when any permissible speed or speed restriction is lower than the SH ceiling speed.

6.3.12 Unfitted mode speed limit
6.3.12.1 When operating in UN the movement will be restricted to a ceiling speed, which will default to the lower of the following:
   a) The national value for the UN speed limit (V_NVUNFIT).
   b) The maximum speed of the train as defined during data entry.

6.3.12.2 The value of V_NVUNFIT must be determined using the process defined in (RD25).

6.3.13 Reversing mode speed limit
6.3.13.1 The reversing speed limit (V_REVERSE) will only be transmitted by the trackside as part of information related to a defined Reversing area (See section 5.16 of this document). There is no national or default value.

6.4 Driving under the supervision of ERTMS
6.4.1 Driving style
6.4.1.1 Under Level 1 or Level 2 operation the driver of an ERTMS fitted train must normally drive to the signalling and speed information displayed on the ERTMS DMI and not that presented at the lineside.
In Level 1 operation, the driver of a train brought to a stand at a lineside signal may be required to follow lineside signal aspects to facilitate the move up to and over the signal balise group to receive the associated Level 1 ERTMS MA. There may also be occasions where the information on the ERTMS DMI is supplemented by external signalling information, for example the Drivers Crossing Indicator at a locally monitored crossing.

6.4.1.2 The train must not be driven faster than the permitted speed displayed on the ERTMS DMI.

6.4.1.3 Irrespective of the fitment of ERTMS, drivers are required to observe the track ahead (especially in the case of station stops not supervised by ERTMS) and to control risks outside of the scope of ERTMS, for example permissive working, engineering work and external hazards.

6.4.1.4 Drivers of fitted trains must still report any irregularities with the fixed signalling system such as aspect not shown or incorrectly shown or signals being obscured by vegetation.

6.4.1.5 On a Level 1 or Level 2 with signals implementation, if a driver observes a signal at danger ahead and has an ERTMS MA to pass that signal but has not received the additional information associated with a Proceed on Sight Authority (PoSA) route (see section 8.8 of this document), the driver must either stop the train at the signal (if the braking distance is available) or apply the brake immediately (if not enough braking distance is available). Once stopped, the driver must not move until authorised by the signaller.

6.4.2 Drivers Route Knowledge

6.4.2.1 RUs must assess the driver route knowledge and skills requirements for operations on ERTMS fitted lines and include a process in their Competence Management Systems for ensuring that the necessary route knowledge and skills are acquired and retained.

The assessment should consider the impact of drivers being required to operate on a combination of fitted and unfitted lines, or fitted and unfitted trains while the ERTMS implementation is ongoing. Consideration should also be given to route knowledge requirements during degraded ERTMS operation.
6.4.3 Light locomotives and short formation trains

6.4.3.1 In general, there is no need to restrict speeds of ERTMS fitted trains operating under ERTMS supervision to take account of poor braking performance, for example light locomotives and short-formed trains, because the braking capability is taken into account by the ERTMS onboard equipment provided that suitable train data is used.

GN90 The speed of ERTMS fitted trains operating under ERTMS supervision on overlay implementations does not need to be restricted if the train has insufficient braking capability for the conventional signal spacing.

6.4.3.2 Consideration must however be given to the impact of higher speeds on conventional approach locking arrangements (see section 13.6 of this document).

6.4.4 Low adhesion

6.4.4.1 ERTMS provides functionality to assist in the management of low adhesion.

6.4.4.2 The calculated braking characteristics of a train must reflect the train’s actual braking ability taking into account train parameters and anticipated adhesion.

6.4.4.3 The ERTMS low adhesion functionality must not be used, except where an appropriate level of risk analysis has proved that any risks associated with the low adhesion functionality are adequately mitigated on a specific ERTMS application.

GN91 The level of protection (based on the assumed available adhesion) may not be representative of actual conditions and the use of the ERTMS low adhesion functionality may place an over-reliance on the protection when, in some cases, it may be inadequate.

6.4.4.4 Drivers must still be made aware where rail adhesion is reduced and must anticipate the likely effects on the braking performance of the train and control the train accordingly by correctly interpreting information displayed on the ERTMS DMI, including planning information (when available), and braking earlier and braking lighter.

6.4.5 Train stopping location

6.4.5.1 The information provided by the system to facilitate the stopping of the train at a defined point must be presented to the driver in a form that enables the driver to accurately and reliably interpret it prior to being required to respond. This includes both information presented on the ERTMS DMI and supplementary information provided or retained at the lineside in order to support the driver of a fitted train in identifying a required stopping location.

GN92 Stopping locations may include, for example:

a) Any location defined as an EoA, including buffer stops (see section 13.3 of this document).
b) **Platform stopping positions.**

c) **To facilitate “rear end clear”.**

6.4.5.2 Supplementary information provided to facilitate the driver in identifying a required stopping location must be presented in a form that enables the driver to accurately and reliably interpret it prior to being required to respond. Consideration should be given to the readability of the information, and the circumstances when it may be required.

6.4.5.3 On the approach to an EoA the ERTMS system must not present the driver with information on the ERTMS DMI that can be misinterpreted as authority to proceed beyond the EoA.

**GN93** *Where release speeds are used to support drivers being able to closely approach an EoA, it must be considered that the onboard calculation of release speeds can, in certain cases (for example, where there is a long overlap), result in an unacceptably high release speed for some trains which could be misinterpreted by the driver as an extension of the ERTMS MA.*

6.5 **Units of measurement**

**GN94** *ERTMS is designed and operates in metric units of speed and distance measurement. The GB railway uses imperial units for speed and distance information, although there is limited use of metric units.*

**GN95** *A Specific Case in the CCS TSI (RD4) permits the use of imperial units, that is, mph, for the real-time display of speed information on the ERTMS DMI. However, this permission does not extend to the display of distance information (such as the distance range graduations in the planning information or distance-to-go) or the entry of speed or distance related train data, which will be in metric units. GE/RT8402 (RD2) sets out the national requirements for the display of real time imperial speed measurement on the ERTMS DMI.*

**GN96** *In December 2013 the following policy was supported by the ERTMS Systems Body (ESB) (RD33) regarding the speed display units on the ERTMS DMI:*

a) **The default units for speed display on the ERTMS DMI should be km/h on trains operating in Level 0, Level 1 and Level 2.**

b) **The default units for speed display on the ERTMS DMI should be mph on trains operating in Level NTC.**

c) **A packet 44 based function should be implemented to override the default speed unit for each level.**

6.5.1 Any future migration from imperial to metric units of measurement must consider all of the following:

a) **The effect on train journeys, in particular the frequency of changes in units a driver might experience.**

b) **Consistency of units across a signaller’s control area.**
c) The impact on infrastructure maintenance processes and procedures.

**GN97** In several aspects of railway engineering and operation there has been a gradual migration to metric units; it is expected that this will continue. While the rate of migration to metric units might be affected by ERTMS it will largely be dictated by influences external to ERTMS.

6.5.2 Regardless of the ERTMS operating level or mode, the driver must be able to safely and accurately determine the speeds (permissible or restrictions) applicable to the train and the move being undertaken, and to control the train movement within the limits of that speed.

**GN98** When operating with an ERTMS MA, permitted (including restrictions) and current train speed information is presented on the ERTMS DMI. When operating without an ERTMS MA, for example in Level 0 and Level NTC, or in Level 1 or Level 2 in certain degraded situations, only current train speed information is presented and the driver still needs to be supported in determining the appropriate speed to drive at. This could be through the provision of lineside speed signage in units appropriate to the operating level.

6.5.3 A detailed analysis of the route speed profile must be undertaken in order to determine whether there is a need to provide lineside signage for degraded operation. The analysis must consider, as a minimum; the SR ceiling speed, the number of speed restrictions that fall below the SR ceiling speed and the units of measure displayed by the trains with authorised route clearance.

**GN99** The analysis of the route speed profile is normally undertaken as part of the detailed design and is therefore not discussed further in this document.

6.5.4 If degraded mode speed signage is required, speed information presented at the trackside for the purposes of degraded working and that presented on the ERTMS DMI must be in the same units of measurement.

6.5.5 Where users require distance related location information to be indicated at the lineside (for example, milepost/kilometre post), a single unit of distance must be used.

**GN100** The ERTMS DMI is capable of giving geographic position information, in metres, relative to a datum, which, if available can be used to support the signaller and driver in coming to a clear and common understanding of a train's position, provided that there is no confusion about the units of measure and the information is accurate. It is feasible that there will be locations where fitted trains operating on an ERTMS with signals implementation will have imperial lineside location markers to support the operation of unfitted trains.
In May 2013 the following policy was supported by the ERTMS Systems Body (ESB) (RD30); for a Level 2 railway without lineside signals the lineside location used by train drivers, planners, maintenance and emergency staff should be a single system consistent with the ERTMS system, namely metric measurements from a common datum. In order to achieve the policy there should be a plan to provide new signage, systems and documentation in a structured way to support staff involved in the change in accordance with a risk assessed transitional plan.

6.5.6 The system must not require front line staff (for example, signallers, drivers and maintainers) to make manual unit conversions for operational purposes.

6.5.7 When required, the system must be capable of switching to a different system of measurement with minimal impact.

This might be required when the GB railway is completely fitted, or when a discrete part of the GB Railway is completely fitted, with ERTMS Level 2 without lineside signals.
7 Train preparation

7.1 General

7.1.1 The train preparation tasks identified in the following sections must be incorporated into existing train preparation activities, while limiting the overall impact on workload and timings.

GN103 The implementation of ERTMS has the negative potential to increase the time taken to perform current train preparation related tasks due to:

a) Additional onboard equipment that may require visual inspection.

b) The possibility of extending the train preparation time due to additional time being required for ERTMS onboard equipment power up and self-test.

c) Additional in-cab driver activities such as ERTMS data entry.

7.2 Power up

7.2.1 When power is applied to the ERTMS onboard equipment, no manual intervention must be required, and there must be no reliance on the provision of trackside equipment, for the completion of the ERTMS onboard equipment power up routine.

GN105 The ERTMS onboard equipment is powered in the same way as other onboard safety critical systems, with power normally being applied during train preparation duties when the traction unit’s auxiliary circuits are energised.

GN106 When there is no power applied to the ERTMS onboard equipment it is in NP and a continuous emergency brake demand is made.

GN107 When power is applied to the ERTMS onboard equipment it will transition from NP to SB which is the default mode for an active ERTMS onboard equipment.

7.2.2 The ERTMS onboard equipment must indicate the presence of any faults or failures that have been detected during power up (see section 17.2.1 of this document).

7.2.3 Where required, the system design must support the prevention of a fitted train transitioning to a new level if the driver does not possess the necessary competency to drive a train in that level.

GN108 A requirement for this functionality might arise where driver training lags behind the entry into service of an ERTMS overlay scheme, and this cannot be managed adequately through the roster planning processes. This functionality should be achieved without resorting to:

a) Isolation of the onboard assembly.
b) The driver having to manually select or input data. For example, the onboard assembly could include a chip and pin type card reader that reads the driver's ID and competence from the driver's driving licence.

7.3 Visual inspection

7.3.1 The introduction of ERTMS will increase the amount of onboard equipment, both in the cab and on the exterior of the train, some of which may be checked during train preparation, for example:

a) ERTMS DMI.

b) ERTMS isolation switch.

c) Balise antennas

7.4 Commissioning of a driving cab

7.4.1 When the driving desk is opened, the ERTMS DMI must present all of the following information:

a) Mode of operation.

b) The presence of relevant faults that need to be indicated to the driver (see section 17.2.1 of this document).

c) Stored train data (invalid or valid), if available.

GN109 When the ERTMS onboard equipment transitions to SB the change in mode will be indicated on the ERTMS DMI.

GN110 Stored train data will be deleted if the ERTMS onboard equipment transitions to NP, invalidated if the ERTMS onboard equipment transitions to SB or SH, and unaffected by a transition to any other operating mode. If no train data is available, train data may need to be entered during the start of mission process. Invalid data may need to be revalidated during the start of mission process (see section 7.5 of this document).

7.5 ERTMS system data

7.5.1 General

7.5.1.1 ERTMS is a data-driven system. The ERTMS trackside equipment and the ERTMS onboard equipment are able to perform checks that the transmission process has not corrupted data, but they both assume that the basic underlying data is correct.

7.5.1.2 The processes and procedures relating to the gathering and management of ERTMS data must be robust and adequately control the risks associated with incorrect, incompatible or out-of-date data. Consideration must be given to all of the following:

a) System configuration (including national values).

b) Data entry (including amendment).

c) Data validation.

d) System resilience with regard to external threats.
e) Maintenance.

f) Human error.

7.5.1.3 In order to mitigate the risk of errors during data entry, the amount of data required to be manually entered must be minimised and whenever possible preconfigured.

**GN111** This is not only applicable to onboard data entry, but also the manual entry of data into other systems that support ERTMS operations, for example:

a) *Total Operations Processing System (TOPS) or other train configuration applications that provide onboard train data, either directly or indirectly, for entry into the ERTMS onboard equipment.*

b) *Systems for the entry of speed restriction information into the ERTMS system (see section 6.3.6 of this document).*

7.5.1.4 Where a data parameter is common to other systems, then whenever practicable it must be possible for the data to be entered through a single interface and shared automatically among those systems, thus only requiring it to be entered or revalidated once.

**GN112** *Systems that utilise common data parameters might include GSM-R voice, ERTMS, DAS and ATO systems.*

7.5.1.5 Any update to common data parameters must not result in an operational or safety critical inconsistency in common data stored or used by other systems, both onboard and trackside.

7.5.1.6 If there is a need for pre-existing data to be amended, then this should be achieved automatically (whenever possible).

7.5.1.7 When there is a need to manually enter data, then it must be possible for it to be achieved safely and efficiently.

7.5.2 **ERTMS onboard data**

7.5.2.1 The ERTMS onboard data will include:

a) Train category(ies) (see section 6.3 of this document).

b) Train length.

c) Traction/brake parameters.

d) Maximum train speed.

e) Loading gauge

f) Axle load category.

g) Traction system(s) accepted by the engine.

h) Train fitted with airtight system.

i) List of national systems available onboard.

j) Axle number
k) Train running number (see section 7.6 of this document).
l) Driver ID (see section 7.5.3 of this document).

Onboard data items may be preconfigured onboard, or received from other ERTMS/ETCS external sources (for example from the train interface). The driver will not be involved in the entry, modification or validation of the following onboard data items:

a) Traction system(s) accepted by the engine.
b) List of national systems available onboard.
c) Axle number.

7.5.2.2 The preparation and provision of data for onboard configuration and data entry purposes, and the onboard configuration and data entry processes, must adequately manage the hazards associated with incorrect or inaccurate data being utilised by the onboard system.

This includes the preparation and provision of data for onboard data entry prior to the start of a train journey, and when the train consist changes during a journey.

7.5.2.3 Data required to configure the ERTMS onboard equipment must be prepared and input with the minimum manual intervention being required. Ideally, data should be made available to the ERTMS onboard equipment automatically to a suitable level of integrity with the driver only being required to validate.

7.5.2.4 The integrity of the ERTMS supervision functions is dependent on the accuracy of the entered ERTMS onboard data. Therefore, any changes to train consist or operating characteristics (for example brake isolations) must be accurately reflected in the train data for ERTMS operations.

In addition the ERTMS onboard data may include data relating to STMs where one is provided (see section 3.3.11 of this document).

7.5.2.5 The braking and other parameters entered into and used by the ERTMS onboard system in the calculation of braking curves must, as far as is practicable, reflect the actual characteristics of the train to optimise performance.

7.5.2.6 When manual onboard data entry is required, the method by which data is entered into the onboard system must be sufficiently flexible to meet the operational needs of the train.

The ERTMS DMI offers three options for controlling the method of manual onboard data entry available to the driver:

a) Fixed data entry - the driver is only able to select a train type from a number of pre-configured train types.
b) Flexible data entry - the driver has to enter/modify various onboard data parameters in presented input fields.
c) **Switchable data entry - the driver is offered the possibility of switching between fixed and flexible data entry.**

**GN117** Fixed formation passenger trains are expected to only require fixed data entry, with various preconfigured train types allowing for all normal consist permutations and certain degraded permutations to allow for changes to onboard data parameters required by faults or failures on the train, for example a change in braking parameters following the isolation of a train brake.

**GN118** Freight trains are expected to require switchable data entry to allow for greater flexibility in data entry options. So, for example, a driver starting a freight train from a depot will use flexible data entry to accurately define the consist of the train, and subsequently redefine it where necessary during the journey if the consist changes. After uncoupling the locomotive from the train, the driver could switch to fixed data entry to allow selection of a pre-configured set of data suitable for the light locomotive only.

7.5.2.7 When operational incidents occur that require a change to existing ERTMS onboard data (for example, a broken window, or the isolation of train brakes), it will be necessary to enter/select new data through the start of mission procedure.

7.5.2.8 If data is selected from a predefined list (for example, train types), then once the data set has been selected the ERTMS system will not offer any possibility for the user to change any individual value within the selected data set.

7.5.2.9 Train data input is not required to enter SH or NL from start of mission. However, a valid driver ID will be required.

7.5.2.10 It would be desirable for the key parameters that must be considered in assessing whether the load of a train is acceptable for a planned movement to be expressed in the same way for movement over ERTMS fitted and unfitted lines. This would permit the same train formation to be conveyed throughout, although in some instances the maximum speed would require to be restricted on lines without ERTMS.

### 7.5.3 Driver ID

7.5.3.1 The Driver ID parameter must be defined by each RU, as it forms part of the juridical data (see section 3.3.10 of this document) and may be used to confirm the identification of a train driver at a specified time and date.

7.5.3.2 It will be possible for the train driver to enter the Driver ID via the ERTMS DMI. Where the same data is required to be input to other onboard systems, consideration must be given to achieving this via a common interface (for example, an electronic tag or swipe card reader).

7.5.3.3 The Driver ID parameter may consist of an all numeric, alpha, or alphanumeric value, but must not exceed 16 characters in length. This flexibility enables railway undertakings to use an existing number already used to identify train driving personnel within their organisation, for example:
a) Train driver licence number.

b) Employee number.

**GN119** The Driver ID data entry field on the ERTMS DMI consists of two lines. Each line is capable of displaying up to a maximum of eight characters. Therefore, it may be advisable for railway undertakings to limit the length of the Driver ID to a maximum of eight characters in order to prevent it being spread over two lines.

### 7.5.4 Radio Network Identity and RBC Contact Information

7.5.4.1 Information must be available to support the correct selection or entry of GSM-R radio network and/or RBC contact information into the ERTMS onboard equipment where this is required as part of the start of mission process for operations in Level 2.

**GN120** Normal operation in Level 2 requires that the onboard GSM-R data radio be registered with the GSM-R radio network and a communications session be established with the correct RBC. The information necessary to support this is the GSM-radio network identity, and the RBC contact information (RBC identity/phone number).

**GN121** The GSM-R radio network identity information is retained onboard regardless of mode or level transitions, including transitions to NP mode, and is not affected by the detection of cold movement (see section 3.3.14 of this document). Trains hauled dead across a GSM-R radio network boundary (unlikely for operations in GB, but possible for trains crossing country borders) will therefore retain the last GSM-R network information and the driver may be required to select the correct network information when the train is powered and starts.

**GN122** RBC contact information held by the ERTMS onboard equipment is deleted on transition to UN and SN, and may require revalidation following exit from NP subject to cold movement being detected or not (see section 3.3.14 of this document).

### 7.5.5 Data entry at driver handover

7.5.5.1 If another driver takes control of the train in service (that is, driving from the same cab as previously), the new driver's Driver ID must be entered into the ERTMS onboard equipment.

7.5.5.2 The presentation of a new Driver ID will automatically overwrite the existing Driver ID and will form part of the juridical data (see section 3.3.10 of this document) with a time and date stamp.

7.5.5.3 It will not be necessary to re-enter the train data unless the train consist or parameters have changed. However, if the cab is shut down for the purpose of removing the master key at driver handover, train data will need to be revalidated or re-entered. Therefore it may be advantageous to allow drivers to exchange master keys during handover or, to limit the time lag between opening the cab and the ERTMS DMI being available for data entry.
If shutting the cab results in the ERTMS onboard equipment remaining in SB until the new driver takes over, the train data will be retained but will need to be revalidated. However, if the ERTMS onboard equipment enters NP mode the train data will be deleted and the new driver will be required to re-enter the train data.

7.5.5.4 The relieving driver is responsible for checking, and driving in accordance with, the current status of the authority to move (see section 8 of this document).

7.6 Train reporting numbers

Train Reporting Numbers (TRN) are used to differentiate between trains, giving each train its own identity, which can be used for train planning, regulation or communication purposes.

In GB a TRN currently consists of a four digit alphanumeric number (for example, 1L26), which contains three pieces of information:

a) The class of train.

b) An indication of destination and possibly stopping pattern.

c) The Train’s identification or line of route.

TRNs in GB are not unique and can be used more than once within the same 24-hour period. This can result in duplicate TRNs appearing in a signaller’s area of control.

However, as the control areas increase through the introduction of a traffic management layer and much larger signalling control centres, duplicate TRNs may become more operationally problematic. Therefore, it is likely that GB will gradually migrate towards the European all numeric TRN, as these are designed to be unique, thus eradicating the possibility of duplicate TRNs.

The migration towards all numeric TRNs will probably take many years, but might occur during the lifecycle of an ERTMS implementation.

ERTMS is already designed to support all numeric TRNs and must support the continued use of alphanumeric TRNs in GB without the need for manual conversions to be undertaken in real time.

7.7 Cab voice radio registration

The FTN/GSM-R Programme is currently rolling out the GSM-R voice network.

The operational characteristics of the GSM-R voice system are set out in RSSB GSM-R OC UK Application of GSM-R, The Operational Concept (RD9) and are therefore not discussed in detail within this document.

The EIRENE Function Requirements Specification (FRS) (RD13) currently mandates the passing of the TRN from the ERTMS onboard equipment to the GSM-R onboard assembly.
This requirement is not mandated for the purposes of interoperability (category 'MI' in (RD13)) but is mandatory for standardisation.

The intent of this requirement is to simplify data entry from the driver’s perspective, by only requiring the TRN to be entered once via the ERTMS DMI.
8 Train movements

8.1 Authority to Move

8.1.1 In order for an ERTMS fitted train to move it will require an authority to move. An authority to move can be given by one of the following means:

a) An ERTMS MA.

b) Permission to proceed from the controlling signaller or the person controlling the train movement:
   i) To start in SR (with the exception of starting in SR from a signal), or
   ii) To pass an EoA, or
   iii) After a transition to TR, or
   iv) To commence a shunting movement.

c) A trackside signal displaying a proceed aspect.

8.1.2 The normal method of authorising an ERTMS fitted train to move must be through the issuing of an ERTMS MA.

8.1.3 Level 1 ERTMS MAs must permit fitted trains to closely approach and pass signals displaying a proceed aspect in order to read the signal balise group and receive an onwards ERTMS MA.

8.1.4 The way in which an ERTMS MA is transmitted is dependent on the ERTMS application level (see section 4 of this document).

8.1.5 An ERTMS MA must only be issued once the ERTMS system has proved that all of the conditions have been met for the train movement to be made safely (that is, the route has been set, locked and the conditions for a non-permissive or permissive route have been met).

8.1.6 The information contained within an ERTMS MA will include all the necessary data to support the ERTMS onboard equipment in providing continuous speed supervision and protect against overrun of the authorised movement.

8.1.7 The ERTMS onboard equipment will use the data contained within the ERTMS MA to calculate the braking curves and the permitted, warning and intervention speed curves against which the train movement is supervised to limit the risks associated with overspeed and protect the SvL (see section 6.3 of this document).

8.1.8 Information about the ERTMS MA will be displayed on the ERTMS DMI and the driver must control the train in accordance with the information displayed (see section 6.4 of this document).
8.2 Pressing start

8.2.1 General

8.2.1.1 For Level 1 and Level 2 operation, the driver must press start in order to obtain a valid authority to move.

8.2.1.2 Pressing start in Level 1 operation will result in the train entering SR mode.

8.2.1.3 In Level 1 the driver must only move the train forward and over the balise group upon receiving a proceed aspect from the lineside signal ahead. This is so that the ERTMS onboard equipment can receive an ERTMS MA from the balise group.

8.2.1.4 Pressing start in Level 2 operation will initiate a request for a movement authority to the RBC.

8.2.1.5 In the case of two or more trains occupying the same block section and ready to depart in the same direction, an ERTMS MA to leave the block section must only be provided to the train at the departure end of the block section.

8.2.1.6 In the case of two trains occupying the same block section and departing in opposite directions, each train must be capable of receiving an ERTMS MA at the same time.

8.2.1.7 Where a fixed signal is provided at the trackside to control the movements of trains, there must be no need for the driver to check the signal before pressing start.

8.2.1.8 The objective is to run in FS whenever possible, and the system must be designed to achieve this at the earliest opportunity. The train will automatically receive new ERTMS MAs as required, as long as it is safe to provide them. Operation in other modes may be necessary or appropriate, according to the circumstances (see sections 4.3, 8.2.2 and 8.2.3 of this document).

GN135 In Level 2, and in the case of two trains occupying the same section and ready to depart in the same direction, the first driver to press start may receive an ERTMS MA from the RBC. Therefore there is potential for the wrong train (the train not at the departure end of the block section) to receive the available ERTMS MA.

GN136 Where this cannot be achieved technically this can be prevented by requiring that drivers not press start unless the driver can observe, or is otherwise made aware, that the section of line from the front of the train to the next signal or ERTMS stop marker is clear.

8.2.1.8 The objective is to run in FS whenever possible, and the system must be designed to achieve this at the earliest opportunity. The train will automatically receive new ERTMS MAs as required, as long as it is safe to provide them. Operation in other modes may be necessary or appropriate, according to the circumstances (see sections 4.3, 8.2.2 and 8.2.3 of this document).

GN137 The above clause also applies to trains departing depots and sidings into Level 2 areas. Trains which are not able to start with an ERTMS MA have the potential to impact on the timetable.
8.2.1.9 The type of authority given to the train from the RBC when starting is dependent on the validity of the train’s position information (stored by the ERTMS onboard equipment) and the condition of the infrastructure.

**GN138** The validity (or not) of the train position is only relevant to ERTMS Level 2 operations.

8.2.2 Valid position

8.2.2.1 The onboard application must be designed to maximise the circumstances of starting with a valid position.

**GN139** The position will be valid if either the ERTMS onboard equipment has not transitioned to NP, or the ERTMS onboard equipment has transitioned to NP and the cold movement detector reports no movement.

8.2.2.2 If a train reports a valid position, the ERTMS trackside must only issue an ERTMS MA if the reported valid train position can be unambiguously determined by the trackside (see section 13.1 in this document).

**GN140** Onboard train position is determined, and reported, as a distance travelled in a certain direction from a previously read balise group. In areas with points, it may be possible for a valid position relative to a particular balise group to be ambiguous unless the trackside system has access to additional information to allow determination of the line on which a train is located, or additional trackside balises are provided. This is demonstrated in Figure 4 below.
a) Train route to ERTMS stop marker

b) Train reports position to trackside relative to BG

Figure 4  Ambiguous train position

**GN141**  *The trackside could be provided with routing or point position information to allow the position to be determined unambiguously, or additional balise groups could be installed after the points so that the position can be reported unambiguously.*

8.2.2.3 When a route is set, the line ahead is known to be clear and the driver has pressed start, ideally an FS movement authority must be issued.

**GN142**  *ERTMS might be unable to issue an FS MA for the initial movement of a train, as the train requesting the MA is already occupying the track section and the system is unable to determine whether it is the only train in that section. This will mean that the initial movement up to the train detection boundary will be made in OS (see section 5.4 of this document).*
8.2.2.4 The means by which the ERTMS trackside subsystem issues the first FS MA must not, as far as is reasonably practicable, constrain the available acceleration curve of the departure movement.

8.2.3 Invalid/unknown position

8.2.3.1 A train will have an invalid position if the ERTMS onboard equipment has been powered up from NP and no cold movement detection is provided, or cold movement detection indicates that the train has moved, or cold movement detection has become unavailable.

8.2.3.2 The train will have had a valid position immediately prior to powering down, but this cannot be relied upon in the absence of cold movement detection, as the ERTMS onboard equipment cannot determine train movement when unpowered.

8.2.3.3 A train will have an unknown position if it has never had a valid position (for example, after maintenance of the ERTMS onboard equipment) or it had previously had an invalid position and the ERTMS onboard equipment deletes this information in accordance with the start of mission procedure.

8.2.3.4 The RBC must accept a train with an invalid/unknown position and in this case will automatically authorise a mode change to SR (see section 5.5 of this document) when the driver presses start. This automatic change in mode must not be assumed to be authority to move.

8.2.3.5 The authority to move upon receipt of SR might be given as permission to proceed received from the signaller or person controlling the train movement (see section 8.3 of this document), or by the clearing of a signal or lineside indicator showing a proceed aspect (see section 5.5 of this document).

GN143 This means that if the train is awakening in a Level 2 with signals area, the signal may display a proceed aspect, but the initial movement up to the train detection boundary is made in SR. This is equivalent to conventional signalling, as a conventional signal aspect conveys no information about the state of the infrastructure between the train and the signal.

8.2.3.6 Once the train has started to move and has passed over a balise group, it will determine its position and report it to the RBC; two or more balises (which may be co-located in the same group) are required for the train to report its direction. When the RBC is aware of the position and direction it might be able to issue an FS MA that may initially have a short section of running in OS, depending upon the application design.

8.2.3.7 Where trains might regularly start with an invalid position, the system design must facilitate the onboard receiving a valid position at the earliest opportunity.
8.3 Instructions to manage train movement

8.3.1 General

8.3.1.1 There are operational circumstances when a signaller, or person controlling the move, and a driver must communicate to reach a clear understanding of the instructions relating to a specific train movement. This is to manage a potential risk which may be caused by the degradation of the system. Examples of this include:

a) Permission to pass an EoA.
b) Permission to proceed after a trip.
c) Instruction to remain at standstill.
d) Instruction to run under restrictions.
e) Permission to start in SR after preparing a movement.
f) Instructions for the driver to run at caution.
g) Instructions for wrong direction movements.

The common ERTMS term for instructions relating to a specific train movement is ‘written order’. The application and minimum content of written orders are set out in (RD18) and (RD19).

8.3.2 Use of track ahead free function

Track Ahead Free (TAF) is an ERTMS function that allows the RBC to transmit an FS MA from the current position of the train if the driver confirms (by responding to an onboard TAF request) that there is no train/vehicle between the train and the signal or ERTMS stop marker ahead for which an FS MA would be available, where this cannot be automatically determined by the RBC. The TAF function could be applied in areas where trains regularly perform start of mission, or at every EoA to facilitate step up from SR or OS to FS following completion of a degraded mode move.

The use of the TAF function requires further assessment by the ERTMS Programme to determine whether it would be appropriate to include it within the operational design, where it should be applied, and the application rules.

The decision as to whether the TAF function is incorporated within the GB operational design is required to be supported by the wider industry and subject to formal consideration by the relevant industry governance groups, including the Traffic, Operations and Management Standards Committee (TOM SC).

8.4 Data radio coverage

Data radio coverage to support the establishment and maintenance of radio communications necessary for Level 2 operations must be provided.
8.4.2 Providing complete data radio coverage over areas of Level 2 operation may not always be possible, or indeed necessary to support the operations required, and significant financial savings may be possible by restricting coverage on simple, low capacity, lines. Where complete radio coverage is not possible or required, the designed locations of holes in data radio coverage must limit the impact on safety or operational performance.

**GN148 Areas that should be considered as not suitable for planned radio holes include:**

a) Areas where trains normally start in Level 2.
b) Areas where trains operating in Level 2 can normally be brought to a stand.
c) Areas where trains operating in Level 2 normally request ERTMS MA extensions.
d) Transition areas leading into areas of Level 2 operation (including at the exit from depots and yards).
e) Areas where RBC-RBC handover occurs.
f) Areas where co-operative shortening requests may need to be processed.
g) Areas where it is critical for the ERTMS onboard equipment to receive emergency stop commands.
h) In depots and yards where operations are required to be undertaken in Level 2.
i) Areas where moves in Level 2 SH are required to start, for example at the entry to work sites within a possession (see section 16 of this document).
j) Areas where maintenance and testing of data radio equipment are undertaken.

8.4.3 Design radio holes may be included in ERTMS track condition data where required.

**GN149 Depending on the time required to traverse a design radio hole and onboard parameter configuration trains may be brought to a stand in response to a loss of safe radio connection. This can be avoided through announcing design radio holes to the onboard using the radio hole track condition functionality where required.**

8.4.4 When the safe radio connection is lost within an announced radio hole (defined in track condition data), the ERTMS onboard equipment will not attempt to re-establish a safe radio connection until the front of the train reaches the end of the announced radio hole.

8.4.5 When used, the radio hole track condition data must be designed so that the ERTMS onboard equipment is not unnecessarily delayed in attempting to re-establish a safe radio connection.
8.4.6 Train operations in the event of a data radio coverage failure must still be supported.

8.4.7 In the event of a data radio coverage failure, the system must support the automatic re-initiation of data communications at the earliest opportunity.

8.5 Banking, hauling, tandem and multiple working

8.5.1 Banking

8.5.1.1 The implementation of ERTMS must support banking movements where required.

**GN150** Banking movements are performed with a banking locomotive providing additional tractive effort from the rear of a train in one of the following train/banking locomotive configurations:

a) Banking locomotive not coupled to the train at all. Traction and braking of the train and the banking locomotive are controlled by the train and banking locomotive drivers respectively.

b) Banking locomotive mechanically but not pneumatically coupled to the train. Traction and braking of the train and the banking locomotive are controlled by the train and banking locomotive drivers respectively.

c) Banking locomotive mechanically and pneumatically coupled to the train. Traction of the train, and braking of the train and the banking locomotive are controlled by the train driver; banking locomotive traction is controlled by the banking locomotive driver.

8.5.1.2 During the banking movement, the driver of the banking locomotive must obey the instructions of the train driver in respect of when to apply tractive effort.

8.5.1.3 Locations where routine banking movements are required must form part of the trackside design.

**GN151** Operational publications define the locations where routine banking movements are authorised.

8.5.1.4 The limit of routine banking movements must be marked at the trackside to support banking operations in degraded situations.

8.5.1.5 Where the banking locomotive is required to be signalled into an occupied section, the trackside design must support this being achieved through permissive working (see section 11.2 of this document).

8.5.1.6 Once in position for the banking move to be made, and with the necessary couplings and connections to support the move in place, the driver of an ERTMS fitted banking locomotive must select the operating level and/or mode appropriate to the move that meets the following criteria:

a) During the banking move the driver of the banking locomotive must not be required to use the onboard ERTMS override function.
b) During the banking move, any speed supervision in force due to the operating mode of the ERTMS onboard of the banking locomotive must not limit the effectiveness of the tractive effort required from the banking locomotive.

c) The likelihood of a transition to TR mode during a banking move in any operating level or mode other than NL must be no greater than if operating in NL.

d) In normal operation, the banking move must not be made with the banking locomotive in IS to avoid the need for de-isolation before the locomotive can operate under ERTMS supervision.

e) The operating level selected must be supported in the operating area.

As the driver of the banking locomotive is not at the front of the train, it may be difficult to judge when and where the override control should be used. Failure to use the override control, or use of the override control in the wrong place, could result in a transition to TR in the banking locomotive which could cause severe damage to couplings and brake pipe connections. It is also not acceptable for the train driver to be required to advise the banking locomotive driver where and when the override button is to be pressed.

The banking move may be required to be made at a certain speed, and any speed supervision provided by the ERTMS onboard should not prevent adequate assistance being given.

Subject to the above conditions, the banking locomotive could make the banking move in modes NL (if the necessary conditions for NL availability are met, see section 5.10 of this document), SN (with the TPWS onboard temporarily isolated), SR, SH, or UN.

The onboard TPWS system (if provided) on fitted banking locomotives must be inhibited from tripping the locomotive for the duration of the banking move.

If the onboard TPWS system is operative on the banking locomotive then the banking locomotive might be tripped by a TPWS TSS installation due to the train replacing the associated signal. The resulting brake application on the banking locomotive could damage the couplings.

The ERTMS onboard equipment of a banking locomotive might, depending on the operating mode employed for the move, process transition related orders received from the trackside. If the banking move crosses a transition to a Level NTC area the ERTMS onboard equipment might therefore complete the transition to Level NTC and the banking move would continue with an activated AWS/TPWS system (see sections 20 and 21.3.10 of this document).

The system design, and operational rules and procedures must mitigate the risk of the banking locomotive travelling too far.
8.5.1.9 Following completion of the banking movement (which may require decoupling), the driver of the banking locomotive must not move the train, either to proceed in the same direction as the assisted train or to return to the start of the banking move, without authority to do so.

8.5.1.10 Following completion of the banking movement, the system design must support ERTMS fitted banking locomotives making subsequent moves in the highest level of supervision available at the earliest opportunity.

8.5.1.11 The driver of an ERTMS fitted train must amend train data if they are controlling the banking locomotive’s brakes (that is, mechanically and pneumatically coupled), and must be provided with the data necessary for this to be undertaken.

8.5.2 Hauling

8.5.2.1 The implementation of ERTMS must support the following hauling operations:

a) Hauling of a running locomotive both with, and without, an attending driver.

b) Hauling of a dead locomotive (that is, one with all power switched off, and the ERTMS onboard equipment in NP).

GN157 A running locomotive may be hauled to provide Electric Train Supply (ETS).

GN158 For the movement of locomotives in NP, see section 5.17 of this document.

8.5.2.2 When hauling a running ERTMS fitted locomotive the driving desk of the hauled locomotive must be closed and the brake controller isolated.

GN159 For the use of PS to support the hauling of running locomotives, see section 5.7 of this document.

8.5.2.3 Where an ERTMS fitted locomotive is being hauled dead, IS may be used subject to there being provision for a maintenance intervention to be undertaken to de-isolate the ERTMS onboard equipment prior to the hauled locomotive entering service.

8.5.2.4 The train data of an ERTMS fitted leading locomotive must be amended to reflect the correct length and braking characteristics of the train.

8.5.3 Tandem working

8.5.3.1 The implementation of ERTMS must support tandem working.

GN160 Tandem working involves a second locomotive being provided in rear of the leading locomotive which is mechanically and pneumatically coupled but is attended and controlled by a second driver in order to provide additional tractive effort for the train movement. Braking is controlled by the leading driver.

8.5.3.2 The driver of the rear locomotive must select NL before the tandem movement commences (see section 5.10 of this document).
8.5.3.3 The onboard TPWS system (if provided) of the rear locomotive must be inhibited from tripping the locomotive for the duration of the tandem operation.

**GN161** If the onboard TPWS system is operative on the rear locomotive then the rear locomotive will be tripped by a TPWS TSS installation due to the leading locomotive replacing the associated signal. The resulting brake application on the rear locomotive could damage the couplings.

8.5.4 Multiple working

8.5.4.1 Multiple working will be performed with unmanned driving cabs in SL (see section 5.13 of this document).

8.5.4.2 The implementation of ERTMS must support required arrangements for the coupling of multiple units in different configurations.

**GN162** Different coupling configurations might include where multiple units of different classes are required to be coupled, for example class 150 and class 158, or where multiple units are configured in a hybrid form, for example class 150 and class 158 where the unit has three cabs.

8.6 Shunting operations

8.6.1 Shunting movements must be conducted in the highest level of ERTMS supervision available that supports the requirements of the move, or sequence of moves, being made.

8.6.2 SH must only be used when higher levels of supervision do not support the movement, or are not available, or if the move is locally authorised.

8.6.3 Increases in the time taken currently to set up and complete a shunting movement as a result of ERTMS must be minimised.

8.6.4 The implementation of ERTMS must support all shunting operations required at any given location.

8.6.5 Staff involved in shunting operations must be provided with the information necessary to determine the boundaries of areas in which movements in SH are permitted (shunting areas).

8.6.6 Trains operating in SH mode must be prevented from crossing the boundary of a shunting area without authority.

8.6.7 The driver must be provided with clear and unambiguous information with regard to when a shunting movement may commence, how far the movement may proceed and the speed at which the movement can be made.

8.6.8 Where a shunter is involved in the movement, the shunter must be provided with clear and unambiguous information, as to when a shunting movement may commence and how far the movement may proceed.
The provision of clear and unambiguous information to drivers or shunters performing or controlling shunting moves could be via lineside signage, shunting signals, point indicators or other means, or a combination of these.

8.6.9 The signaller must be provided with a control to activate and deactivate shunting areas on the running line.

8.6.10 Shunting areas must not be activated when there is any train that has been routed into, through or out of the shunting area unless special arrangements are in place.

Special arrangements include, but are not limited to, communications between the signaller and the shunter controlling the moves within the shunting area to determine if it safe to signal a train into the shunting area.

8.6.11 When a shunting area is active, the ERTMS system must not allow a train to receive an ERTMS MA into the shunting area unless special arrangements are in place.

8.6.12 The ERTMS system must mitigate the risk of train movements in SH travelling beyond the exit of a defined shunt area. However, this may require a combination of ERTMS and national train control trackside equipment to be provided, as ‘Danger for Shunting’ packets are ignored when operating in Level 0 or NTC (unless accompanied by an immediate level transition order to Levels 1 or 2).

8.6.13 ERTMS is not able to protect a train that is being propelled from travelling beyond the exit of a defined shunting area. This risk must be controlled by operational rules and procedures.

8.6.14 In order to facilitate shunting movements within a possession, it must be possible to operate in SH mode at any location on the rail network (see sections 16.5 and 16.6 of this document).

8.7 Depot and siding operations

8.7.1 General

8.7.1.1 The implementation of ERTMS must support all required train moves into, out of, within and through depots and sidings safely and efficiently.

There may be instances where depot and siding operations are required to be performed with unfitted locomotives, possibly even where movements of unfitted locomotives normally confined to the depot or siding, for example industrial or shunting locomotives, are required to be supported on the main line. The implementation of ERTMS should consider the requirements for moves of this nature and provide a suitable means to support them (see section 12.2 of this document).

8.7.1.2 The implementation of ERTMS must support the standardisation of depot and sidings operations across the network as far as is practicable.
There is currently a wide variety of depot and siding layouts with varying levels of train control and associated methods of operation. The implementation of ERTMS provides an opportunity to reduce the number of unique and specialised methods of operation currently in use to manage movements involving depots and sidings. However it is expected that a limited number of bespoke depot or siding configurations and operating methods may still have to be supported, especially where there is little or no business or performance benefit in changing the method of train control.

Depot or siding moves could therefore be conducted:

a) With an ERTMS MA (see sections 5.2 and 5.4), or
b) In SH (see sections 5.6 and 8.6), or
c) In SR (see section 5.5), or
d) In SN (see section 5.18), or
e) In UN (See section 5.8), or
f) in IS (see section 5.9), and
g) Could involve manual or running level transitions (see section 21 of this document).

The operating modes used for the entry to, exit from, and moves within and through depots and sidings must keep to a minimum the number of times a driver will be required to re-enter train data (see section 7.5 of this document).

In normal operation, the arrangements for entering a depot or siding must not impose any additional performance constraints on the timetable or on other train movements within the depot or siding, and, where reasonably practicable should improve performance, compared with the current method of operation.

The term timetable includes the timing margins and point to point timings upon which the timetable is based.

Where possible, the implementation of ERTMS must ensure that a train entering a depot or siding transitions to an operating level and/or mode appropriate to the method of operation within the depot or siding before or at the entry point and without requiring manual level and/or mode selection by the driver.

A train must exit the depot or siding in an operating level supported by the line onto which it is entering.

This means, for example, that:
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a) A fitted train exiting a depot or siding onto ERTMS unfitted infrastructure should be in Level NTC.

b) A fitted train exiting a depot or siding onto an ERTMS with signals line could be in either Level NTC, Level 1 or Level 2.

c) A fitted train leaving a depot or siding onto an ERTMS without signals line should be in Level 2 unless arrangements are in place to control and protect the move being made in a lower level. These arrangements may be required, for example, where a depot is operated in Level NTC, and the train is performing a head shunt on the main line.

d) An unfitted train leaving a depot or siding onto an ERTMS without signals line (for example, an industrial locomotive or a shunting locomotive), may only do so if arrangements are in place to control and protect the move.

GN170 Depending on the reason for, and extent of, the move out of a depot or siding by an unfitted train, or fitted train operating in Level NTC, and subsequent operation on the ERTMS without signals line, the arrangements might include:

a) The provision of conventional signals, signage or indicators, and/or Class B protection.

b) The procedural control of the move, for example under the control of a shunter.

c) Hauling by a fitted locomotive.

8.7.3.2 In normal operation, the arrangements for exiting a depot or siding onto the running line must not impose any performance constraints on the timetable or on other train movements into, within, or out of the depot or siding, and, where reasonably practicable, should reduce performance constraints, compared with the current method of operation.

GN171 Careful consideration should be given to how trains are required to exit a depot or siding and the potential impact of ERTMS on timings given the additional activities that may be required, and the length of track that may be required for those activities to be done automatically. Therefore, where multiple trains are required to leave a depot in quick succession onto a Level 2 without signals line, the system design could support the simultaneous entry of multiple trains into Level 2 while still within the depot instead of implementing a running transition to Level 2 on the exit road, assuming there is space to do this, to manage the risk of a train failing to transition successfully and the subsequent impact on other trains still needing to leave the depot.

8.7.3.3 Train Ready to Start (TRTS) functionality must be provided where operationally required.

GN172 TRTS functionality is currently used for informing the signaller, or automatic route setting (ARS) system, that a train is ready to depart from a depot or siding.
8.7.3.4 Suitable protection must be provided to mitigate the risks associated with a train exceeding the authority for the move when exiting a depot or siding without an ERTMS MA.

8.7.3.5 Before a train leaves a depot or siding for operations on the main line, the consist of the train must have been accurately assessed, and the necessary ERTMS data must be available to allow the configuration of the ERTMS onboard equipment (see section 7.5 of this document).

8.7.4 Moves within a depot or siding

8.7.4.1 The operational level and mode (or modes) employed for a move within a depot or siding must not impose any unacceptable or additional performance constraints on the move or sequence of moves being undertaken.

GN173 Unacceptable or additional performance constraints could be introduced by:

a) Mode related limitations on the direction of movement (see section 6.1 of this document). Using certain modes, for example FS, OS, or SR, could result in repeated changes in driving cab being required to complete a sequence of shunting moves.

b) Additional ERTMS related activities, such as data entry, establishing a communications session etc., that are required on a fitted train before operations in certain operating levels and/or modes are possible.

c) Mode related speed restrictions, defined either by a national value or by the trackside, to which the train speed is supervised (see section 6.3.8 of this document). This is listed here as a possible constraint for completeness only as it is considered unlikely that mode related speed restrictions would actually constrain moves within a depot or siding due to the low speed at which these moves are usually conducted.

8.7.4.2 Suitable protection must be provided to prevent moves within a depot or siding from exiting onto the running line without authority.

GN174 Depending on the operating levels and modes employed for moves within the depot, this may be achieved through trapping, conventional Class B train protection systems or ERTMS functionality.

8.8 Proceed On Sight Authority

8.8.1 The implementation of ERTMS must provide an ERTMS equivalent to conventional PoSA operation where required.

GN175 Conventional PoSA operation relies on the provision within the interlocking for a PoSA route to be set in specified degraded situations that would normally prevent the clearing of a signal. Setting the PoSA route illuminates a specific signal aspect (PoSA aspect) associated with a stop signal if the necessary interlocking conditions are met.
An ERTMS equivalent to the conventional PoSA functionality is a common feature of European ERTMS implementations and is referred to as an 'on-sight route'. For the purposes of this section the term PoSA route will be used to describe this functionality.

8.8.2 Fitted trains must be authorised to enter a PoSA route via an ERTMS MA and in a mode appropriate to the trackside failure that resulted in the PoSA route being set, and the impact of that failure on ERTMS operations.

Different failure types place varying operational requirements on drivers of fitted trains in terms of changes in driving behaviour, and these changes in behaviour should be triggered through the ERTMS modes used for the move:

a) A train detection section that has failed to clear or shows occupied for some other reason within the route impacts directly on fitted train operations in that the driver of a fitted train would still be expected to proceed at caution and be prepared to stop short of any train, vehicle or obstruction - this is consistent with operations in OS mode.

b) Other trackside failures, such as TPWS failures or failure of a main aspect, that hold a previous signal at danger do not impact directly on ERTMS operations (except in regard to the presentation of a red aspect to the driver) and drivers of fitted trains may not be expected to do anything other than drive to the information on the ERTMS DMI. For a failure of this nature, it might be appropriate to traverse the PoSA route in FS.

8.8.3 When a PoSA route is set from a route setting point, the ERTMS system must provide information to the driver that the ERTMS MA authorising movements past the route setting point is for a PoSA route.

8.8.4 The PoSA information must be unambiguous, operationally meaningful, and presented in a manner consistent with the normal method of signalling.

This could take the form of a text message, point to point voice message or broadcast call etc.

8.8.5 The speed of fitted trains approaching a route setting point from which a PoSA route has been set must be controlled appropriately for the mode of operation to be employed for movement over the PoSA route.

8.9 Train Disposal

8.9.1 Drivers of fitted trains ending their journey and not carrying out further operational moves such as coupling or uncoupling with another vehicle, must close the driving desk as soon as possible to release GSM-R data communication channels.

Closing the driving desk causes the ERTMS onboard equipment to automatically initiate the termination of any communication session that is established with an RBC.
9 Train dispatch

9.1 General

The concepts outlined below are appropriate for the dispatch of passenger trains, including those running as empty coaching stock, from station platforms, involving driver only operation (DOO) as well as dispatch involving guards and/or platform staff. The concepts are informed by the Train Dispatch Workshop held on 17 June 2013 attended by Network Rail, RSSB, ATOC and operators directly involved in train dispatch.

The concepts described below are not relevant to the "dispatch" of freight or passenger trains from depots. Concepts related to the "dispatch" of freight or passenger trains from depots are covered in sections 7 and 8.7 of this document.

9.1.1 Train dispatch under ERTMS must not introduce unacceptable delays into the train dispatch process.

9.1.2 The National ERTMS Programme must consider how the ERTMS system could effectively mitigate the risk that is represented at the interface between a train that has been dispatched, but has not yet departed the platform. The analysis should consider the wider context with regard to the interface risk between the train and platform (for example, a person falling between the train and platform, persons trapped in train doors, or a person falling from the platform onto the track etc.), and other non ERTMS measures (for example GSM-R Railway Emergency Group Call), with a view to determining the most appropriate means of reducing risk to an acceptable level.

9.2 ERTMS without lineside signals

9.2.1 If TRTS functionality is currently used for informing the signaller or ARS system then this functionality must be available under future ERTMS operations. If determined to be operationally necessary in future implementations, TRTS functionality must be made available.

TRTS is normally used to indicate that appropriate staff are on board the train and ready to start dispatch procedures so that a route can be set. TRTS can be initiated by platform or train staff. ERTMS introduces the potential use of onboard functionality to be used as TRTS in conjunction with other information. This functionality should be investigated to determine if it brings suitable benefits.

9.2.2 Before the dispatch process is started, train dispatch staff must know with an acceptable degree of confidence that the train has authority, either as an ERTMS MA or as permission to proceed from the signaller, to leave the platform.
Communicating the information that the train has authority to depart to train dispatch staff serves several purposes. It is a ‘trigger’ which (in conjunction with the timetable) informs the dispatch staff that it is appropriate to begin the dispatch procedure. It also reduces the likelihood of the train being dispatched without authority to leave the platform.

This information could be communicated via a number of different technologies or procedures and it is likely that different procedures will be appropriate to different types of line, stations, and trains (or the method of operation of trains). At major termini, and other busy stations where trains can be regularly held without an ERTMS MA, and where guards or platform staff are actively involved with train dispatch, the information could be provided via a trackside indication (similar, for example, to an OFF indicator). On rural or single track routes, it is permissible for the availability of authority to move to be communicated by enhanced use of the bell buzzer code between the driver and guard where required. For DOO, the driver will be aware of the availability of an ERTMS MA or permission to proceed from indications on the ERTMS DMI or via instructions from the signaller. In degraded situations where an ERTMS MA cannot be given, it may be acceptable for the information to be passed between the driver and platform staff verbally.

The person responsible for closing train doors must be provided with the information necessary to determine that it is safe and appropriate to close the doors.

This information could be provided through the use of Close Door (CD) indicators, bell-buzzer codes or handsignals, and, where required by the driver, should be available at the normal driving position.

The driver must be provided with the means to identify that the station work is complete and it is safe for the train to depart.

Station work includes checking, by the responsible person/s, that passengers are safely onboard and train doors are properly closed and nothing is trapped in the doors, and there are no other impediments to starting the train safely.

This information could be provided to the driver through the use of Right Away (RA) indicators, bell-buzzer codes or handsignals, and should be available to the driver at the normal driving position.

ERTMS with lineside signals

Dispatch facilities and procedures for ERTMS with signals applications (for a mixture of fitted and unfitted trains) should remain unchanged from existing conventional arrangements if this is the most appropriate manner to manage a mixture of traffic.
10 **Train routing**

**GN188** A fundamental operating principle as defined in the Operational Concept for the GB Mainline Railway (RD21) is that ‘trains must only be allowed to operate over any portion of line as long as the rolling stock is compatible with the infrastructure on that portion of line’.

**GN189** In some cases, the risks arising from incompatibility with the infrastructure can be mitigated by applying special conditions of travel to a train, such as a reduction in permitted speed or reducing the gross weight of a freight wagon.

**GN190** On the conventional railway, routing information provides information to the driver about the route set, this supports the driver in determining:

a) The appropriate speed for the route.

b) If the train has been correctly routed.

**GN191** If the train has been incorrectly routed then:

a) It may not be technically compatible with the infrastructure.

b) The driver may not hold the necessary competency (route knowledge) to operate over the route.

c) The train may not be able to complete the planned journey correctly that is, the train may be routed to an incorrect destination or to the correct destination but via a route that does not permit stopping at planned stations.

10.1 In degraded conditions, the signaller must provide instructions to the driver in relation to the route set and speed unless this information is provided from another source.

**GN192** ERTMS cannot adequately be used to prevent trains entering an incorrectly set route. The route suitability function relies on train parameters which are not appropriate for the GB railway, and is expected to be removed from future versions of the ERTMS specifications. The ERTMS system does not currently include a traffic management layer and can therefore not solely manage train routing.

10.2 Routing of trains must be managed on an ERTMS railway by another system (for example, traffic management) so that a train is only routed so that:

a) Technical compatibility with the infrastructure can be achieved (for example, traction type, gauge, weight, signalling system, platform length).

b) The planned journey can be achieved (for example, the train can stop at its booked station/s or destination.

c) The driver is competent for the specific route.

10.3 The implementation of ERTMS must continue to manage the safety and performance of incorrectly routed trains.
10.4 If the other system (for example, traffic management) cannot be demonstrated to be wholly reliable or is not implemented prior to the operation of ERTMS then a form of routing information must be provided to the driver at the following locations:

a) Where a train if incorrectly routed could cause technical incompatibility between the rolling stock and the infrastructure (for example, traction type, gauge, weight, signalling system, platform length).

b) Where it is essential for a train to be correctly routed so that it can stop at its booked station(s) or destination.

In normal operation in Levels 1 and 2, ERTMS provides speed supervision functionality; therefore it is not necessary to provide routing information just for the purpose of determining the appropriate speed.
11 Working track sections not known to be clear

11.1 General

11.1.1 Trains must only be authorised to enter track sections not known to be clear when there is a particular operational need, for example:

a) For a permissive move.
b) In the event of train detection failure.
c) When assisting a failed train.
d) Moves onto undetected infrastructure (such as sidings).

11.2 Permissive working where authorised by operational publications

11.2.1 Permissive working is where national operational rules permit sharing of signalling block sections. Where permissive working is normally required, the implementation of ERTMS must continue to support this.

11.2.2 Areas where permissive working is permitted must be defined in operational publications.

11.2.3 A train (second train) must not be permitted to enter a track section occupied by another train (first train) unless it is known that the first train will remain at a standstill.

**GN194** This may be achieved technically through the application design or through the national operational rules.

11.2.4 Permissively worked sections must be kept as short as reasonably practicable.

11.2.5 Transitions to OS must occur as late as is practicable and do not need to commence at the start of a movement. The transition to OS can occur within a conventionally signalled permissively-worked section, it need not be coincident with the signal controlling entry into the section, that is:

a) If a train (second train) is to enter a route where permissive working is authorised and the interlocking conditions are met, the system can offer the driver an FS MA for the section of the route (train detection section or sections) which has been proven to be clear.

b) As the second train approaches the end of the route (train detection section or sections) that has been proven to be clear, the system then offers the driver a change of mode to OS (see section 5.4 of this document).

**GN195** This means that a conventional signal may display a call-on route but a fitted train may pass it with an FS MA, changing to OS at some stage after having passed the signal; the transition to OS need not be at the signal itself.

**GN196** The location where the transition to OS occurs should not lead to the driver being distracted when attention should be focussed on stopping short of an obstruction.
11.2.6 Where a fitted train approaching the start of a permissive route is already in OS, it is permissible for the train to continue in OS for the full extent of the permissive route, including over the section of the route that has been proved to be clear.

11.2.7 If the system is unable to offer a FS MA or change of mode to OS, then the train movement must be undertaken in SR (see section 5.5 of this document).

11.3 **Emergency permissive working**

11.3.1 The implementation of ERTMS must not prevent a train entering an occupied section where permissive working is not provided, in order to facilitate the detraining of passengers in an emergency.

11.3.2 The operational rules must define how and when the signaller advises the driver of the situation before authorising the move.

11.4 **Movements when an ERTMS MA cannot be given**

11.4.1 When an ERTMS MA cannot be given, SR can be sent to a train, or the driver can select override which will initiate a transition to SR (see section 5.5 of this document).
12 Operation of unfitted trains

12.1 Operation of unfitted trains on ERTMS with lineside signals applications

12.1.1 All movements of unfitted trains must continue to operate and comply with the current national operating rules and signalling regulations for the route concerned.

12.1.2 Personnel involved in the operation of unfitted trains, and whose role does not cause them to become involved in the operation of ERTMS fitted trains, must not require any additional competence to continue operating the same unfitted trains over the same infrastructure after ERTMS has been implemented.

12.1.3 Where this is not possible, personnel must understand the operating characteristics of an ERTMS with lineside signals application; particularly where there is a divergence from the operating characteristics associated with conventionally signalled trains.

12.1.4 Personnel may need to be educated with regard to any divergence from conventional operating characteristics in order to avoid unnecessary confusion, which would otherwise lead to an increase in the number of reports received concerning signalling irregularities.

12.2 Operation of unfitted trains on ERTMS without lineside signals application

12.2.1 Where required, a means must be provided to support the limited operation of unfitted trains in areas where the ERTMS implementation is nominally one without lineside signals.

**GN197** It is recognised that one option for supporting these limited moves is the local provision of a small number of lineside signals, and that this effectively results in a small ERTMS with lineside signals ‘island’ within a larger ERTMS without lineside signals area.

**GN198** Movements by unfitted locomotives on ERTMS without signals implementation are to be avoided as far as possible, but there may be some situations where it is necessary to support certain limited operations procedurally, because it is uneconomic or physically or technically not possible to fit a locomotive with ERTMS. Moves by unfitted trains might, for example, be required to facilitate moves out of, into, and between depots and sidings (including private sidings) by unfitted shunting or industrial locomotives (see section 8.7 of this document). While certain moves may be supported by hauling the unfitted locomotive with a fitted locomotive (see section 8.5.2 of this document), other moves such as using the main line as a headshunt may need to be completed by the unfitted locomotive alone.
13 Signalling principles

13.1 Route setting and movement authorities

13.1.1 When a route has been successfully requested, there must be no further input from the signaller or automatic route setting equipment to issue an ERTMS MA under normal operating conditions.

13.1.2 Once the route is requested and open, the appropriate ERTMS MA will be sent to a train providing that any other relevant conditions are met.

Other relevant conditions include, but are not limited to:

a) The ERTMS operating mode of the train.

b) The status of the ERTMS onboard train position (see sections 8.2.2 and 8.2.3 of this document).

c) The type of route set.

13.2 Approach control

Because ERTMS is a speed supervision system, there is no requirement for approach control functionality for trains with an ERTMS MA. In ERTMS Level 2 with signals areas, ideally approach control should not be used when the route is set for an ERTMS fitted train.

The application of approach control has implications on train performance, in particular for freight trains. The removal of approach control functionality through the application of ERTMS is expected to support reductions in timing margins, brake wear and fuel consumption.

Requirements for approach control for unfitted trains are unaffected by ERTMS.

If approach control from red is provided on ERTMS Level 2 with signals lines, the ERTMS MA must only be extended once the approach controlled signal shows a proceed aspect.

If approach control from yellow is provided on ERTMS Level 2 with signals lines, there are no specific requirements relating to an ERTMS MA beyond the signal.

13.3 Marking an end of authority

The minimum requirements for marking locations designated as EoA are:

a) EoAs that protect a fouling point must be marked at the lineside to provide a marked location from which an authority for a train to go beyond the fouling point can be given.

b) EoAs that have associated release speeds must be marked at the lineside to provide a stop location for a driver.
c) EoAs must be marked to provide reasonable capacity during degraded mode operations (in degraded operation, capacity is constrained to a maximum of one train between each ERTMS stop marker or signal).

d) EoAs that mark the limits of routine banking operations (see section 8.5.1 of this document).

e) EoAs where TAF is used (see section 8.3.2 of this document).

f) EoAs used as the entrance and exit of possessions (see section 16.4 of this document).

g) EoAs that are approached and supervised with the ERTMS onboard equipment in OS.

GN204 The latter is due to the limited availability of speed supervision and distance to go data on the ERTMS DMI when the onboard is in OS. Marking these EoAs reduces the risk of drivers being led into a "trip trap".

13.3.2 Drivers must be provided with information so they can identify the EoA the train is stopped at, and signallers must be able to correlate the driver's reported position with a track location.

GN205 This could be supported through marking the EoA (ERTMS stop markers will be clearly and unambiguously identified to enable the driver to refer to a specific ERTMS stop marker (see (RD29)), or through other means such as geographic position information (See section 6.5 of this document), or other lineside information, for example kilometre posts or OLE stanchion IDs. To correlate the reported position, signallers need to be able to determine both the position of the train along the track and the actual line the train is on.

13.3.3 The design of an ERTMS stop marker will conform to the requirements set out in (RD29).

13.3.4 An ERTMS stop marker must be sighted so that, in situations where it is required to be used by the driver, it can be observed and the train braked to a stand at the location concerned from the highest attainable approach speed.

GN206 In determining the highest attainable speed, consideration should be given to both degraded mode speeds and available release speeds at the location concerned.

13.3.5 Subject to the minimum requirements for marking EoA locations, if there is a hazard of drivers misreading ERTMS stop markers on adjacent lines, then ERTMS stop markers for each line must be co-located.

GN207 Co-location of ERTMS stop markers with ERTMS stop markers or signals on adjacent lines should also be considered where access to 'common' lineside equipment or infrastructure, for example lineside telephones or walking routes, is required.
13.3.6 If an EoA is marked with a signal, conventional signalling rules must apply for unfitted trains on the route, including sighting and braking distance requirements, and aspect sequences.

GN208 If an EoA is marked with a signal there is no need to provide an ERTMS stop marker as the signal fulfils this purpose.

GN209 It is permissible to provide ERTMS stop markers on one track in one direction and signals on the same track in the opposite direction, especially if this is a cost-effective means of providing bi-directional functionality.

13.4 Aspect sequences

13.4.1 Where existing signals are retained, the application of ERTMS must not change the aspect sequences presented to drivers of unfitted trains.

13.4.2 New applications of ERTMS with signals must provide compliant aspect sequences to drivers.

13.4.2 Divergence between lineside signal and ERTMS information

13.4.2.1 ERTMS must be designed and implemented to minimise the duration of divergent signalling indications. Any residual divergence must be managed.

GN210 Information on the ERTMS DMI can diverge from that available at the lineside, even under normal operating conditions. The integrity of the signalled route is unaffected, because this is controlled by the interlocking for both lineside signals (where fitted) and ERTMS MAs.

GN211 Reasons for divergence include:

a) Inherent differences in delays between the interlocking and a signal aspect (where fitted) to those between the interlocking and the display of an ERTMS MA can cause an apparent momentary divergence.

b) Train awakening situations where the ERTMS trackside equipment is unable to update the ERTMS MA until it receives a valid position report from the ERTMS onboard equipment.

c) Lack of information updates from one of the signalling sources. In general, previously received information continues to be valid until new information is received. This represents the previous signal having been passed and the next one not yet being visible. In ERTMS this represents the previously received information continuing to be presented on the ERTMS DMI pending receipt of new information.
d) In degraded situations, such as equipment failures and operating emergencies, the likelihood and significance of divergences may increase. Examples of scenarios include; signals reverting to danger because of a right side signalling failure, the signaller replacing the signals in error, signals automatically reverting to danger in an emergency because of a wrong side event (such as a train overrunning protecting signals), the signaller replacing the signals to protect an unsafe event (such as for an obstruction on the line).

13.5 Signalling sections

GN212 Signalling sections for trains operating with an ERTMS MA (on ERTMS fitted lines with and without lineside signals) can be shorter than would be possible if conventional signal spacing was applied.

GN213 The implementation of ERTMS can support improvements in capacity / throughput on sections of route with mixed traffic speed and type over that possible with conventional signalling. Conventional signal spacing is designed to provide for the highest speed user of the line concerned, so use by slower speed trains gives sub-optimal headway and throughput. Under ERTMS operation, shorter length signalling sections reduce the distance separation between slower moving trains while continuing to cater for faster traffic too.

GN214 On ERTMS with signals implementations, where there are more signalling sections available for trains operating with an ERTMS MA than for a conventionally signalled train, these shorter sections are referred to as 'ERTMS intermediate block sections'.

GN215 ERTMS intermediate block sections provide an opportunity to increase the performance and/or capacity of an ERTMS with signals line for fitted trains when compared to conventional signalling sections. Actual provision will need to be determined by cost-benefit analysis.

GN216 Requirements for marking an EoA, including those for ERTMS intermediate block sections are covered in section 13.3 of this document.

13.5.1 ERTMS intermediate block sections must only be used to signal fitted trains with an ERTMS MA.

13.5.2 If a fitted train can be given an ERTMS MA into an ERTMS Intermediate block section then where entry to the ERTMS Intermediate block section is controlled by a signal, it must display a proceed aspect.

13.6 Approach locking

13.6.1 Applying approach locking

13.6.1.1 A route must be approach locked before a MA can be issued.

GN217 The requirement for approach locking for unfitted trains on lines equipped with lineside signals is unaffected by the application of ERTMS.
13.6.1.2 On lines equipped with lineside signals, approach locking for the route ahead must still be applied for fitted trains when an ERTMS MA cannot be given for the route ahead.

**GN218** Where instead of a movement authority permission to proceed is granted, ideally approach locking should be applied.

**GN219** It is acceptable to apply operational rules if a technical means for achieving this is not available.

13.6.2 Approach locking release

13.6.2.1 Approach locking must only be released for a fitted train when one of the following conditions is met:

- a) Assurance has been obtained that the train that held an ERTMS MA for the route has entered the route.
- b) Assurance has been obtained that any approaching train can or has stopped on the approach to the route and the train has no ERTMS MA for the remainder of the route (see section 13.10 of this document).

13.7 Route locking

13.7.1 Applying route locking

13.7.1.1 Route locking must be applied once the route has been set.

13.7.2 Route locking release initiation

**GN220** Route locking release may be initiated by either:

- a) The signaller cancelling the route.
- b) Train Operated Route Release (TORR) conditions being satisfied.

**GN221** Route locking release can only occur once approach locking is released.

13.7.3 Route release failure management

13.7.3.1 Functionality must be provided to enable the release of a route during all credible ERTMS failure conditions.

**GN222** If the ERTMS MA forms part of the route locking, there may be failure situations where the ERTMS MA locking element cannot be released automatically and an alternative means to force route release in a safe and controlled manner should be provided.

13.7.4 Sectional route locking

13.7.4.1 Sectional route locking release must be provided to allow a new route to be set from a route setting point in rear as soon as possible that is, the full route does not remain locked until the train has stopped at the EoA or passed into the next route.

13.7.4.2 When the train enters the route, sectional route locking must be maintained in front of the train for the remainder of the route.
13.8 Loss of proving

13.8.1 With lineside signalling momentary loss of any element of the aspect level controls can result in the change of a signal aspect, but often this will not be observed as the driver may not be looking at the signal at that instance or inherent delays in the signalling system, including the lamp filament, may mean that it is not perceptible. Usually the signal will return to its intended aspect after the momentary change.

**GN223** With ERTMS, it is possible that momentary loss of proving could cause an immediate shortening of a train’s MA and possible intervention or trip.

13.8.2 The trackside design must minimise the likelihood of shortening of MAs if momentary loss of proving occurs. An MA must only be shortened when a loss of proving has been sustained over a suitably predefined period.

13.8.3 Operationally, the period must be long enough to filter out erroneous loss of proving events, but short enough so that "ignoring" an actual loss of proving for the period does not introduce any unacceptable risk.

13.8.4 There must be no operational impact from the consequences of timing differences between the reported position of the train and the detected position of the train, for example as a result of a loss of proving due to a train occupying a replacement track section that it is authorised to enter.

**GN224** This requirement is also applicable in situations where the location of the Eurobalise antennae in relation to the “front” of a train may be temporarily made non-compliant with the requirements in Subset-040 (RD23), for example when coupled to an independent snow plough or officer’s saloon.

13.9 Movement authority timers

13.9.1 There are a number of timers (section, overlap, LoA) associated with MAs where appropriate values have yet to be established. Suitable values must be established by the IM on a scheme specific basis.

13.10 Change of routing or regulation

13.10.1 The signaller must be provided with a means to initiate the cancellation of a route.

13.10.2 Any change in regulation must be done in a manner so that it does not cause a train to brake immediately.

**GN225** For ERTMS without signals lines this could use a handshake between RBC and interlocking such that the interlocking knows when any movement authority into the route has been known (beyond reasonable doubt) to be revoked.

**GN226** The cooperative shortening function can be used to enable the signaller to regulate an ERTMS fitted train with an ERTMS MA.

13.10.3 Within a Level 1 area, the conventional rules for changing the regulation must continue to be applied.
13.11 **Flank protection**

**GN227** Because ERTMS provides speed and distance supervision, the risk of overrun is expected to be reduced, therefore the need for flank protection for trains operating with an ERTMS MA might be reduced, possibly to nil.

13.11.1 Various factors may influence the risk of overrun, including trains operating without an ERTMS MA or where the supervision provided by ERTMS is not providing the necessary protection, for example in low rail adhesion areas, or when incorrect train data is utilised by the ERTMS onboard equipment. A risk assessment must therefore determine the control measures required to manage overrun risk for all trains on a site-by-site basis.

13.11.2 This risk assessment must consider the expected frequency of overrun and the effectiveness of other control measures that may apply to these trains.

13.11.3 On lines with lineside signals, conventional flank protection arrangements must apply for unfitted trains. Subject to the risk assessment, and considering the potential complexity of implementing differential flank protection, the arrangements may not need to apply to trains operating with an ERTMS MA.

13.12 **RBC boundaries**

13.12.1 In normal operation, there must be no specific action required by the driver at RBC-RBC boundaries.

13.12.2 In normal operation, there must be no degradation in train running performance at RBC-RBC boundaries.

13.12.3 RBC-RBC boundaries must be designed to minimise the operational impact of failure of RBC-RBC handover. This is likely to require an assessment of the operational implications of failure of RBC-RBC handover when designing the location of RBC-RBC boundaries.

**GN228** The assessment should consider the probability of failure of the proposed RBC and/or the possibility to reconfigure automatically the area of the failed RBC to an NTC area.

13.13 **Overlaps**

13.13.1 The swinging of an overlap must not result in any of the following:

a) An onboard warning or intervention.

b) A loss of proving (see section 13.8 of this document).

c) An unsafe discrepancy between the ERTMS onboard supervised location and the track section locked by the interlocking.

d) A driver believing that an ERTMS MA has been extended (See section 6.4.5 of this document).

13.13.2 A facility must be provided for an overlap to be released as soon as it is no longer required at pre-determined locations.
13.13.3 The implementation of ERTMS must not increase the timed release of the interlocking overlaps.

13.14 **Local point release**

13.14.1 Local points release arrangements must only be permitted when no movement with an ERTMS MA can be made that conflicts with any movement that may be made by the operator requesting the release.

13.14.2 Locally released points must be proved normal and locked before any ERTMS MA over them can be issued.

13.15 **Bi-directional running**

13.15.1 The implementation of ERTMS must support the capability for bi-directional running to facilitate operations during, and recovery from, perturbation, and track access.

**GN229** Providing bi-directional running with ERTMS is potentially simpler and cheaper than with conventional signalling, but it is by no means a given. The provision of bi-directional capability will still require appropriate signalling controls, and dedicated “wrong direction” balises supported by validated RBC data, including gradient and speed profiles. To support the operational need, it may not be financially viable, or indeed necessary, to provide full bi-directional capability on all lines. Instead it might be acceptable to provide it on certain lines only, for example on the two fast or the two slow lines in a four track area. It might also be acceptable to provide for simplified bi-directional operation for the wrong direction moves with less signalling sections or simplified or reduced speed profiles, etc. The provision of bi-directional operation, and the level to which it is provided, should therefore be determined by the business benefit gained from improved recovery and additional track access compared against the cost and complexity of the design and whole-life system management.
14 Signalling control

14.1 The role of the signaller

14.1.1 In normal operation, the role of the signaller in an ERTMS area is unlikely to change and will continue to include overseeing safe operation, route setting and the efficient regulation of trains.

14.1.2 In degraded operation, when it is not possible for an ERTMS MA to be issued to a train which is required to move, the signaller must provide permission for the driver to proceed. This includes authorising trains to move following recovery from an ERTMS system failure or transition to TR, or to pass an EoA in the event that an ERTMS MA cannot be issued.

14.1.3 Before providing permission to proceed, the signaller must make sure that the line is safe for the extent of the movement. This includes, but is not limited to:

a) Making sure the portion of line concerned is clear and safe for the movement.

b) The barriers or gates at any interlocked level crossings are closed to road traffic.

c) Facing points are in the required position for the move and will not move; trailing points are in the required position and will not move.

d) Any ground-frame release giving access to the route is ‘normal’ unless it is to be operated for the movement.

14.1.4 When providing permission to proceed, the signaller’s authority is limited to advising the extent of movement, maximum speeds and other information relevant to the nature of the failure and move; it may also be appropriate to instruct the ERTMS mode required. How the train should be driven remains the driver’s responsibility.

14.2 Management of ERTMS failures

14.2.1 A suitable system for reporting and logging signalling control centre system failures and anomalies must be provided.

14.2.2 The fault reporting system must be able to provide information on trackside failures with the ability to identify faults that have the potential for significant impact on safety or performance of the railway.

14.2.3 Trackside failure information must be simple to interpret, unambiguous, and standardised across the network, to facilitate ease of fault reporting and determination of response.

14.3 Functionality provided to the signaller

14.3.1 The signaller must be provided with information and controls that support the safe and efficient management of train movements in their area of control.
The implementation of ERTMS might result in additional signaller interfaces being required that have a direct impact on railway operations and are additional to the functionality normally provided.

14.3.2 On ERTMS with signals implementations the signaller must not be required to make a decision on which signalling control to use or apply in a given situation based on the fitted/unfitted status of a train.

14.3.3 The system design must determine the most effective means of applying the functionality related to specific controls (for example, route cancellation), taking into consideration whether affected trains are fitted with ERTMS or not.

14.3.4 Signaller controls that if used incorrectly could lead to a hazardous event should be designed such that the signaller is required to perform a conscious act, which cannot be achieved accidently, before the associated function is requested.

These controls should require the signaller to make a definite and sustained action, the combination of which allows the signaller time to think and realise an error before the action is taken. On VDU systems this may require the operation of icons followed by entry of a typed command/password or the operation of a sequence of icons within a given period of time.
15 Operation of level crossings

15.1 Level crossing protection improvements

15.1.1 Emergency control

15.1.1.1 The signaller must be provided with an emergency control that when activated is capable of stopping or reducing the train to a slow speed on the approach to a crossing or group of crossings.

**GN233** The activation of the emergency stop control should not cause the train to lose its ERTMS MA, as long as the signalling conditions that led to the ERTMS MA originally being issued still exist.

15.1.1.2 The signaller must be provided with a means to revoke the emergency stop control.

15.1.1.3 Once the signaller has revoked the emergency stop control a train must be able to immediately start its journey again subject to operational procedures and rules.

**GN234** The potential exists to use this control in more circumstances than just emergencies, for example to provide protection for unusual movements over the crossing or to assist in managing rail movements when the crossing is not fully operational.

15.1.2 Whistle boards

15.1.2.1 Where currently implemented, whistle boards must continue to be provided on lines that support the operation of unfitted and fitted trains and their meaning must not be affected by the introduction of ERTMS.

15.1.2.2 Whistle boards must continue to be provided on lines that support the operation of fitted trains only unless an alternative safe means to provide the same information to the driver for all operations over the crossing is available.

15.1.3 Protection and possession arrangements

15.1.3.1 Appropriate controls for the operation of level crossings during ERTMS possessions must be developed. This could include technical and operational controls including the use of stop in SH balises if appropriate.

15.1.4 Bi-directional operations

15.1.4.1 Where the deployment of ERTMS supports bi-directional operations, strike-ins appropriate for each direction at the relevant linespeeds must be provided on all affected level crossings, if not already present.

15.1.4.2 Where the type of crossing requires it, whistle boards for movement in both directions must be provided.
15.2  **Locally monitored crossings (AOCL/ABCL)**

15.2.1 Where the train is not normally required to stop, in the event of the crossing equipment being not proven, the ERTMS onboard equipment must, where required:

a) Inform the driver about the failed status of the crossing.

b) Supervise the train to a stand on the approach to the crossing, and then permit the train to proceed over the crossing at low speed without the need for a change in operating mode.

15.2.2 A safety cost benefit analysis (see (RD28)) does not immediately justify the application of this functionality at all locally monitored crossings where trains are not normally required to stop. Therefore, the adoption of this functionality for a locally monitored crossing is something a project must justify through an appropriate risk based criteria.

15.2.3 AWS is provided in association with the level crossing warning board (for unfitted trains) and an ERTMS text message, sent by balise, must be provided to provide equivalent functionality for a fitted train.

15.2.4 The text message must be acknowledged and failure to do so will stop the train before the crossing. The timing of the message must be such that it does not cause undue distraction for the driver during the sighting period for the crossing and driver’s crossing indicator.

15.2.5 The speed restriction indication normally provided on a special speed restriction board (St. Andrew’s Cross with speed restriction) is required for unfitted trains and fitted trains in degraded mode. ERTMS must supervise ERTMS fitted trains to an appropriate speed profile, ensuring that the required ‘strike in’ timings are maintained, but this profile need not be identical to that signed for unfitted trains (see section 6.3.2 of this document).

15.2.6 Where the train is required to stop to facilitate the initiation of the crossing sequence from the driving position, the implementation of ERTMS must allow the train to reach the location of trackside equipment provided for that purpose.

15.2.7 If the line speed profile permits, the driver must be able to accelerate as soon as the front of the train has reached the road surface.

15.2.8 Barriers Up indicators can be provided if required.
15.3 Manually controlled crossings

15.3.1 Manually controlled crossings with barriers (MCB), barriers and CCTV (MCB-CCTV), barriers and obstacle detection (MCB-OD) or gates (MG) must be interlocked with the signalling system. Trains must only be allowed to proceed over a crossing and/or a signals cleared over the when the crossing is closed to road traffic and it has been confirmed that the crossing is clear that is, the ‘crossing clear’ input has been given.

Stopping a train proceeding over a crossing when the signalling system has not received a "crossing clear" input can be implemented as either one of the following options:

a) Protect the level crossing by an End of Authority positioned on the immediate approach to the crossing. An ERTMS MA is granted up to this EoA until the crossing is proved protected after which the ERTMS MA is extended over the crossing.

b) The provision of level crossing information with the ERTMS MA. This is configured so that the train is instructed to stop on the immediate approach of the crossing until the crossing is proved to be protected.

The ‘crossing clear’ input can be given by one or more of the following:

a) A signaller activating the ‘crossing clear’ control once it is confirmed that the barriers are down and the crossing is clear of obstructions.

b) An obstacle detection system detecting that the crossing is clear of obstructions.

c) The system proving that manually operated gates are closed and locked.

15.3.2 The implementation of ERTMS must support the initiation of the crossing closure sequence such that road closure times are minimised.

15.3.3 Where possible, the implementation of ERTMS must decrease road closure times from their current durations and eliminate trackside infrastructure required to initiate closing a crossing to road traffic.

Messages transmitted from the ERTMS onboard equipment to the trackside may provide the means to achieve this. In particular, the use of these messages can adjust the crossing initiation point to match the different speeds of the various train types using the route. This means that the crossing will close just in time for the train not to be delayed. Use of the ERTMS MA request parameter T_MAR is one way in which this could be achieved.

The minimisation of road closure times may reduce the risk of abuse of the level crossing by users and may provide the potential for more train paths which will increase line capacity.
Discrimination is required between stopping and non-stopping services where the station platform is on the approach to the crossing. This is likely to require a link with the Network Rail Train Service Data Base (TSDB) to allow either manipulation of the response to the T_MAR request or selection of the appropriate track side initiation point. The suitability of this link and design of the solution is likely to require further safety and performance analysis.

To cater for trains in SR mode that is, where messages from the train are not available to initiate the crossing closure sequence, a local strike-in, suitable for an approach speed equal to the maximum degraded mode speed limit, must be provided.

This strike in could for example be provided by train detection or treadles.

Unauthorised movements over a crossing by trains in SR must be prevented by means of ‘Stop if in SR’ messages in local balises.

The National ERTMS programme is investigating the provision of a type of driver’s crossing indicator which becomes operational for trains approaching MCB type crossings in SR. This has the potential to increase performance over MCB type crossings in SR.

Reopening of the crossing after the passage of a train can be by occupation/clearance of train detection sections or by a train position report upon passing a balise on the far side of a level crossing.

Automatic Half Barrier Crossings

Automatic half barrier crossings (AHBC) need not be interlocked with conventional signalling or ERTMS; there is no need to provide an interface for the normal issuing of ERTMS MAs. However the signaller must have indications if the crossing has failed or is under local control. Under these circumstances trains must be stopped and advised of the circumstances before passing over the crossing.

The crossing sequence is initiated by the approach of the train. The application of ERTMS must not directly affect the normal operation.

The speed supervision functionality provided by ERTMS must guarantee that the minimum strike-in time can be achieved. In normal operation ERTMS fitted trains must be issued with an FS MA over the crossing.

Operations over AHBC in degraded circumstances needs further development, in particular the possibility of changing the ERTMS MA, either to include an OS section over the crossing, or to enforce a lower speed over the crossing, if the crossing has failed or is under local control.

User Worked Crossings

The signaller must be provided with information on the train’s position in relation to a user worked crossing or group of user worked crossings. This is so that the signaller can use more accurate information that can provide an increased level of protection for crossing users.
15.5.2 The manner in which train position information is provided to the signaller must be designed to a sufficient safety integrity so that the signaller is able to take a safe decision with regard to train position.

15.5.3 The train position information must be provided such that it can be viewed and accurately interpreted from the signaller's normal working position.

15.5.4 Trains running in SR mode may be providing position information only by means of occupation of train detection sections. The signaller must manage crossing usage on this information rather than with the aid of position information from the train position report.
16 Engineering work

16.1 Facilitating track access

16.1.1 ERTMS schemes must be designed to facilitate track access. This can include bi-directional working on multiple-track lines and controls within the system that enable protection arrangements to be set up and removed quickly and securely. The basic principle of keeping people a safe distance from moving trains must be strictly adhered to no matter what scheme is being proposed.

16.1.2 Operational and engineering staff often use signalling information to infer train movements. Current training and competence management means that staff should not rely on this information and the detail of this must be re-evaluated when ERTMS is applied to routes with lineside signalling.

16.1.3 Unless it can be established that all trains, including those working under degraded arrangements, are operating with ERTMS, protection and possession arrangements on lines equipped with lineside signals must be the same as conventional lines not equipped with ERTMS.

GN248 It is unlikely that ERTMS could alleviate the requirements for lookout protection. However, ERTMS could be used to provide a warning to track workers of the approach of a train that is operating in FS or OS but this is subject to further analysis.

GN249 ERTMS may offer the opportunity to automate some possession management tasks to assist in the efficient and safe, establishment of trackside possessions. The use of hand-held devices could be introduced and coupled with modern GPS technology, could allow the establishment of a possession that could protect a work site and work force via interaction with the RBC to the signalling interlocking but this is yet to be evaluated. Similar arrangements could also be made for protection arrangements where the work being carried out is not under a possession.

GN250 For a level crossing or a group of level crossings, where a hand held device for protection arrangements is used, this could allow for the local activation of a level crossing emergency stop control (see section 15.1.1 of this document) to provide protection for maintenance and inspection activities.

GN251 To facilitate this, the area affected by the emergency stop control could be made large enough to allow inspection of any associated trackside signage.

16.2 Operation of on-track machines (OTM) and on-track plant (OTP)

16.2.1 The implementation of ERTMS must support the current operational requirements for on track machines as detailed in Rule Book module Working of on-track Machines (see (RD10)).
OTM are rail maintenance vehicles such as tamping machines, ballast cleaners, rail grinders and Overhead Line Equipment (OLE) maintenance machines which are authorised to travel under their own power, or within a train formation, on lines that are not under possession. In other words, they can transit throughout the conventional railway system to locations where they are required to work (‘work’ in this context meaning using a machine for the purpose for which it was built, other than travelling).

OTM are currently equipped with safety features as on ordinary trains, such as AWS, Driver’s Safety Device (DSD), headlights, tail lights and warning horns and are subject to the same restrictions in the event of defective train borne safety equipment.

Work carried out by OTM normally takes place within a possession but certain types of work such as that performed by rail grinding trains are permitted outside a possession.

OTM operating within ERTMS Level 2 without signals area must be fitted to be able to approach, enter and exit a T3 ERTMS possession. Similarly, OTM must be fitted to work on a line outside of a possession.

The operating mode used for working moves by OTM must keep to a minimum the number of times a driver is required to re-enter train data (see section 7.5 of this document).

OTP includes machines such as road-rail vehicles (RRV) and rail-mounted maintenance machines (RMMM) which are not normally permitted to operate outside a possession. Some types may be conveyed in a train formation (but not under their own power) outside a possession. In normal circumstances, OTP is brought to the site by road and can only be placed on a line which is already under a possession.

Protection arrangements for line blockages

On ERTMS with signals schemes, protection arrangements must be by a signal held at danger which must close the route for ERTMS fitted trains. Reminder appliances must be used by the signaller and any additional protection (for example, signalling equipment disconnections) must continue as today. This ensures both fitted and unfitted trains are not able to proceed towards the line blockage.

On ERTMS Level 2 without signals schemes, the protection arrangements are similar inasmuch as the signaller must close the route at the route setting point. If additional protection is required then route barring must be used.

Route barring should be applied automatically by the system, avoiding the need for a signalling technician to do so independently.

Appropriate safeguards must be provided to prevent the inadvertent removal of route barring.
16.4 Possession arrangements

GN257 Where a possession has been taken on an ERTMS with signals line, conventional arrangements can be applied to allow unfitted engineering trains and OTM to enter or exit a possession.

GN258 When the train fitment programme for the route is at a stage where the majority of locomotives and OTM are fitted then T3 ERTMS arrangements may then be applied to enter or exit a possession.

16.4.1 As with the current arrangements, where a possession has been taken on an ERTMS without signals line the system must be used to protect the possession. Only fitted trains must be allowed to approach, enter or exit the possession. Any unfitted trains, for example engineering trains or OTM, must be hauled in. The exception to this is when an unfitted train can enter and exit a T3 ERTMS possession to or from a siding.

16.4.2 A possession on an ERTMS without signals line must be protected by closing and barring the route at the protecting EoAs. Fitted trains approaching the possession must therefore have an ERTMS MA for movements up to the protecting EoA. Worksites must always be provided, not only for efficient working but also to mark the possession limits which will be from the first worksite marker board immediately after the protecting EoA to the last worksite marker board on the approach to the EoA protecting the exit from the possession. These EoAs must be marked at the lineside for reference purposes by the end users.

GN259 At present, there is no requirement to protect a possession on an ERTMS without signals line with detonators or to indicate the limits of the possession by possession limit boards.

16.5 Operation of engineering trains in a T3 ERTMS possession

16.5.1 A fitted train must enter a T3 ERTMS possession in SR mode and only exit with the authority of the Person in Charge of Possession (PICOP).

GN260 Engineering train movements within work sites and between work sites within the same possession do not require ERTMS (and so can be made by unfitted trains).

GN261 A fitted train can operate within the possession in SR (entering/leaving the possession and between work sites) and SH (within work sites).

GN262 Balise groups containing ‘Stop-in-SR’ or ‘Danger-for-Shunting’ packets within the possession may affect train operation.

16.5.2 The national rules/procedures must define these arrangements to control the risk of an engineering train travelling too far or too fast within a possession, regardless of whether the train is fitted or not.

16.5.3 The national rules must also define arrangements for entering and exiting an engineering possession, taking into consideration the ERTMS application level and available operating modes.
16.6 Operation of engineering trains in a T3 possession on an ERTMS with signals line

**GN263** Fitted trains approaching a conventional T3 possession must be in the highest available level of supervision when approaching the signal (EoA) protecting the possession and the signaller should additionally apply route barring if this facility is available.

16.6.1 A fitted train must enter a conventional T3 possession in SR mode and only exit with the authority of the signaller.

**GN264** A fitted train can operate within the possession in SR (entering/leaving the possession and between work sites) and SH (within work sites).

**GN265** Note that balise groups containing Stop-in-SR or Danger-for-Shunting messages, within the possession may affect train operation.

16.6.2 The national rules/procedures must define these arrangements to control the risk of an engineering train travelling too far or too fast within a possession, regardless of whether the train is fitted or not.

16.7 ERTMS Onboard Data

16.7.1 Before engineering trains are required to operate under ERTMS supervision (for example, when leaving a possession), if the actual train consist changes as a result of the engineering work (for example, changes to weight, length etc.) the actual train consist must be safely determined and the ERTMS onboard data amended accordingly (see section 7.5 of this document).

16.8 Movements on adjacent running lines

16.8.1 It must be possible to provide speed supervision on running lines open to traffic adjacent to possessions or worksites to reduce the speed of trains where this is necessary for safety. This can be achieved by imposing a temporary speed restriction (see section 6.3.3 of this document).

**GN266** The arrangements for TSRs associated with possession for unfitted trains are unaffected by the introduction of ERTMS.
17  Degraded working

17.1  General

17.1.1  The system must be designed to minimise the likelihood of degraded working.

*GN267* Degraded working in the context of ERTMS relates to an ERTMS onboard equipment failure where one train is affected or a trackside failure where one or more trains may be affected.

17.1.2  The driver in conjunction with the signaller must determine if the cause is onboard the train or generated from trackside equipment.

17.1.3  The system must provide appropriate failure information to the end user which informs of the nature of the fault. Normally this is achieved through observance of the ERTMS DMI indications for the driver and panel indications for the signaller. However, in the event of a system failure that prevents information being displayed to either party, this must be achieved through communication and application of procedures.

17.1.4  The national operational rules and procedures must define how detected ERTMS failures are to be managed.

*GN268* This includes reporting of failures and the response to those failures.

17.1.5  Management of ERTMS failures must maintain the safety integrity balanced with a need to maintain operational performance.

17.1.6  A means must be provided to support the early detection and subsequent maintenance of failed balises, particularly those performing ‘critical’ functions such as Stop-in-SR or Danger-for-Shunting. The means employed to do this must not rely on the critical function not working before the failure is detected.

17.2  ERTMS onboard equipment failure

17.2.1  System health monitoring

17.2.1.1  The ERTMS onboard equipment must continually monitor for faults and failures within the system, and record the details of such faults and failures electronically onboard for later analysis (see section 17.2.2 of this document).

17.2.1.2  The ERTMS onboard equipment must be able to differentiate between faults and failures that require immediate attention and those that do not (see section 17.2.3 of this document).

17.2.1.3  The ERTMS onboard equipment must present real time information to the driver when a fault or failure is detected or is present that requires immediate attention. Information presented must be unambiguous, operationally meaningful and, where appropriate, persist until acknowledged.
17.2.1.4 Where required to support remote train fault monitoring and associated train maintenance processes, the ERTMS onboard equipment must support the notification of detected system faults.

Over-the-air transmission of recorded data while the train is moving could support the identification and diagnosis of ERTMS onboard or trackside faults sooner than if recorded data is manually downloaded, leading to earlier diagnosis of faults or failures, and the identification and scheduling of maintenance activities to resolve them. This is however not a specified ERTMS function and if required would need to be specified as part of the onboard data recorder requirements.

17.2.2 Fault diagnosis and rectification

17.2.2.1 The ERTMS onboard equipment must support the onboard recording of the results of any diagnostic tests and detected failures that have occurred since the associated fault log(s) were last analysed. In addition, detected safety-critical failures must be recorded onboard.

17.2.2.2 All recorded data must be accompanied by a specific time stamp with sufficient resolution to identify all events accurately and to be able to correlate with other independent recording devices.

Correlation with trackside and other recorded data to fractions of a second could be important in an incident.

17.2.3 Managing onboard ERTMS failures

An onboard ERTMS failure is defined as a failure with any part of the ERTMS onboard equipment, which stops information being received and/or displayed to allow the safe running of the train. This includes:

a) ERTMS onboard equipment transition to SF as a result of the onboard detection of a safety critical fault (see section 5.15 of this document).

b) ERTMS onboard equipment failures that are notified to or observed by the driver but which do not result in a transition to SF.

17.2.3.1 Figure 5 below shows a process flow chart for degraded working in the event of an ERTMS onboard equipment failure. Text below the diagram is provided to aid understanding.
Apply Driver Procedures and Contingency Arrangements to Move Train

**Decision Criteria:**
- Nature of the fault
- Safety of the movement
- Current train location
- Need to detrain passengers
- Availability of Class B onboard and trackside
- Competency of driver to operate under Class B supervision
- Availability of fitted cabs within train consist

**Figure 5  Degraded working in the event of an ERTMS onboard equipment failure**

17.2.3.2 If a driver is notified of or observes an identifiable ERTMS onboard equipment failure, the circumstances must be investigated in line with instructions for that application.
17.2.3.3 Driver’s procedures and company contingency arrangements must define the necessary response to an ERTMS onboard equipment failure, which might, depending on the nature of the failure, include:

a) Reset of the ERTMS onboard equipment to attempt to clear the fault (see section 3.3.13 of this document).

b) Manual selection of Level NTC or Level 0 in areas where lineside signals are provided (see section 21.2 of this document).

c) Continuing the move in the current ERTMS level but in a degraded mode.

d) Isolation of the ERTMS onboard equipment (see section 5.9 of this document).

17.2.3.4 A facility for the driver to manually reset the ERTMS onboard equipment in an attempt to rectify a service affecting system fault must be provided (see section 3.3.13 of this document).

17.2.3.5 The driver must have the means to be able to isolate the ERTMS onboard equipment in order to be able to move the train (see section 3.3.12 of this document).

17.2.3.6 Where operation under Class B supervision following isolation of the ERTMS onboard equipment is required, Class B system indications and controls must still be available to the driver.

17.2.3.7 A train in IS must be moved according to local contingency plans and national rules.

17.2.3.8 The infrastructure manager in conjunction with the railway undertaking must implement local contingency arrangements concerning the movement of trains in IS, as a minimum taking into consideration the following criteria:

a) If the infrastructure has lineside signals and Class B system protection - conventional operating rules with Class B systems must apply in accordance with the national rulebook.

b) If the infrastructure has lineside signals but no Class B system protection - conventional operating rules without Class B systems must apply in accordance with the National Rulebook.

c) If there are no lineside signals - rules for train movements with isolated ERTMS onboard equipment must apply in accordance with the National Rulebook.

**GN272 The above points are dependent on the competency of drivers to operate under conventional signalling rules.**

17.2.3.9 When developing local contingency plans, criteria to consider when making a decision on how to respond to a failure and move a defective train must include (but are not limited to):

a) Safety of the movement.

b) The location of the train.
c) The need to detrain passengers.
d) The length of journey required to reach an area for maintenance.
e) Whether an assisting train can be used.
f) The possibility to drive from another cab/unit.

17.2.3.10 ERTMS onboard equipment failures must be reported and logged within the ERTMS Defect Reporting and Corrective Action System (DRACAS) system.

17.3 Assisting a failed train

17.3.1 General

17.3.1.1 Currently, when a failed train is to be assisted from the front or rear detonator protection is given at 300 yards to provide a mitigation of the risk of a potential train collision. ERTMS does not offer any alternative to mitigate this risk and therefore the current arrangement must be maintained.

17.3.2 Authorising the assisting train to enter section

17.3.2.1 If the assisting train is entering a route where permissive working is authorised or where PoSA functionality is provided, the assisting train movement must be undertaken as set out in sections 11.2 or 8.8 respectively. If not, an assisting train movement must be undertaken in SR and authorised by the signaller (see section 5.5 of this document).

17.3.2.2 If the assisting train is unfitted, then the movement must be controlled as defined in the conventional operational rules and procedures.

17.3.3 Assisting from the front

17.3.3.1 On ERTMS fitted lines, when assistance is provided from the front by a fitted train, the forward movement must normally be controlled under the supervision of ERTMS. The driver in the leading cab must check that the train data accurately reflects the new train consist and braking capability; the nature of the changes to train data will be dependent on the nature of the fault (see section 7.5 of this document).

17.3.4 Assisting from the rear

17.3.4.1 The system must facilitate assisting from the rear.

17.3.4.2 Where possible the forward movement must be controlled (power and brake) from the leading cab, and on ERTMS fitted lines, under the supervision of ERTMS. The driver in the leading cab must check that the train data accurately reflects the new train consist and braking capability; the nature of the changes to train data will be dependent on the nature of the fault (see section 7.5 of this document).

17.3.4.3 Where this is not possible, the system must support driving from a cab other than the leading cab in the situation where a train is assisted from the rear, or where other circumstances require it, for example where the driving controls have failed.
17.3.4.4 The operational rules and procedures must define how any loss of ERTMS supervision functionality caused by an onboard failure is managed.

**GN273** Although there may be authority to move granted by the trackside, the onboard supervision function may not be capable of supervising the train to the authority due to the nature of the onboard failure, either due to the lack of an applicable data preset, or to the train brake not being controllable from the leading cab.

17.3.4.5 The onward movement of the combined train must be facilitated, and it must be achieved without the need to isolate the ERTMS onboard equipment of the assisting train.

17.4 Trackside failures

17.4.1 Trackside equipment failures could result in a direct reaction from the ERTMS onboard equipment from which the system would need to recover. These include:

a) ERTMS onboard equipment transitioning to TR mode (see sections 5.11 and 5.12 of this document) or commanding a service brake application, for example due to a failed or missing balise.

b) The ERTMS onboard transitioning to SF mode if the trackside failure results in a detectable safety critical fault (see section 17.2 of this document).

17.4.2 Alternatively, trackside failures could lead to it not being possible for an ERTMS MA to be transmitted to a fitted train, and the train being brought to a stand at an EoA. This could be due to:

a) The normal trackside conditions required for an ERTMS MA to be generated being only partially met (see section 8.8 of this document) or not being met at all.

b) An RBC, GSM-R, LEU or balise failure.

17.4.3 ERTMS trackside failures, including those that do not impact on train operations but which are notified to the driver, must be reported and logged within the ERTMS DRACAS system.

17.4.4 Figure 6 below shows a process flow chart for degraded working in the event of a trackside failure affecting the ERTMS MA to be transmitted to a fitted train. Text below the diagram is provided to aid understanding.
Figure 6  Degraded working in the event of a trackside failure
17.4.5 When a fitted train has arrived at an EoA and has not received an ERTMS MA to proceed, the driver must contact the signaller. Depending on the nature of the failure the means by which the train is authorised to proceed may require:

a) Setting of a permissive (see section 11.2 of this document) or PoSA (see section 8.8 of this document) route if the trackside failure is such that these routes can be set and the appropriate ERTMS MA provided.

b) Selection of override and proceeding in SR mode on signaller’s authority.

c) Manual selection of Level NTC or Level 0 on lines with lineside signals subject to the driver being competent to drive under conventional signalling.

GN274 Where the reason why an ERTMS MA is not available cannot be determined to be at the trackside then subject to contingency arrangements the driver may manually reset the ERTMS onboard equipment in an attempt to rectify the fault (see section 17.2 of this document).

17.4.6 Level NTC must only be used for degraded operations where lineside signalling is fitted and Class B systems are available. Conventional driver training and route knowledge must be maintained to ensure competency when required to drive under conventional signalling and a Class B system.

17.4.7 Level 0 must only be used for degraded operations where lineside signalling is fitted. Conventional driver training and route knowledge must be maintained to ensure competency when required to drive under conventional signalling.

17.4.8 In all other cases SR must be used as deemed appropriate by the railway undertaking.

17.4.9 When developing local contingency plans; criteria to consider when making a decision on how to move a train in a degraded situation must include (but is not limited to):

a) Safety of the movement.

b) Location of the train.

c) The extent of the failure (for example multiple sections or single section).

d) Operational and performance benefits.

GN275 Taking into account the expected reliability of the ERTMS system, the use of conventional signalling as the method of operation when multiple consecutive MAs cannot be issued should be considered.
17.5 Voice communications failure

17.5.1.1 The arrangements for managing GSM-R related failures are defined in the national operational rules (RD10).

17.5.1.2 Driver/signaller communications must still be supported in the event of common mode GSM-R failures that result in a loss of both GSM-R voice and data communication capability.
18 Emergencies

18.1 General

18.1.1 When a hazard is detected suitable actions must be taken to mitigate the risks associated with the event.

18.1.2 The national operational rules must define all of the following:
   a) Roles and responsibilities of railway personnel likely to be involved.
   b) Immediate actions to limit the exposure to risk.
   c) Actions necessary for containing the event to limit the overall effect.
   d) Actions necessary to facilitate the safe and efficient return to normal operating conditions.

18.1.3 When defining the national operational rules, consideration must be given to how the following ERTMS and GSM-R functions must be used (this list is not exhaustive):
   a) GSM-R Railway Emergency Call (REC).
   b) Emergency stop (unconditional and conditional).
   c) Revocation of emergency stop.
   d) Recovery from PT (see section 5.12 of this document).
   e) RV for reverse movements in emergency situations (see section 5.16 of this document).

18.1.4 In addition, the national operational rules must consider the effect each of the emergency controls available within the ERTMS system will have on the ERTMS onboard equipment (for example on the current ERTMS MA and/or ERTMS operating mode).

18.2 Stopping trains in an emergency

18.2.1 The signaller must be provided with controls for stopping trains in an emergency. The controls must:
   a) Be effective for all trains operating in the signaller's area of control or in predefined subsections of the signaller's area of control.
   b) Be capable of targeting individual trains by location or by identity.

GN276 REC, part of GSM-R voice functionality (RD3) is also available to stop trains in an emergency.

18.2.2 The system must provide the capability of automatically detecting emergency situations and taking action to stop affected trains.

18.2.3 The signaller must be made aware of any automatic systems response to an emergency situation.

18.2.4 The ERTMS "method" used to stop fitted trains in an emergency must be determined.
ERTMS provides a number of "methods" by which trains can be stopped in an emergency. These methods include, but are not limited to:

- **a)** Unconditional emergency stop.
- **b)** Conditional emergency stop.
- **c)** 0km/h ERTMS TSR.
- **d)** Withdrawal of an ERTMS MA.

18.2.5 The signaller must receive feedback from the system when the trackside system has applied the requested emergency command.

18.2.6 The signaller must be provided with controls for revoking any emergency stop commands.

18.2.7 The potential for stopping the train in an emergency during train dispatch is discussed in section 9.1 of this document.
19 System management

19.1 Communication systems

19.1.1 The minimum quality of service targets for GSM-R voice and data, and any other signalling data bearer services, must be specified and the system must satisfy these requirements and exceed them where reasonably practicable.

19.2 System security

19.2.1 ERTMS equipment must be operated and maintained by competent personnel. Access to ERTMS systems must be controlled in line with the authority and competence of the role to which it is being applied. This can be enforced through password protection and physical key design for physical locking arrangements. This can be supported by maintaining records of access and/or issue of keys.

19.3 Configuration management and life cycle support

19.3.1 RUs and IMs must maintain records to support the whole-life management of ERTMS. If there is any change of responsibility for ERTMS equipment the previous responsible organisation must make arrangements to transfer relevant records and equipment to the new responsible organisation. RUs and IMs must cooperate when it is necessary to do so to support whole life management of ERTMS. GE/RT8270 (RD7) sets out a process for cooperation.

19.3.2 Processes must be in place for the timely sharing of data to support efficient operation, maintenance, performance management and corrective action. These processes must clearly define roles, responsibilities and scope of data.

19.4 Maintenance

19.4.1 Maintenance of ERTMS equipment must be scheduled to minimise the impact on operation of the railway. Exposure of maintenance personnel to potentially hazardous circumstances (including trackside and depot environments) must be minimised.

19.4.2 ERTMS onboard and trackside components must be modular in design such that any failure can be quickly isolated and the fault rectified. Support arrangements must be set up to rectify or replace defective components.

19.4.3 RUs and IMs must cooperate when it is necessary to do so to support maintenance of ERTMS. GE/RT8270 (RD7) sets out a process for cooperation.

19.5 Security

19.5.1 Measures must be taken to prevent unauthorised access to ERTMS. This includes physical access and electronic access through interference, malware and viruses.
Radio communication to ERTMS fitted trains uses cryptographic keys to provide security for data transmission over GSM-R as it is an open communications network.

The keys are secret, long numbers used by specific cryptographic algorithms to setup a GSM-R data communication session between the ERTMS onboard equipment and the trackside.

Railway Group Standard GE/RT8403 (RD8) sets out the requirements for key management.

19.5.2 The management of keys into ERTMS entities (RBC or OBU) must meet all of the following criteria:

a) No staff intervention is required for the distribution, deletion or updating of any key entry.

b) The remote management can take place at any time it is required

c) ERTMS entities can be located anywhere on the network

This is not currently permitted by the specifications, but proposals to change the specifications are being developed.

19.5.3 A back up system must be provided for distribution, deletion or updating of key entry into ERTMS entities when this cannot be done automatically.
20 Onboard systems

20.1 General

20.1.1 For the purposes of this section, operation on conventionally signalled lines includes the operation of:

a) Any train on lines equipped with conventional block signalling.

b) Unfitted trains in ERTMS Level 2 with signals areas.

20.1.2 Onboard Class B systems must not provide train protection functionality, related indications or require driver interaction on a fitted train operating in Levels 0, 1 or 2.

GN282 Onboard Class B systems are as defined in (RD20).

GN283 This could be achieved through various means, for example:

a) An interface between the onboard Class B system and the ERTMS onboard equipment that supports the automatic suppression of onboard Class B systems on fitted trains at transition borders to Level 0, 1 or 2 areas or on manual selection of Level 0, 1 or 2.

b) The onboard Class B system could remain active in non-overlay ERTMS areas where trackside Class B equipment is removed.

c) Provision of a manual suppression or isolation control.

20.1.3 The onboard ERTMS equipment must not prevent onboard Class B system functionality being available on a fitted train operating in Level NTC, or if the ERTMS onboard equipment is in, or transitions to, IS (and optionally NP) mode.

20.1.4 Before an onboard Class B system is required to be relied upon, the system must be determined to be available.

GN284 The method of determining the availability of an onboard Class B system is considered to be a level of detail below this Operational Concept. However, failure analysis might allow onboard availability to be proven without requiring a technical proving of functionality through positive interaction with Class B trackside equipment.

20.1.5 Following power up, the ERTMS onboard equipment must allow for the completion of any required Class B onboard system power-up tests before determining the availability of that system.

20.1.6 Where a Class B onboard system requires operational data to be entered, the amount of data required to be manually entered during the start of mission process must be minimised and whenever possible preconfigured (see section 7.5.1 of this document).

20.1.7 The ERTMS onboard equipment must not prevent the onboard Class B system from carrying out any required power up tests.

20.1.8 The system design must take into account the situation where an onboard Class B system fails to suppress or unsuppress.
20.1.9 Indications for the driver to monitor the operational status of onboard Class B systems must be provided.

20.1.10 Where a Class B system is implemented as an STM, the driver will be notified of any STM transition to the FA (Failure) state using a system status message on the ERTMS DMI (see (RD14) and (RD17)).

20.1.11 Monitoring systems must give sufficient warning of defective non-isolated onboard Class B equipment so that the train can be prevented from passing beyond the point at which safety depends on the correct functioning of the onboard equipment, either automatically or by driver action.

20.2 AWS/TPWS

20.2.1 Onboard AWS/TPWS equipment need only be provided if the train is required to operate using the national train control system, including where operation might be required on diversionary routes.

20.2.2 If AWS and TPWS controls and indications (visual and audible (speech messages)) are displayed on the ERTMS DMI, their location and size must be designed within the constraints of the ERTMS DMI specification (RD14). The controls and indications must be designed to support effective detection, decision making and operation by the driver.

20.2.3 Class B system controls and indications that are to be displayed on the ERTMS DMI must be consistent with those available to the driver on an unfitted train.

GN285 It is possible to use text messages on the ERTMS DMI to supplement information presented by the Class B indications and controls. Whether or not text messages are used should be subject to further assessment.

GN286 The presentation of the Class B indications via the ERTMS DMI may provide an opportunity to present separate indications for temporary isolation and faults. Historically these indications have been combined using the same indicator and have relied on the interpretation by the driver of their meaning; flashing (fault) and steady (isolated).

20.2.4 Where AWS and TPWS are integrated with the ERTMS DMI, the train stop override control and indicator must be accommodated by the ERTMS DMI to allow the passing of a single signal at danger without getting tripped by TPWS.

20.2.5 The integration of AWS and TPWS with the ERTMS onboard equipment must incorporate the modifications to the TPWS interface to mitigate 'reset and continue' risk (as set out in GE/RT8075 (RD15)). This includes:

a) The provision of separate and clearly identifiable indications (visual and audible) for brake demands initiated by train stop activations, overspeed activations or late acknowledgement of the AWS caution warning.

b) A brake release action to prevent inadvertent operation by drivers.
Where the ERTMS DMI cannot support simultaneous activation of controls for brake release, a sequential brake release solution or a text message requiring positive acknowledgement are possible options.

20.2.6 Where AWS and TPWS are integrated with the ERTMS DMI, it must be possible for tones and alerts generated by these systems to be active and audible at the same time.

20.2.7 Where AWS and TPWS are integrated with the ERTMS DMI, the AWS acknowledgement device must be separate.

This is to avoid wear and tear to the ERTMS DMI when the driver acknowledges the AWS caution tone

No specific layout has been agreed for the presentation of Class B information via the ERTMS DMI. RSSB research project T906 recommended that the detailed designs should be developed with input from end users including trials of the proposed options in the cab environment. A key factor to test is the visibility of the indications in all lighting conditions.

Indications must not pose a visual irritation to drivers, for example, indications too bright in a dark cab. Equally visual indications must not be masked by reflections or glare on or from the ERTMS DMI.

The AWS sunflower when presented via the ERTMS DMI should be readily recognisable by drivers and thus be similar in appearance to existing designs.

Driver's reminder appliance

The use of DRA is discussed in section 3.3.15 of this document.

Driver's safety device/vigilance

ERTMS does not affect the provision or functionality of the driver's safety device/vigilance equipment.

The system design should however consider the use of driver interaction with the ERTMS DMI as a means of resetting the vigilance timer.

Speed sensor fitted

The level of protection provided by ERTMS supersedes the requirement for trains to be Speed Sensor Fitted (SSF). SSF equipment need only be provided if the train is required to operate using a national train control system.

Trip cocks

The level of protection provided by ERTMS supersedes the requirement for trip cocks. Trip cock equipment need only be provided if the train is required to operate using the national train control system that includes trip cock protection.
20.7 **Automatic train protection**

20.7.1 Onboard Automatic Train Protection (ATP) equipment need only be provided if the train is required to operate using the national train control system that includes ATP.

20.8 **Automatic train operation**

20.8.1 ERTMS can support ATO functionality by providing speed and distance to go information, and braking supervision. Additional information may be required by ATO systems and this can be provided using ERTMS as the communication bearer ("packet 44").

**GN291** *The use of ATO is not discussed further in this version of the document. The decision to implement ATO, and how ERTMS is required to support it, is project specific. A European workstream to determine ERTMS system requirements to support ATO is ongoing.*

20.9 **Tilt authorisation and speed supervision**

**GN292** *Tilt Authorisation and Speed Supervision (TASS) is a system provided on conventional infrastructure and tilting trains to authorise the use of tilt, and the use of an Enhanced Permissible Speed (EPS), on a geographic basis where these are permitted. Tilt authority and speed profile information is provided to TASS onboard equipment via balises using ERTMS as the communications bearer ("packet 44").*

20.9.1 When ERTMS fitted tilting trains operate on an ERTMS route, it is desirable that tilt authority is controlled automatically by ERTMS.

20.9.2 The integration and operation of TASS with ERTMS is not discussed further in this version of the document, but may be considered in future releases.

20.10 **Door controls**

20.10.1 ERTMS Level 2 does not require changes to door safety systems and current methods of release and closure. See section 9 of this document for issues and requirements related to train dispatch.

20.10.2 Existing Selective Door Operation (SDO) systems must not be affected by the introduction of ERTMS, unless ERTMS SDO functionality is to be implemented.

20.10.3 It is desirable to specify a national design of SDO functionality using ERTMS for compatibility and economic reasons. The application of this specification for ERTMS SDO functionality is a project decision.

20.11 **Driver advisory systems**

20.11.1 DAS are discussed in section 3.3.15 of this document.
20.12 Ancillary functions

20.12.1 The ERTMS onboard equipment must support the automatic control of ancillary functions where required by the operational deployment (current or future) and supported by onboard systems (for example, Automatic Power Control (APC)).

20.12.2 Where automatic control is not supported by onboard systems, the necessary information to support the driver in the manual control of ancillary functions must be provided by the ERTMS trackside implementation.

20.12.3 Track condition information received from the trackside that supports the manual control of ancillary functions will be displayed on the ERTMS DMI according to where the train is in relation to the start and end locations of an area (Neutral section, “air tightness” area, brake inhibition area etc.), or the location of a required traction changeover, defined in the received data. Drivers are nominally provided with:

a) An announcement that the start of the defined area or the change location is approaching and whether the related functionality will be executed automatically or is required to be manually controlled.

b) Notification when the train enters the defined area or passes the change location.

c) An announcement that the end of the defined area is approaching and whether the related functionality will be executed automatically or is required to be manually controlled.

d) Notification when the train exits the defined area.

20.13 Safety system testing

20.13.1 See section 7 of this document for train safety system testing and entry into service.
21 Transitions

21.1 Running level transitions

21.1.1 The implementation of ERTMS must support transition between different ERTMS operating levels while a train is on the move.

In order to transition from one ERTMS operating level to another while on the move, depending on the level being transitioned to some or all of the following functions need to take place for the transition to be successfully completed – see Figure 7 below:

a) Registration with the GSM-R network (transition to Level 2 only).

b) Establishment of a communications session with the RBC (transition to Level 2 only).

c) Transition announcement.

d) Receive an ERTMS MA for the move across the transition border and beyond (necessary for transition to Levels 1 and 2 to avoid entry to TR mode at transition, and for transitions from Levels 1 and 2 to other levels to provide authority to proceed over the boundary in normal operation.

e) Suppression/unsuppression of Class B onboard systems (transitions to/from Level NTC).

f) Transition acknowledgement (only required when transitioning between certain levels - see section 21.1.6 of this document).

g) Transition.

Figure 7 Running transition functions

Although these are listed in a logical order of occurrence and as separate functions, they may not necessarily happen in the order listed and there are dependencies between them for transitions to certain operating levels, for example:
a) For transitions to Level 2, establishing a communication session with the RBC can only happen if the GSM-R data radio is registered with the GSM-R network.

b) For transitions to or from Level 2, if the transition announcement is sent by the RBC, this will be dependent on the establishment or availability of a communications session with that RBC.

c) The transition announcement and receipt of the ERTMS MA may happen at the same time.

d) The transition acknowledgement, where required (see section 21.1.6), will be requested before the transition takes place.

e) For transitions to Level NTC, the process for unsuppression of Class B systems implemented as an STM starts with the receipt of the transition announcement, but this may not be the case for onboard Class B systems not implemented as an STM.

21.1.1 Registration

21.1.1.1 For successful running transitions to Level 2, the onboard GSM-R data radio must be registered with the GSM-R network.

GN296 The ERTMS onboard equipment will attempt to register at power up according to network ID information stored onboard. The identity of the network with which to register and the command to register can also be transmitted to the train by balise group, or can be selected from a list provided on the ERTMS DMI and initiated by the driver.

If the GSM-R data radio is not registered with the network, a connection with the RBC cannot be established, and an ERTMS MA will not be forthcoming. The driver will require permission to proceed into the Level 2 area in Level 2 (see section 8.3 of this document), or continue in the previous level if supported in the new area (see section 21.3.1 of this document).

21.1.2 Communication session

21.1.2.1 Drivers must not normally be required to enter RBC contact information as part of a running transition to Level 2.

GN298 For transitions to Level 2 operation only, the ERTMS onboard equipment will need to establish a communication session with the correct RBC. The command for the ERTMS onboard equipment to establish the communication session, and the identity of the network with which to register can be transmitted to the train by balise group.

Connection can only be established if the GSM-R data radio is registered with a GSM-R network.
If a connection with the RBC cannot be established, it will not be possible to receive an ERTMS MA for the Level 2 area and it may not be possible to receive the transition announcement (see section 21.1.3 of this document). The ERTMS onboard equipment on trains crossing the transition border will still transition to Level 2 without a connection to the RBC, but will subsequently transition to TR mode if coming from Level 0 or Level NTC due to there being no ERTMS MA onboard.

21.1.3 Transition announcement

21.1.3.1 All running level transitions must be announced.

(RD6) only requires that transitions to Levels 2 or NTC are announced to the ERTMS onboard equipment via balise group or via the RBC; this does not preclude announcements for Levels 1 or 0. The ERTMS operational principles and rules (RD19) require that drivers prepare to apply the rules related to the announced level when the announcement is displayed on the ERTMS DMI.

The transition announcement specifies a distance to go to the point at which the transition to the new level will be made (transition border), and the table of trackside supported levels beyond the transition border in order of priority (even if only one level is permitted this is considered as a table of priority). The ERTMS onboard equipment will decide to which ordered level the transition will be made depending on the received priorities and the onboard availability criteria associated with each level - the highest priority available level will be selected. If none of the ordered levels are available, the ERTMS onboard equipment will select the ordered level with the lowest priority.

The table of trackside supported levels will be stored by the ERTMS onboard equipment and used to support validation of level during start of mission or manual change of level in degraded situations (see section 17 of this document). The table of trackside supported levels forms part of the information that is invalidated by a transition to NP, and which can be automatically revalidated if no cold movement is detected (see section 3.3.14 of this document).

If the transition announcement will result in a change of level, the ERTMS onboard equipment immediately informs the driver about the approaching change via the ERTMS DMI. The transition announcement can also define the location from which the driver must acknowledge the transition (See section 21.1.6 of this document).

21.1.4 ERTMS MA for the new level

In normal operation, before a fitted train crosses a level transition border from Level 0 or NTC into a Level 1 or 2 area it must have an ERTMS MA (including the relevant track description, speed profiles and linking information) onboard. Drivers must be provided with the means to determine to an acceptable level of certainty whether this is the case, to avoid the ERTMS onboard equipment entering TR following the transition.
An ERTMS MA received by the ERTMS onboard equipment for the new level will only come into effect once the transition to the new level is completed. There is no specified means for drivers approaching a transition border to a Level 2 area to be definitively made aware via the ERTMS DMI that an ERTMS MA has been accepted and is available onboard until the transition to the new level is made unless the transition design provides a means to do so. Examples for how this might be achieved include:

a) If the level transition announcement is only transmitted with the ERTMS MA across the transition border then the announcement of the transition to the driver infers that the ERTMS MA is onboard.

b) A lineside signal aspect linked to the issue of an ERTMS MA by the RBC and/or the onboard acknowledgement of receipt of the ERTMS MA could be used to control movements over the transition border. The display of a proceed aspect by the lineside signal provides a degree of confidence that the ERTMS MA is onboard.

Consideration must be given to the ineffectiveness of RBC based controls when, following a transition from Level 1 to Level 2, a train can continue to operate under the Level 1 MA in the Level 2 area without radio contact with the RBC.

For running transitions between levels 1 or 2 an ERTMS MA across the transition border received in the previous level area will remain valid in the new level area if no new level MA is received. So, for example, at a transition from Level 1 to Level 2, a Level 1 MA that extends across the transition border will remain valid after the transition to Level 2 if no Level 2 ERTMS MA is received; the ERTMS onboard equipment will not transition to TR and will continue to supervise the train movements accordingly. It might therefore be possible for a train to continue into the Level 2 area without having established a connection with the RBC and any RBC dependent controls for stopping that train before the EoA defined in the Level 1 MA will be ineffective.

Suppression/unsuppression of Class B onboard systems

Where the suppression and unsuppression of onboard Class B systems at running level transitions is required, it must be performed automatically (see section 20 of this document).

The behaviour of onboard Class B systems, and any driver interactions with the onboard Class B system at the transition to or from Level NTC must, as far as is possible, be the same from a driver perspective, regardless of whether the onboard Class B system is implemented as an STM or not.

Transitions between onboard train protection systems (for example from Class B to ERTMS and vice versa, or between different Class B systems), or between ERTMS levels, must not affect any train protection system initiated brake applications already in force at the transition.
While this forms part of the STM functionality defined in (RD17), when the onboard Class B system is not implemented as an STM, transitions from/to Level NTC must not affect any ERTMS or Class B system commanded brake applications. The behaviour of the ERTMS onboard equipment in this situation when an onboard Class B system is implemented as an STM is as follows:

a) If the onboard Class B system is in “national trip” at a transition from Level NTC, the ERTMS onboard equipment will transition to the new level, command the Onboard Class B system to the Cold Standby (CS) state and transition to TR. The driver will need to acknowledge the transition to TR in order to proceed (see section 5.11 of this document). The driver will be informed of the reason for the Train Trip via the system status message “[name of Class B System] brake demand” on the ERTMS DMI.

b) If the ERTMS onboard equipment is in TR at a transition to Level NTC, it will transition to Level NTC but remain in TR after the transition to Level NTC until the train is at a stand and the driver has acknowledged the Train Trip (see section 5.11 of this document). The ERTMS onboard equipment will then transition to SN mode and command the national system to the Data Available (DA) state.

Drivers must not be required to acknowledge any Class B indication changes as part of the transition process. Associated audible tones must not be emitted by the onboard Class B systems due to the suppression/unsuppression arrangements.

Tones/indications and any other interaction with onboard Class B systems should be associated with the normal operation of the system, and not due to the suppression/unsuppression associated with the transition arrangements

Drivers will only be requested to acknowledge level transitions as indicated in Table 2 below (“Yes” indicates those level transitions where the driver will be requested to acknowledge, “No” where not).
### Table 2 Transition acknowledgement required

#### GN309
*(RD6) requires that transitions between different Class B national train control systems (Level NTCx to Level NTCy) are acknowledged.*

#### GN310
*(RD6) allows for the acknowledgement request to be presented to the driver either when the transition takes place, or at a location before the transition border defined in the transition announcement.*

#### GN311
*The acknowledgement request is displayed and acknowledged on the ERTMS DMI.*

21.1.6.2 The location at which the acknowledgement request is presented must be designed such that:

- a) The acknowledgement request does not distract the driver from other priority tasks, for example, preparing to stop at a platform, approaching level crossings or traction power changeovers.
- b) Acknowledgement requests associated with different functions (for example an acknowledgement for a level transition and for an OS mode change) are not required to be presented to the driver at the same time.

#### GN312
*The ERTMS DMI manages acknowledgement requests on a first in, first out basis - the first acknowledgement request will be displayed to the driver, with subsequent acknowledgement requests queued and displayed in order one second after the first request is acknowledged (see (RD6)).*

21.1.6.3 If the driver has not responded to the transition acknowledgement request within 5s of the transition occurring, the ERTMS onboard equipment will command a service brake application that will be released when the driver does acknowledge the level transition. This acknowledgement process is shown in Figure 8 below.
21.1.6.4 If the transition is not announced, the request for acknowledgement will be presented to the driver (in accordance with Table 2) when the immediate transition order is received from the trackside (see section 21.1.7 of this document).

21.1.7 Transition

21.1.7.1 (RD6) requires that a balise group be located at the transition border that transmits an order to immediately transition to the required level. This order is effectively the same message used for the transition announcement but with the distance to go to the transition border set to zero (see section 21.1.3 of this document).

21.1.7.2 The ERTMS onboard equipment will perform the transition to the new level immediately after receipt of the immediate transition order or after the distance specified in the transition announcement is reached, whichever happens first.

21.1.7.3 The ERTMS operational principles and rules (RD19) require that drivers apply the rules related to the new level when the transition to the new level is made.

21.2 Manual level transitions

21.2.1 Situations where drivers are required to manually change levels must be minimised as far as is reasonably practicable.

**GN313** Drivers of fitted trains can manually enter the required operating level as part of the start of mission procedure or manually change the ERTMS level via the ERTMS DMI if the train is at a stand without having to redo the start of mission procedure.
21.2.2 Where manual selection of an operating level or, for Level NTC selections, a particular Class B system, is required, drivers must be provided with sufficient information to support the accurate selection of the appropriate level/system.

21.2.3 The ERTMS onboard equipment must be configured such that only those levels supported within a given area are available for manual selection.

**GN314** If a valid table of supported levels given by trackside is available onboard, the selection of level by the driver will be limited to those contained in the table. If the table of trackside supported levels is not available, the driver can select any level within a default list configured within the ERTMS onboard equipment.

21.2.4 Where a manual selection of Level 2 is required, drivers must have access to the relevant GSM-R network identity and RBC contact information to support registration of the GSM-R Data radio and the establishment of a communications session with the RBC.

**GN315** Any available and allowed GSM-R network identities will be accessible by the driver for selection on the ERTMS DMI. Where multiple network identities are presented, the driver might require support in determining which is the correct network ID to select.

21.2.5 Where the suppression and unsuppression of onboard Class B systems at manual level transitions is required, it must be performed automatically (see section 20 of this document).

21.3 **Transitions general concepts**

21.3.1 **Performance**

21.3.1.1 In normal operation, when trains are compatible with the infrastructure the level transition arrangements must not impose any performance constraints on the timetable.

21.3.1.2 In degraded operation, when trains are compatible with the infrastructure, performance constraints on the timetable due to the level transition arrangements must be minimised.

21.3.1.3 A fitted train approaching a transition border to an area where, in addition to the new operating level, the level before the border continues to be supported beyond the transition border, must be permitted to continue across the transition border without having to change levels and without having to stop, if the necessary conditions for the transition to occur cannot be met.

**GN316** So, for example, a train operating in Level NTC approaching a transition border to an area that supports both Level 2 and Level NTC operations, should continue in Level NTC without needing to stop if the conditions for the transition to Level 2 cannot be met.
There may be additional transition points defined at other locations along the route to support the ability for a fitted train to be able to automatically transition to the appropriate level after the initial transition border. The provision, and number, of these additional transition points might be dependent on the transition failure rate and the length of the area.

The level transition arrangements must, as far as is reasonably practicable, be optimised for all fitted trains on the route and must not be constrained by fitted trains with poor braking performance.

Driver notifications and activities associated with a level transition must, as far as practicable, be consistent from all potential approaches to the level transition border.

At converging junctions, fitted trains must be in a supported operating level before entering the line.

This reduces the risk of a fitted train failing to transition having an operational impact on the line being joined.

Operations within the transition area

Fitted trains operating within a level transition area, but not intending to cross the transition border, must not be affected by the level transition arrangements.

While it is accepted that under certain circumstances it might not be possible to avoid the display of transition related information on the ERTMS DMI, the ERTMS system must not require drivers of fitted trains to respond to any transition related ERTMS messages displayed on the ERTMS DMI, or require signallers controlling the movement of trains to perform additional activities to prevent this being required.

Unfitted trains operating within a level transition area or authorised to cross a level transition border and operate within an ERTMS with signals area (for example in a Level 1 or Level 2 with signals area) must not be affected by the level transition arrangements.

A train already operating in Level 2 must not be affected by transition arrangements if it crosses a transition border from a Level 2 with signals to a Level 2 without signals area (or vice versa).

Managing incompatibilities

The system design must allow trains to cross a transition border into an area where the train is compatible with the supported levels of operation in a controlled, safe and efficient manner.

A means must be provided to trap trains crossing a transition border into an area where the train is incompatible with the supported levels of operation.

The operational rules must define how trains that cross a transition border into an area where the train is incompatible with the supported levels of operation are managed.
21.3.3.4 Where required, the system design must support the prevention of a fitted train transitioning to a new level if the driver does not possess the necessary competency to drive a train in the new level and the current level is still supported beyond the transition border.

**GN320** A requirement for this functionality might arise where driver training lags behind the entry into service of an ERTMS overlay scheme, and this cannot be managed adequately through roster planning processes. This functionality should be achieved without resorting to:

- a) Isolation of the onboard assembly.
- b) The driver having to manually select or input data. For example, the onboard assembly could include a chip and pin type card reader that reads the driver's ID and competence from the driver's driving licence.

21.3.4 Transition information

21.3.4.1 Drivers must be warned of approaching level transitions and must fully understand the changes to the method of signalling and the associated operational rules and procedures.

21.3.4.2 The level transition border must be clearly indicated to support the identification of where a change in the method of signalling might occur. This includes, for example, indication at the lineside, on signaller’s control panels, and in the Sectional Appendix.

**GN321** It may not always be appropriate to use the Warning of the start of Cab Signalling and the indication of the Start of Cab Signalling boards defined in (RD5). Where a transition from one area of cab signalling to another (for example Level 1 to Level 2) is required, it is only the level that is changed rather than the method of signalling. The ERA Operational Harmonisation Workgroup has agreed the design, but not the application requirements, for a harmonised Level Transition sign that could be used to mark transition borders where the method of signalling is not changing.

21.3.4.3 Drivers of fitted trains transitioning to a new Level must be provided with the necessary and appropriate trackside information before or at the level transition border to support safe and efficient operations in the new area. This includes, but is not limited to:

- a) Speed restriction information (TSR/ESR).
- b) Routing information.

21.3.4.4 The safety and performance risk of a fitted train failing to transition must be minimised by the (in order of preference) system design, configuration and operational rules and procedures.

21.3.4.5 The means by which train movements are managed on either side of a level transition border must not impose unacceptably high levels of workload on the signaller or signallers affected.
21.3.4.6 Drivers must be provided with sufficient and adequate information appropriate to the method of signalling applicable in the area being entered to allow the safe and efficient operation of trains across a level transition border.

21.3.4.7 Level transition related information presented by ERTMS, including text messaging, must be developed and presented to prompt the driver to behave in the desired way (for example, executing a related operational rule or procedure).

21.3.4.8 Level transition related information must be presented to drivers such that sufficient time is allowed to observe, interpret, acknowledge (where necessary) and respond accordingly.

21.3.4.9 Information must be available to end users to support the identification of any changes in units of measurement at a level transition border. This includes changes to the trackside and in-cab presentation of speed information and/or the trackside presentation of distance information (see section 6.5 of this document).

21.3.5 **Level transition area location**

21.3.5.1 The level transition area and border must be located such that level transition arrangements and related information do not distract the driver from other priority tasks, for example preparing to stop at a platform, approaching level crossings or traction power changeovers.

21.3.5.2 The level transition area and border must be located such that sufficient time is allowed for drivers to adjust to a new “method of signalling” before other priority tasks are required to be completed, for example preparing to stop at a platform or approaching level crossings.

21.3.5.3 Where the level transition area, and the area immediately after a level transition border is not under the control of a single signaller, the necessary information, operational rules and procedures required to support the normal and degraded operation of trains or engineering work up to and across a transition border, and to manage emergency situations on either side of the transition border must be provided.

**GN322** _Staged implementation, additional competency requirements or workload concerns may mean that responsibility of signalling control is split at transition borders._

21.3.5.4 The level transition arrangements must not reduce capacity at junctions, that is, the ability to set routes as late as possible across junctions must not be affected.

21.3.6 **Signalling**

21.3.6.1 There must be a safe reaction in case one or more conditions supervised to protect the route from the level transition border changes in the following circumstances:

a) Conditions fail, for example due to unexpected track occupations or emergency stops initiated by staff or automatic systems.
b) The route across the level transition border is cancelled for regulatory purposes or due to wrong routing.

21.3.7 Engineering work in the transition area

21.3.7.1 The system design must support possession and protection arrangements that extend across, or start or end at, a level transition border.

21.3.7.2 The possession and protection arrangements in transition areas especially from non-ERTMS lines into Level 2 with signals areas might differ from location to location. Differences in the rules or local instructions applied to control the risk of a train moving towards engineering work locations without authority must be kept to a minimum. The signalling design schemes must take this requirement into consideration for each transition area.

21.3.7.3 Drivers of fitted trains must ensure that on leaving a possession, the train is operating in a level appropriate to the line being entered.

21.3.7.4 Where a possession extends across, or starts or ends at, a transition border, the possession protection arrangements appropriate to the lowest level train allowed to enter the possession area must be positioned at each entrance to and each exit from the possession area.

21.3.7.5 Drivers of fitted trains operating within a possession must not be required to perform any ERTMS level transition related activities.

21.3.7.6 Where this is managed through the removal of balises, the PICOPs procedure for handing back the possession must include proving that removed balises have been replaced in the correct location.

21.3.7.7 The concept for engineering work is set out in section 16 of this document.

21.3.7.8 For example, if unfitted trains are permitted to enter a possession area that straddles a transition to a Level 2 only line, detonators required for unfitted trains or trains operating in Level NTC must be provided at the possession boundary in the Level NTC area and at the possession boundary in the Level 2 area.

21.3.7.9 Consideration needs to be given to management of balise linking information if balises are to be removed. This may not be a problem if it can be assured that trains will not move through the affected area in FS/OS mode. If balises are to be removed, complete groups will need to be removed to prevent balise group message consistency errors. Also, additional time will need to be allowed at the end of the possession to reinstall and test any removed balises.
21.3.8 Train speed at the transition border

21.3.8.1 The speed of fitted trains transitioning between ERTMS levels must be controlled appropriately for the new area. This might require the condition of the interlocking (including lineside aspects and routing), speed profile and speed restrictions (TSR/ESRs) for the new line of route, and any Class B system related speed restrictions to be taken into account in the ERTMS MA to cross the transition border.

21.3.8.2 For a transition from Level NTC to Levels 1 or 2 the trackside design must prevent warnings and brake interventions at transitions by defining an appropriate speed at the level transition border.

GN326 Differences in braking parameters used by ERTMS and Class B systems that provide similar speed and distance supervision functionality may also cause speed related issues at transitions between the systems. For example, if ERTMS braking curves are less restrictive than those of the Class B system, there may be a Class B warning or intervention following the transition. This should be considered for TPWS OSS loops immediately after a transition border, and for any future transitions to/from other ATP systems, for example CBTC or GW-ATP.

21.3.9 Speed restrictions

21.3.9.1 The system design must support the implementation and withdrawal of speed restrictions that extend across transition borders, or start or end in close proximity to a transition border.

21.3.9.2 Drivers of fitted trains must be provided with speed restriction information at or on the approach to the transition border in a manner appropriate to the operating level of the train after the transition has taken place.

GN327 Fitted trains should normally receive speed restriction information from the ERTMS trackside and the onboard system will include these speeds in the supervised speed profile. At transition borders where the method of signalling changes between cab signalling and conventional signalling, conventional trackside furniture for TSRs or ESRs should be provided.

21.3.9.3 The operational rules must define what conventional TSR and ESR trackside furniture is required and where it is positioned relative to a transition border to support the provision of the necessary speed restriction information to drivers crossing a transition border.

GN328 Trackside furniture required to support conventional temporary and emergency speed restrictions includes:

a) AWS permanent magnets.
b) Emergency indicators (ESR only).
c) Warning boards and, where required, repeater warning boards.
d) Speed indicators.
e) Termination indicators.
f) AWS cancellation boards.
No speed restriction related trackside furniture should be provided in a Level 2 only area, therefore:

a) Trackside furniture appropriate for a speed restriction starting after the transition border from a Level 2 only area should only be provided from the transition border onwards. Consideration should be given to the location of speed restriction related AWS magnets (if required) relative to the transition border and the point at which suppressed onboard Class B systems are expected to be unsuppressed.

b) If a speed restriction starts in close proximity after a transition border to a Level 2 only area, speed restriction information contained within an MA may be displayed too late for a driver to reduce speed sufficiently on the approach to the restriction. Consideration should therefore be given to the provision of trackside furniture on the approach to the transition border if the speed restriction starts within the required braking distance after the transition border, and possibly even extending the speed restriction so that it starts at the transition border.

c) Trackside furniture appropriate for a speed restriction spanning the transition border to a level 2 only area need only be provided up to the transition border.

d) Although trackside furniture must be provided for unfitted train operations in overlay areas, drivers of fitted trains will obtain speed restriction information from the ERTMS DMI. The location of trackside furniture for speed restrictions spanning a transition between overlay and unfitted areas must be considered for fitted trains.

21.3.10 AWS/TPWS at transitions

21.3.10.1 After transitioning from Level NTC to Level 1 or Level 2, if an AWS indication is still provided it must not lead the driver to believe that the train has just passed a restrictive aspect.

Where the AWS indications are integrated with the ERTMS DMI, these indications should no longer be shown following transition to Level 1 or Level 2. Where they are not integrated, this may be achieved by changing the AWS display to black if it is not already black.

21.3.10.2 After transitioning from Level 1 or Level 2 to Level NTC, the onboard AWS display must represent the status of the conventional signalling at the transition.

This can be achieved by displaying the indication read from an AWS magnet installed immediately prior to the transition border.

21.3.10.3 After transitioning from Level 1 or Level 2 to Level NTC, where it is not possible to represent the actual status of the conventional signalling at the transition, the AWS indication provided must not lead the driver to believe that the train has just passed a less restrictive aspect.
21.3.10.4 On the approach to a transition border to a Level NTC area, fitted trains with faulty or isolated AWS/TPWS systems must not transition to Level 0 rather than Level NTC.

**GN332** The ERTMS onboard equipment will transition to the highest ordered level which is available onboard. As level 0 is required to be available for manual selection (see section 17 of this document), it must form part of the table of trackside supported levels. However, if an onboard Class B system has failed, this could result in the ERTMS onboard equipment choosing to transition to Level 0 instead of Level NTC. For consistency with conventional AWS/TPWS operations, the transition to Level NTC should still take place with the driver reacting accordingly.

21.3.10.5 The temporary isolation of an onboard TPWS system must not be seen as a failure of the AWS/TPWS system by the ERTMS onboard equipment.

21.3.11 Permissive working

21.3.11.1 Ideally the transition border location should be chosen to avoid areas where permissive working is authorised in operational publications (see section 11.2 of this document). However, where permissive working across a level transition border is authorised, consideration must be given to the following:

a) Where a train transitions from Level 1 or 2 to Level NTC (or Level 0) while in the process of carrying out a permissive move, the ERTMS onboard equipment will no longer be operating in a mode that prompts the driver to observe the line ahead and stop short of any obstruction.

b) The relative location of acknowledgement windows for the transition and any mode changes associated with the permissive move across the transition border (see section 21.1.6 of this document).

21.3.12 Wrong direction movements

21.3.12.1 Wrong direction movements across a level transition border must be supported where required and the train must be in an appropriate ERTMS operating level after crossing the transition border.

**GN333** It is not intended for ERTMS to technically support automatic transition to the appropriate level for wrong direction movements, although this might be required.

21.3.13 Degraded working

21.3.13.1 In degraded operation, drivers must be authorised to cross transition border by a means, and in an operating mode, appropriate to the operating levels supported in the new area.

**GN334** The concept for degraded working is set out in section 17 of this document.
21.3.14 Emergencies at transitions

21.3.14.1 Alarms provided to detect unauthorised movements past a level transition border must be effective for unauthorised movements by any train that can approach the level transition border.

21.3.14.2 Controls provided at a transition border to stop trains in an emergency must be effective for any train that can approach the level transition border.
22  Glossary

Abnormal operation
An unforeseen or unplanned event, which does not have life threatening or extreme loss implication, including faults and failures external to ERTMS equipment.

Examples would include the failure of a train due to traction problems, or the reduction of infrastructure availability due to a bridge strike or broken rail. Under these conditions it is expected that ERTMS will operate as designed but be subject to abnormal system loading. Abnormal would also include any planned maintenance activity not affecting the functionality of ERTMS on the lines remaining open to traffic.

Application design
The process of applying a generic technology and/or equipment to particular situations on railway infrastructure and vehicles to achieve a defined requirement.

Application level
The different ERTMS/ETCS application levels are a way to express the possible operating relationships between track and train. Level definitions are principally related to the track side equipment used, to the way the track side information reaches the on board units and to which functions are processed in the track side and in the on board equipment respectively. For the purposes of this document, Application Level additionally includes relevant ‘implementation types’ such as with or without signals, and with or without STM implementations of onboard Class B systems.

Automatic Route Setting
A system that provides the automatic setting of routes according to a trains’ planned timetable to give trains a clear run without locking up excessive routing.

Automatic Train Protection (ATP)
A system associated with railway signalling that supervises the driving of a train and applies the brakes to reduce the risk of travelling at excessive speed or passing a signal at danger.

Automatic Warning System (AWS)
A system that alerts the driver to the presence of a signal, or sign associated with a speed restriction, as the train approaches. Either a warning or clear indication can be given. If a warning is not acknowledged the brakes will be applied.

Banking
A movement where an additional traction unit is provided temporarily at the rear of a train to provide additional tractive support.
Blanket speed restriction
An emergency speed restriction imposed over a wide area, for reasons such as adverse weather affecting the infrastructure, overhead line damage or condition of track.

Block section
A section of track in which, normally, no more than one train is allowed.

Cab signalling
A system of signalling whereby a set of visual display devices, fitted in the driving cab of the train, conveys instructions and information regarding the driver’s authority to proceed.

Ceiling speed
A term which refers to the maximum steady-state speed limit used as the basis of the ERTMS overspeed supervision function, that is, that limit which if exceeded by more than a predetermined intervention margin, will result in an over speed supervision intervention.

Class B system
Control, Command and Signalling functions, interfaces and performances existing before the entry in force of the CR CCS TSI and HS CCS TSI, under the responsibility of the corresponding Member State. For the GB Mainline Railway, Class B CCS systems include GW-ATP, RETB, TPWS (which includes AWS), and TVM430.

Cold Standby (CS)
An STM state in which the STM has been initialised, tested (if required), configured and is in possession of all required information for operating, but is not able to receive a message from the trackside, because the reception is turned off. The ERTMS onboard equipment will command an STM to the Cold Standby state at a transition from Level NTC.

Conditional Emergency Stop (CES)
A train location dependent means of stopping fitted trains operating in Levels 2 and 3. A message from the RBC defines a location that a receiving ERTMS onboard equipment either ignores, or supervises as a new EoA and SvL, depending on the location of the train minimum safe front end relative to the defined location:

- If the train minimum safe front end has passed the defined location, the conditional emergency stop is ignored, the RBC informed, and the train can proceed.

- If the train minimum safe front end has not passed the defined location, the conditional emergency stop is accepted and the location is used by the onboard to define a new EoA and SvL (only if the new EoA and SvL are not beyond those already defined by the current MA). The onboard supervises the train to the new EoA/SvL

Recovery from an accepted conditional emergency stop requires a revocation message to be received by the ERTMS onboard equipment.
Conditional emergency stop control
A control provided to a signaller that initiates the transmission of a conditional emergency stop message to a fitted train operating in Levels 2 or 3.

Control area
The geographical area of the track layout over which the signalling system operator(s) is able to directly control trains and shunting units. The control area also includes any transition areas where control may be shared.

Co-operative shortening of an ERTMS movement authority
A condition where the RBC proposes a new EoA at a location closer to the train than the current EoA. The ERTMS onboard equipment checks if the train can be stopped without a brake intervention at the requested location. If that is possible the new EoA will be accepted by the ERTMS onboard equipment. If it is not possible the request will be rejected and the previous MA remains valid.

Data Available (DA)
An STM state in which the STM is responsible for the train movement supervision, according to the received national trackside information. The ERTMS onboard equipment will command an STM to the Data Available state at a transition to Level NTC.

Data entry
The process by which the Train Preparer enters data, via the ERTMS DMI, providing relevant details of the train for use by the ERTMS onboard equipment.

Degraded operation
A planned or unplanned reduction in the ability of ERTMS to operate in its normal manner. This could include ‘graceful’ or partial degradation where it remains acceptable to continue to operate the ERTMS equipment.

It would also include any planned outages to amend or upgrade ERTMS equipment where this will result in a reduction of service during the changeover.

Differential speeds
A set of different maximum permissible speeds at the same geographical location used by different types of train. The speeds are set depending on characteristics of the train such as suspension, axle load etc.

Driver Advisory System (DAS)
Driver advisory systems provide information to support drivers in controlling the speed of trains to meet the required timetable while ensuring greater efficiency.

ERTMS Driver Machine Interface (ERTMS DMI)
The onboard constituent, which enables communication between ERTMS and the driver.
Driver's Reminder Appliance (DRA)
A device in a driving cab to enable the driver to set a reminder that the signal ahead may be at danger.

Driver's Safety Device (DSD)
An existing safety system that requires the driver to act against a spring-loaded mechanism when released, applies the driver's emergency brake. When released there is a time delay before the brakes are applied allowing the device to be reset by the driver. It may also be designed to incorporate a vigilance device, which requires the driver to released and re-operate the Drivers Safety Device periodically.

Emergency operation
A current unforeseen or unplanned event which has life threatening or extreme loss implication and requires immediate attention.

Includes any failures of the ERTMS system that may cause immediate risk or extreme loss.

Emergency Brake Intervention (EBI)
An ERTMS commanded application of the Emergency Brake in the following conditions: for Ceiling Speed Monitoring, the speed exceeds a specified margin, for Target Speed monitoring, the speed exceeds the emergency brake intervention curve, for Release Speed Monitoring, the speed exceeds the release speed.

End of Authority (EoA)
Location to which the train is authorised to proceed and where target speed = 0.

End of Loop Marker (EoLM)
A device used to mark the beginning or the end of a Euroloop. When receiving this information, the ERTMS onboard equipment knows that it is entering/leaving a track equipped with a Euroloop.

Enhanced Permissible Speed (EPS)
A speed higher than the Permissible Speed that is applicable only to specific vehicles with special capabilities and equipment, for example those of tilting trains.

ERTMS harmonised operational rules
A set of harmonised rules to standardise certain aspects of operations across Europe.

ERTMS intermediate block section
Signalling sections for trains operating with an ERTMS MA (on ERTMS fitted lines with and without lineside signals) can be shorter than would be possible if conventional signal spacing was applied. Where there are more signalling sections available for trains operating with an ERTMS MA than for a conventionally signalled train, these shorter sections are referred to as 'ERTMS Intermediate block sections'.
ERTMS Level 2 with signals area
An area fitted with both ERTMS Level 2 and conventional lineside signals.

ERTMS Movement Authority (ERTMS MA)
Authority issued to a train via ERTMS for the train to move along a section of line up to an End of Authority, in compliance with prevailing linespeed, gradient, etc.

ERTMS onboard equipment
The complete installation of ERTMS Level 2 equipment on a vehicle including EVC, ERTMS DMI, GSM-R data radio, GSM-R data antenna, odometry (position and speed) monitoring system and relevant interfaces to other onboard systems.

Failure (FA)
An STM state in which the STM is not able to work anymore, due to internal or external reasons. The STM will report this state to the ERTMS onboard equipment if the STM detects that it has failed. The ERTMS onboard equipment can also command the STM into this state under certain conditions (see (RD17)).

Fitted train
A train equipped with a commissioned and fully functional ERTMS onboard equipment.

Full Supervision mode (FS)
ERTMS operating mode when the ERTMS onboard equipment has all train and track data available that is required for complete supervision of train movements against a dynamic speed profile. This is the normal operation mode for ERTMS. This mode cannot be selected by the driver, but is entered automatically when all necessary conditions are fulfilled.

Industrial locomotive
Locomotives owned and operated by third parties that have, in some locations, a derogation (set out in licence exemptions obtained directly from the ORR) to operate a variety of hauled and propelled moves on the network, accessed from private sidings.

Isolation mode (IS)
ERTMS operating mode in which the ERTMS onboard equipment has been isolated and is performing no supervisory functions.

Level transition
The safe transfer of control of a train from one ERTMS application level to another, which may additionally include the safe transfer of control of a train from one signalling system to another.

Level transition area
The section of line before a level transition border over which all activities associated with an ERTMS Level transition (announcement, registration with GSM-R network etc.) are designed to occur.
Level transition border
The trackside location where an automatic changeover of ERTMS levels, signalling systems, and any associated changes in the method of signalling is designed to occur, and where the driver is required to take action if this is not the case.

Limit of Authority (LoA)
Location to which the train is authorised to proceed and where target speed ≠ 0.

Lineside Electronic Unit (LEU)
A device for communicating variable signalling data to switchable balises.

Lineside movement authority
Movement authority granted by the signalling system via a lineside signal/indicator.

Manual level transition
A level transition that is manually initiated by the driver, either during a start of mission or in operational fallback situations. Manual transitions can only occur with the train at a standstill.

Movement Authority (MA)
The permission given by the signalling system for a train to proceed to a specific location. This includes an ERTMS MA and lineside MA.

Multiple
Two or more traction units in service, mechanically pneumatically and electrically coupled, which are operated by one driver.

National Value (NV)
Values that are transmitted to a train when entering the infrastructure of an administration related to rules and regulations of the administration. National values may be changed within an administrations area.

Non Leading mode (NL)
ERTMS operating mode which can be used when two or more traction units are marshalled into a train to provide traction, but are not electrically connected for multiple working by one driver, and therefore each is being driven in tandem by its own driver. The leading traction unit performs train movement supervision, so the ERTMS onboard equipment on the other(s) does not perform any train movement supervision, but does perform a train location function and provides an indication of actual train speed.

No Power mode (NP)
ERTMS mode when the ERTMS onboard equipment is not powered. When in no power mode, the ERTMS onboard equipment continuously commands an ERTMS emergency brake.
Normal operation

Normal operation is to be considered as situations expected to be encountered entering, exiting and making train movements in the ERTMS area and any set up or close down arrangements as part of start of service or end of service duties.

Normal operation also includes any routine maintenance activities that do not affect the ability of the system to provide a fully functional operational railway.

Odometry

The equipment used to measure the train's movement along the track; namely, speed measurement and distance measurement.

Odometry error

The difference between the estimated and actual location of the train.

Onboard train protection system

Includes ERTMS, and national Class B systems.

On Sight mode (OS)

ERTMS operating mode, which allows restricted movement, to a defined maximum speed and distance, in situations where track occupancy is not known by the system. The driver is responsible for checking the track occupancy when moving the train. It will also be used where the scheme provides for permissive working.

Open (Driving Desk)

‘Open’ refers to a situation when the driving desk has its electrical systems active (switched on). Inserting and turning the master key and moving the master switch away from the ‘off’ position usually achieve this. The corollary is that when the driving desk is not open it is ‘closed’

Operationally meaningful

The presentation of information which when interpreted correctly will prompt the intended recipient to behave in the anticipated way in the operational context (for example, executing a related operational rule or procedure).

Overlap

The distance beyond an EoA which must be clear, and where necessary locked, before a movement authority up to the EoA can be issued to a train.

Permissible speed

The maximum permitted speed as shown in the Sectional Appendix.

Permission to proceed

Procedural authority to move
Radio Block Centre (RBC)
A centralised computer unit working with an interlocking(s) to establish and control safe train separation. Receives location information via radio from trains and sends movement authorities via radio to trains.

Ready to start signal
A signal given by platform staff or guards during train dispatch activities that tells the driver that all station work is complete and doors are closed correctly. It is not an authority to move. The ready to start signal can be provided using handsignals, bell/buzzer codes, or a Right Away (RA) indicator.

Release speed
Where it is essential for operational reasons for a train to be able to stop very close to the end of authority, then on approach to that end of authority a train may be permitted to calculate or issued with a release speed. The release speed will have a low value that enables the train to be stopped before the supervised location should it pass the end of authority taking account of odometry errors.

Revocation of an emergency stop control
A control provided to a signaller that initiates the transmission of an unconditional or conditional emergency stop revocation message to fitted trains operating in Levels 2 or 3.

Route
A path for a train movement from one location to another that can be set by the signaller.

Route closed
No movement authority can be given for the route.

Route open
The conditions are satisfied for a movement authority to be given for the route.

Route setting point
The locations on the railway where an authority can be given for a movement to be made or terminated.

Running level transition
A transition between ERTMS application levels that is executed automatically by the ERTMS onboard equipment, while the train is moving, according to instructions received from the ERTMS trackside system. Running level transitions may require driver acknowledgement.

Sectional route release
Route releasing designed to release sequentially, usually one track section at a time behind the train.
Service brake
The brake that is normally used by the driver to reduce the speed of the train. This brake is activated from the driver's brake controller or the ERTMS onboard equipment. This brake is not considered to be fail-safe and therefore not guaranteed to reduce the train speed.

Shunting mode (SH)
ERTMS operating mode when the vehicle is performing shunting movements.

Shunting area
A predefined area where routine shunting takes place that is protected from entry by other trains.

Signal Passed at Danger (SPAD)
The Railways and Other Guided Transport Systems, Safety Regulations 2006 (ROGS), as amended August 2011 defines a signal passed at danger (SPAD) as meaning:

Any occasion when any part of a train proceeds beyond its authorised movement to an unauthorised movement.

Unauthorised movement means to pass:

(a) A trackside colour light signal or semaphore at danger, order to STOP, where an Automatic Train Control System (ATCS) or train protection system (as described in paragraph 7(a) of Part 1 of this Schedule) is not operational;

(b) The end of a safety related movement authority provided in an ATCS or train protection system;

(c) A point communicated by verbal or written authorisation laid down in regulations; or

(d) Stop boards (buffer stops are not included) or hand signals;

But excludes cases in which:

(e) Vehicles without any traction unit attached or a train that is unattended run away past a signal at danger; or

(f) For any reason, the signal is not turned to danger in time to allow the driver to stop the train before the signal.

Sleeping mode (SL)
ERTMS operating mode when the ERTMS onboard equipment is in a vehicle that is being remotely controlled. As the vehicle is under remote control from the leading vehicle, the ERTMS onboard equipment does not perform any train movement supervision, but does perform a train location function.
Specific Transmission Module (STM)
A STM is a means of implementing the onboard element of national Class B train protection systems with a defined interface to the ERTMS onboard equipment so that:
- The ERTMS onboard equipment can safely manage transitions between national Class B system supervision and ERTMS supervision.
- The STM can access the following resources via the ERTMS onboard equipment: ERTMS DMI, juridical data, odometer, train interface and brakes as required.

Staff Responsible mode (SR)
An ERTMS operating mode which allows the driver to move the train under his own responsibility in an ERTMS equipped area. This mode is used when the system does not know the route, for example, at awakening or after a loss of radio contact, or in degraded conditions where an ERTMS MA cannot be received by the train.

Stand-By mode (SB)
An ERTMS default mode when the ERTMS onboard equipment is powered up. When first powered up (awakening), the ERTMS onboard equipment performs its self-test and the test of the external devices, the results of which are shown to the driver. When a driving desk is opened, the ERTMS onboard equipment associated with that cab remains in SB and data entry/revalidation can take place.

Start of Mission (SoM)
A procedure followed by the driver which includes data, to enable the train to operate in an ERTMS mode.

Station work complete signal
A signal given by platform staff during train dispatch activities. On a train fitted with power-operated doors, this is an indication to the guard (or driver if it is a driver only (DO) train) that the doors are ready to be closed. On a train fitted with slam doors, it is an indication that the doors are properly closed.

Supervised Location (SvL)
The position considered by ERTMS as the furthest point that a train shall not pass without potentially being in a place of danger. The supervised location is defined onboard as:
- The end of the overlap (if any, and before timeout).
- If not, the Danger point (if any).
- If not, the End of Authority (EoA).

System design
System design is not considered to just cover the ERTMS system, rather it includes the IXL, ERTMS, Class B, control centre, operational rules etc.
**Tandem**
Two or more traction units, mechanically and pneumatically but not electrically coupled together, used in the same train. Each traction unit requires a separate driver.
Only one unit is designated as leading, the other units are therefore classed as non-leading.

**Trackside ERTMS Equipment**
The ERTMS equipment for a section of line including the balises, radio block centre, controller workstation and interfaces to the signalling system.

**Train data**
Parameters that define the characteristics of the train for signalling and supervision calculations.

**Train detection**
The proof of the presence or absence of trains on a defined section of line, achieved using equipment that interfaces with the train wheels.

**Train disposal**
Securing and checking of equipment and systems on rail vehicles before being left unattended.

**Train preparer**
Operational role that is responsible for preparing train equipment, including ERTMS onboard equipment, before a train enters service.

**Unconditional emergency stop (UES)**
A non-train location dependent means of stopping fitted trains operating in Levels 2 and 3. Trains receiving an unconditional emergency stop message transition to Trip mode immediately with the associated emergency brake intervention and deletion of the currently held track information and movement authority.
Recovery from an unconditional emergency stop requires a revocation message to be received by the ERTMS onboard equipment.

**Unconditional emergency stop control**
A control provided to a signaller that initiates the transmission of an unconditional emergency stop message to a fitted train operating in Levels 2 or 3.

**Unfitted mode (UN)**
ERTMS operating mode used to allow train movements in areas that are not equipped with ERTMS trackside equipment. The ERTMS onboard equipment can supervise train movements against a ceiling speed and temporary speed restrictions where information is available.
**Unfitted train**

A train not equipped with a commissioned ERTMS onboard equipment or a train equipped with an ERTMS onboard equipment that is not functional.

**Wrong direction movement**

A train movement made in the direction for which no signal is provided.
23 Abbreviations

**ABCL**
Automatic Barrier Crossing, Locally monitored

**AHBC**
Automatic Half Barrier Crossing

**AOCL**
Automatic Open Crossing, Locally monitored

**APC**
Automatic Power Control

**ARS**
Automatic Route Setting

**ATP**
Automatic Train Protection

**ATOC**
Association of Train Operating Companies

**AWS**
Automatic Warning System

**C-DAS**
Connected Driver Advisory System

**CBTC**
Communication Based Train Control

**CCTV**
Closed Circuit Television

**CD**
Close Doors

**CMD**
Cold Movement Detection

**CS**
Cold Standby (STM state)

**DA**
Data Available (STM state)

**DAS**
Driver Advisory System

**DCI**
Driver’s Crossing Indicator
DMI
Driver Machine Interface

DOO
Driver Only Operation

DRA
Driver's Reminder Appliance

DRACAS
Defect Reporting and Corrective Action System

EoA
End of Authority

EPS
Enhanced Permissible Speed

EoLM
End of loop Marker

ERTMS
European Rail Traffic Management System as defined in EC Decision 2001/260

ERTMS MA
ERTMS Movement Authority

ESR
Emergency Speed Restriction

ETCS
European Train Control System; - the control/command and signalling element of ERTMS

EVC
European Vital Computer

FA
Failure (STM State)

FFFIS
Form, Fit, Function Interface Specification

FS
Full Supervision mode

GSM-R
Global System for Mobile communications - Railways

IS
Isolation mode
Km/h
Kilometres per Hour

LEU
Lineside Electronic Unit

LoA
Limit of Authority

LS
Limited Supervision mode

MA
Movement Authority

NL
Non Leading mode

NP
No Power mode

OLE
Overhead Line Equipment

OS
On Sight mode

OTM
On Track Machine

OTP
On Track Plant

ORR
Office of Rail Regulation

PLS
Position Light Signal

PoSA
Proceed On Sight Authority

PS
Passive Shunting mode

PT
Post Trip mode

RA
Right Away
RBC
Radio Block Centre

RIDDOR
Reporting of Injuries, Diseases and Dangerous Occurrences Regulations

ROGS
Railway and other Guided Transport Systems Regulations

RSSB
Rail Safety and Standards Board

RTS
Rail Technical Strategy

RU
Railway Undertaking

S-DAS
Standalone Driver Advisory System

SF
System Failure mode

SH
Shunt mode

SL
Sleeping mode

SMIS
Safety Management Information System

SN
National System mode

SPAD
Signal Passed At Danger

SR
Staff Responsible mode

SSF
Speed Sensor Fitted

STM
Specific Transmission Module

SvL
Supervised Location


**TAF**
Track Ahead Free

**TAF TSI**
Technical specification for interoperability relating to the telematic applications for freight subsystem

**TAP TSI**
Technical specification for interoperability relating to the telematics applications for passenger services subsystem

**TASS**
Tilt Authorisation and Speed Supervision

**TIU**
Train Interface Unit

**TMO**
Train Crew Operated

**TOM SC**
Traffic, Operations and Management Standards Committee

**TOPS**
Total Operations Processing System

**TPWS**
Train Protection and Warning System

**TR**
Trip mode

**TRUST**
Train Running System on TOPS

**TSLG**
Technical Strategy Leadership Group

**TSI**
Technical Specification for Interoperability

**TSR**
Temporary Speed Restriction

**TSS**
Train Stop System

**UN**
Unfitted mode

**UWC**
User Worked Crossing
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