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RDG Guidance Note

Managing GSM-R Train Radio

Synopsis

This Guidance Note provides guidance to train operators on managing all aspects of the GSM-R Train Radio system.

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Part A

Issue Record

This Guidance Note will be updated when necessary by distribution of a complete replacement.

Amended or additional parts of revised pages will be marked by a vertical black line in the adjacent margin.

Issue	Date	Comments
Draft 1	09 May 2014	Draft for review by GPMM/NR
Draft 2	07 July 2014	Draft for review by GPMM
Draft 3	28 July 2014	Draft for review by NRT (CW)
Draft 4	08 Aug 2014	Final draft for review by GPMM
One	06 Dec 2014	First issue
Two	27 Jan 2017	General update

Responsibilities

Copies of this Guidance Note should be distributed by RDG members to persons responsible for ensuring compliance with the appropriate Railway Group Standards.

Explanatory Note

RDG produces RDG Guidance Notes for the information of its members. RDG is not a regulatory body and compliance with RDG Guidance Notes is not mandatory.

RDG Guidance Notes are intended to reflect good practice. RDG members are recommended to evaluate the guidance against their own arrangements in a structured and systematic way. Some parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not to adopt) elements of the guidance should be documented.

Supply

Copies of this Guidance Note may be obtained from www.rssb.co.uk

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Part B

1. Purpose

This document provides guidance to Railway Undertakings on managing the GSM-R Train Radio system.

2. Scope

This Guidance Note applies to Operations and Engineering Council members and Network Rail Routes in relation to the management of the GSM-R Radio system.

3. Definitions

12nn signs

A GSM-R specific lineside sign denoting that the signaller should be contacted by dialling the number displayed on the sign; the number being in the format '12nn' where 'nn' is a number between 01 and 99.

Alias plate

A GSM-R specific sign that provides a train driver with a location code where the signal identity cannot be used for Registration purposes.

Automatic Code Insertion

An automatic system to load a signalling Train Describer (TD) with the train head codes.

Base Transceiver Station (BTS)

A fixed-location GSM-R Base Transceiver Station (BTS) contains equipment for transmitting and receiving radio signals at trackside.

Cell

The area of GSM-R coverage served by at least one fixed-location Base Transceiver Station (BTS). In a cellular network, each cell uses a different set of frequencies from neighbouring cells to avoid interference and provide guaranteed bandwidth within each cell.

Cell DataFill

DataFill is the configuration of a Base Transceiver Station (BTS) to ensure that trains can register and calls are routed correctly.

Component Tracker (CT)

Component Tracker is a database that tracks faults with shared railway systems, such as TPWS and GSM-R, to facilitate inter-company working, cooperation and long-term data analysis.

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Control Centre of the Future (CCF)

A control mapping system linked to the signalling system that allows control staff to monitor trains running on the network, therefore allowing proactive decisions to be made.

Control, Command and Signalling Standards Committee (CCSSC)

The formal RSSB committee that deals with engineering interface issues between railway companies. This includes interfaces between trackside and train-borne sub-systems and between trackside equipment and railway undertaking operators. It excludes operational rules to operate equipment.

Correlation

A GSM-R process of matching the Registration data entered by the driver with data held in the signalling system to enable calls to be routed to the correct signaller by reference to the track circuit berth the train is occupying.

Coverage

For the purposes of this Guidance Note, coverage is defined as the area over which the GSM-R signal is designed to apply.

Call Type 2 (CT2) Registration

Registration of the train's Functional number onto the GSM-R system using a unique identity made up of the train's head code and specific location code.

Call Type 3 (CT3) Interrogations

Interrogation of the network sub-system by a cab radio to determine that the cab radio's Engine Number is the same as that held by the system. This occurs each time a cab radio is power up from dead.

Call Type 3 (CT3) Registrations

Registration of the cab radio identity and its associated Engine Number with the GSM-R network system. This process takes place when a new radio is installed on a vehicle.

Call Type 7 (CT7)

Call Type 7 is the calling identity for train controller fixed terminals.

Defective On Train Equipment (DOTE)

A contingency plan held by each train operator to provide guidance for control staff on whether trains should continue in service, advising of any mitigation actions that are required for trains to remain in service with defective equipment.

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Delay Attribution Board (DAB)

The industry body which develops and manages the formal industry document the Delay Attribution Guide (DAG).

Delay Attribution Guide (DAG)

Delay Attribution Guide (DAG) is the formal document issued by the Delay Attribution Board and authorised by the ORR which provides the guidance to delay attribution staff on how to allocate delays to the correct cause and code.

Deregistration

The process of removing a CT2 Registration from the GSM-R system at the end of the journey.

Design Authority

The Design Authority is a body with authority to govern the GSM-R system design requirements.

DRACAS

Defect Recording and Corrective Action System – a common repository for fault and failure data relating to a system from which system performance and fault trends can be determined. A DRACAS may also include an asset register.

Defect Recording and Corrective Action System (DRACAS)

A database that records and tracks faults with shared railway systems to facilitate inter-company working, cooperation and long-term data analysis.

Drivers Control Panel (DCP)

The GSM-R cab radio user interface where the driver enters data, initiates/receives calls/messages and can access radio functions.

Driver Only Operation (Passenger) Trains (DOO(P))

A passenger train operated without a guard requiring extra safety functions of the train radio.

Driver's Safety Device (DSD)

A device in train cabs (normally a foot pedal that the train driver must hold pressed) to ensure the driver is in the cab driving position, and to detect if they become incapacitated.

EIRENE

European Integrated Railways Radio Enhanced Network is the specific European railway telecommunications system.

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European Rail Agency

The European Rail Agency (ERA) is an agency of the European Union charged with the facilitation of a safe, modern integrated European railway network so railways must become more competitive and offer high-quality, end-to-end services without being restricted by national borders via interoperability. The Agency also acts as the system authority for the European Rail Traffic Management System (ERTMS) project, including GSM-R, which has been set up to create unique signalling standards throughout Europe.

European Train Control System (ETCS)

A standard Pan-European in-cab signalling and control system defined by the European Rail Agency.

Fault Management System (FMS)

Network Rail's infrastructure fault management system.

Fixed Telecoms Network (FTN)

Network Rail's fixed network infrastructure comprising transmission systems and telephone exchanges linked by a fibre optic and copper cable (i.e. not by radio).

Fixed Terminal (FT)

A GSM-R terminal used in a signal box or control office linked to the Fixed Telecoms Network and able make/receive calls/messages to cab radios and other Fixed Terminals and landlines.

Free-play Simulator

A simulator that allows for unscripted (free) operation of the simulated equipment, (e.g. cab radio as opposed to a structured, rigid process to be followed).

Functional Requirements Specification (FRS)

A specification required by users based on system functions.

Group Call Area (GCA)

A defined service area, or grouping of cells, over which area-based GSM-R calls such as RECs will be received.

'Green' Cab Radio

A special test radio using a SIM card that does not permit RECs to be generated, primarily used for maintainer training and on radio test rigs.

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GSM-R No Fault Found Test Rig/ Radio Test Unit (RTU)

A GSM-R cab radio test rig that provides a second line maintenance test facility for determining whether a suspect Line Replaceable Unit (LRU) is faulty or not.

Head Code

A non-unique train code that identifies each train with its priority, routing and number used by the signalling system. This is also known as a Train Reporting Number.

Incident Resolution Guide (IRG)

A guidance document supporting the DAG, to assist train delay attribution staff and NRT GSM-R investigation staff in the correct attribution of delays caused by GSM-R faults and failures.

Integrated Control Centre (ICC)

A railway control that has both Train Operator and Network Rail control staff working as a single unit.

Location Area Code (LAC)

Identifier for groups of cells in one GSM-R network control group or area. There are normally one or two LACs per Route, which enables control of some Base Transceiver Station functions on an area basis.

Maintainer Training Rigs (MTR)

A desk-based GSM-R cab radio system used for training train maintenance staff.

Master switch

The switch operated by the driver to make a cab live for driving.

Mean Opinion Score (MOS)

A process of determining the quality of speech transmitted.

Misrouted Calls

A call from a train driver that is routed to a signaller who does not control the signalling at the location in which the train is situated.

Mobile Network Operator (MNO)

Public GSM cellular radio network operators offering 2G, 3G, 4G etc. services to the public.

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Mobile Network Operator Interference

Unwanted interaction between public mobile networks and the GSM-R network such that GSM-R calls/messages can be blocked and/or the cab radio prevented from attaching to the GSM-R network.

Network Availability

For the purposes of this Guidance Note, network availability is defined as the proportion of time that the infrastructure equipment is radiating sufficiently to meet the designed coverage.

Network Change Notice (NCN)

Formal industry commercial process for introducing a change to the Network or Rolling Stock.

National Incident Report (NIR)

A report to provide notification by one party to another potentially affected parties of a safety related incident that may affect their own operation using as standard format.

Network Loading

A process of loading up the GSM-R network with calls to monitor the performance of the network, (as the volume of operational call traffic is too low for effective monitoring). This is achieved by cab radios (software version 2) making routing calls to the network when not configured as the cab radio being used by the driver.

Network Management Centre (NMC) (aka. Telecoms Engineering Centre (TEC))

Network Rail's centre for operational and maintenance support for the GSM-R and FTN communications networks.

Network Rail Telecoms (NRT)

Network Rail's organisation tasked with determining telecommunications policy and managing infrastructure telecommunications systems.

No Fault Found (NFF)

A situation where fault investigations cannot trace a cause for a fault and no fault appears to exist at the point of investigation.

Normal Location Update (NLU)

A message sent from a GSM-R cab radio to the GSM-R network conveying location data when the cab radio transits from one LAC to another.

Operational Portable Handheld (OPH)

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A 2 Watt hand portable GSM-R radio that can be configured for various user types.

Operations Enhancements Group (OEG)

Group run by Network Rail Operations team that considered operations and performance developments including GSM-R enhancements.

OTDR

On Train Data Recorder ('black box' train data recorder).

Over the Air (OTA)

A process of uploading/downloading data, configuration, or software to cab radios using the network system to communicate the data.

Passenger Information During Disruption (PIDD)

Passenger Information During Disruption is a national programme to improve passenger information during disruption. One of the elements is to allow Customer Service staff in control to make announcements on the Public-Address system on trains especially Driver Only Trains via the GSM-R system.

Periodic Location Update (PLU)

A time dependent message sent from a GSM-R cab radio to the GSM-R network conveying location data. PLUs can be timed to be sent every 'x' minutes (currently x = 20).

Perturbation

A state where the rail network is not operating to timetable due to an incident.

Portable Maintenance Unit (PMU)

A laptop (or equivalent) with bespoke Siemens GSM-R software, used to configure the cab radio.

RAVERS2 (R2)

An asset management system under development to replace certain existing systems, such as Rolling Stock Library, RAVERs etc.

Radio Electronic Token Block (RETB)

A system of signalling where single line tokens are transmitted wirelessly to train equipment and displays to the driver the section of route available to the train. Verbal permission is required from the signaller for the train to proceed once the token has been received.

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Railway Emergency Call (REC)

The highest priority call in the GSM-R network, configured as a Group Call, conveying an emergency stop request to all trains in receipt of the REC. A REC will be broadcast over defined GCAs.

Railway Group Standard (RGS)

A mandatory standard issued by RSSB to manage cooperation between the Infrastructure Manager and Railway Undertakings.

Railway Industry Standard (RIS)

A voluntary standard issued by RSSB with the objective of gaining efficiencies through common working or system/equipment configuration.

Railway Undertaking (RU)

The operator of trains and/or stations.

Registration (CT2)

Registration of the train's Functional number onto the GSM-R system using a unique identity made up of the train's head code and specific location code.

Registration Focus Group (RFG)

A GSM-R working group tasked with analysis of and recommending solutions to CT2 Registration rejections.

Return Material Authorisation (RMA)

Siemens process for accepting GSM-R cab radio equipment (cab radio unit or DCP) for repair either under warranty or post-warranty.

Reliability Working Group (RWG)

A GSM-R specific working group with a remit to monitor GSM-R system reliability, identify trends and recommend solutions to unreliability.

Return to Coverage (RTC)

A data message sent by cab radio (version 2 software NR3.1 and above) to the network when the cab radio re-attaches to the GSM-R network following loss of coverage.

RoSCos

Owners of the majority of passenger rolling stock in GB.

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Route Operations Control (ROC)

Consolidated control centre incorporating Network Rail signalling, electrification and operations control functions, together with certain train operator operations and maintenance control staff. Each Network Rail Route will have a ROC.

Service Operations Forum (SOF)

Interim body with responsibility for coordination and execution of residual GSM-R programme activities, with the objective of closing or handing over all remaining activities to 'Business As Usual' (BAU).

Signal Number Repeater Signs

A GSM-R specific lineside sign installed at registration locations where the signal is too far from the driving cab position for the driver to reliably read the signal identity number used for GSM-R cab radio registration purposes. The repeater sign repeats the signal identity number.

Soak Test

The process of extended duration testing of a piece of equipment to see if prolonged operation identifies any transitory faults.

Spurious Railway Emergency Call

An unintended Railway Emergency Call (REC) set up in error by pressing the DCP 'red button' inadvertently, or during maintenance activities whilst still connected to the operational GSM-R network.

Stuck Registration

A CT2 Registration that has been retained in the network sub-system when deregistering and not existing in the cab radio sub-system or vice versa.

Subscriber Identity Module (SIM)

A small card inserted into the cab radio that provides core identification issue for the operation of that cab radio in making and receiving calls. The SIM card is part of the infrastructure.

System Authority

A body with authority to govern the GSM-R system functional and technical requirements.

Systems Group (SG)

A GSM-R specific working group with a remit to oversee the performance of the GSM-R system, identifying issues and recommending solutions.

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System Requirements Specification (SRS)

A technical specification translating the FRS requirements into a technical solution.

Track Circuit (Berth) Triggered Broadcast Message

A GSM-R broadcast from a signaller to each train that enters defined track circuits.

Trailing Cab Mode

The GSM-R cab radio is said to be in trailing cab mode when it is powered but has no input from the 'driver's key/master switch on' signal.

Train Describer (TD)

Part of the signalling system that controls the presentation of train head codes to signallers on a user interface.

Uninterruptable Power Supply (UPS)

A battery back-up system to maintain continuity of cab radio power when the main vehicle control supply is interrupted.

Urgent Vehicle Standing (UVS)

This occurs when a piece of rolling stock is unable to return to service from a maintenance location due to the lack of a component.

Vigilance

A device in the train cab linked to the DSD and other cab controls that detects whether the driver is alert or not.

Vehicle Communications Advisory Group (VCAG)

A cross-industry body reporting to the Vehicle & Train Control System Interface Committee (V&TC SIC) with the remit of monitoring the performance and trends in vehicle communication systems.

Vehicle & Train Control System Interface Committee (V&TC SIC)

A cross-industry body with the remit of providing a focus for vehicle/train control systems, telecommunications and signaling systems on behalf of the industry. This includes supporting and informing the industry's Rail Technical Strategy, including the long-term strategy for the development of communications systems via FuTRo.

Weekly Operating Notice (WON)

A weekly publication issued to operations staff notifying them of speed restrictions, engineering work, signalling changes and critical information updates. Each Network Rail Route publishes a WON.

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Wild Card

A series of specific GSM-R cab radio CT2 Registration Location Codes that are used in circumstances where there is no track circuit berth against which the Registration attempt can be compared with, or at times when the Registration process fails due to certain technical issues.

Wrong Cell Registration

A CT2 Registration attempt that has been rejected by the network sub-system due to the cab radio being camped onto a cell that is not associated with the signal being registered at.

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4. Introduction

The GSM-R Train Radio system is a complex system comprising interfaces between a trainborne sub-system and an infrastructure sub-system. Managing GSM-R relies on effective co-operation between Network Rail and the Railway Undertakings (RU). The GSM-R management system is controlled and managed by the Infrastructure Manager's (IM) telecoms organisation Network Rail Telecoms (NRT).

This Guidance Note aims to explain these complexities and provide good practice in management.

In contributing to the system effectively Railway Undertakings (RUs) have several responsibilities:

- Provision of effective GSM-R training and competence management;
- System performance monitoring and analysis of NRT supplied data;
- Reporting and management of faults and failures;
- Liaison with NRT and other industry bodies in system development, system performance and improvement activities;
- Configuration management and maintenance of the train radio and its interfaces.

The RACI table below shows where responsibility lies:

GSM-R system management	ERA	RSSB	VT&C SIC/VCAG	Systems Group	NRT	RUs	NR Operations
GSM-R system requirements (interoperability)	A/R						
GB System requirements (standards)		A/R	C		C	C	C
System development (system authority)		C/I	A	C/I	R	C/I	C/I
Design authority - infrastructure					A/R		C/I
Design authority – cab radio system					A/R	C/I	
Resolution of GSM-R operating issues					C/I	A	A/R
Management of Siemens cab radio contracts					A/R	C/I	
System performance monitoring				A	R	C	I
Provision of GSM-R performance data					A/R	C/I	C/I
IM business GSM-R performance monitoring					A/R		R
RU business GSM-R performance						A/R	

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GSM-R system management	ERA	RSSB	VT&C SIC/VCAG	Systems Group	NRT	RUs	NR Operations
monitoring							
Cab radio maintenance						A/R	
Cab radio configuration management			I	I	A	R	C
IM user training and competence						C	A/R
RU user training and competence						A/R	C
DRACAS			A		R	R	
Fault reporting					R	R	R
Fault management					R	R	R
Sharing critical GSM-R information, e.g. Bulletins, NIR etc.			I	C	A/R	A/R	A/R

Table 1 - Responsibility Matrix for GSM-R Train Radio System

R = Responsible, A = Accountable, C = Consulted, I = Informed

Responsible: Those that do the work.

Accountable: The body that must approve work before it is effective.

Consulted: Those who must be consulted before an action takes place.

Informed: Those who need to be advised after an action.

5. Industry Governance and Standards

5.1 System and Design Authority

The GSM-R Train Radio system is a European system mandated by European specifications. At the highest level the system is governed by the European Rail Agency (ERA), which acts as System Authority for GSM-R interoperability. The International Union of Railways (UIC) currently manages the production of subsidiary standards and detailed system specification requirements.

In Great Britain, the role of overseeing GSM-R system performance is undertaken by the Vehicle and Train Control System Interface Committee (V & TC SIC) via its Vehicle Communications Advisory Group (VCAG). The VCAG will monitor the performance of the system and advise on system management, including upgrades to

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system functionality and performance. A cross-industry body, the Service Operations Forum (SOF) will manage GSM-R programme and operations issues until performance is robust and the system mature enough to pass into 'business as usual' arrangements under VCAG. A GSM-R Systems Group (SG) is operating under the SOF to consider system issues and will transfer to VACG.

- Reliability;
- Registration failures (via a Registration Failures Group (RFG));
- Misrouted calls.

A cross-industry operations forum, the Operations Enhancements Group (OEG), exists to consider operating issues related to GSM-R. This forum is administered by Network Rail Operations.

NRT is the design authority for the GSM-R infrastructure and Siemens GSM-R cab radio.

System requirements are also specified in mandatory Railway Group Standards (RGS) and hence the RSSB Control, Command and Signalling Standards Committee (CCSSC) also fulfils a system requirements role.

5.2 Requirements of Legislation and Standards

The GSM-R Train Radio system is mandated by European specifications (CCS Technical Standards for Interoperability and UIC GSM-R (EIRENE) specifications). The EIRENE Functional Requirements Specification (FRS) and System Requirements Specification (SRS) mandate the minimum requirements and some optional requirements.

Mandatory Great Britain (GB) requirements for GSM-R are contained in Railway Group Standard GK/RT0094; this includes optional requirements in the EIRENE FRS and SRS selected for application in GB. A Railway Group Standard Guidance Note exists (GK/GN0694) to provide guidance on the application of this RGS and the Rail Industry Standard (RIS) detailed below.

To provide a consistent user interface for the end-users, the Siemens cab mobile design is detailed in a RIS, RIS-0794-CCS. This is not a mandatory standard but can be incorporated into contractual requirements to ensure consistency with other fleets using Siemens GSM-R cab radios.

6. System Performance

Managing the much more complex GSM-R system requires TOCs to provide the right level of focus and expertise. Best practice is to have a small number of experts to ensure the system is being monitored/managed.

6.1 General

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GSM-R system performance is governed in part by European standards and in part by Railway Group Standards. Certain Key Performance Indicators (KPIs) are mandated. In addition, Network Rail is required to provide a certain level of system performance as part of the Network Change Notice (NCN5) governing GSM-R implementation.

The current KPIs are:

Network availability	=>98%
Registration success	95% within 30 second
Railway Emergency Call (REC) success rate	98%
Urgent Call success rate	98%
All other calls and messages success rate	97%
Call set-up time REC	2 second
Call set-up time Mobile to Fixed	5 second (normal and Urgent)
Call set-up time Fixed to Mobile	7 second (normal and Urgent)
Low priority call set-up time	10 second
Speech quality	Mean Opinion Score (MOS) =>3
Cab radio reliability	50,000 hours (Mean Time Between Failures) MTBF)

System performance monitoring is undertaken by NRT for the industry, further targets and monitoring requirements are detailed in Ref.11.

Network Rail have implemented a performance improvement programme called Artemis. Artemis Project Managers have been nominated to cover each Route and should be contacted to raise performance issues. RUs are encouraged to participate in their Route-based reviews. It may also be beneficial for Artemis staff to be invited to discuss GSM-R performance issues direct with RU staff, including drivers (driver surgeries), maintainers and delay attribution clerks.

6.2 GSM-R Network Coverage

Network Rail has designed the GSM-R infrastructure to provide 100% GSM-R signal coverage over routes owned or controlled by themselves, except for certain freight only branch lines (which may not achieve 100%) and the Far North and West Highland Radio Electronic Token Block (RETB) lines in Scotland[1].

Not all routes are owned or operated by Network Rail (over which Railway Undertakings (RUs) may operate) also are being or have been equipped with GSM-R:

[1]RETB will continue with its own analogue radio system until ERTMS replaces it

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- East London Line (ELL);
- High Speed 1;
- Heathrow Airport line.

Other routes not owned or operated by Network Rail under contract may not be provided with GSM-R. Typically these are freight lines owned and operated by third parties, such as freight terminals, ports, coal and quarry lines. It is possible that all or parts of these routes may see coverage from a Network Rail GSM-R base station, but this will not be by design. The boundaries of Network Rail infrastructure covered by GSM-R (by design) are indicated by lineside signs.

RUs should expect full coverage on all Network Rail routes and those contracted to Network Rail to supply GSM-R facilities, as defined above. Any loss of network coverage should be considered a fault. Train Drivers should report "Searching networks, please wait" (the message displayed on the Drivers Control Panel (DCP) when coverage is lost). In addition, RUs should monitor 'Return To Coverage' (RTC) messages reported via the daily/weekly performance report, which will identify locations with coverage issues (see section 6.3.3).[2]

Until RTC data is readily published to RUs, NRT have agreed to advise operators of specific instances where RTC data is indicating potential issues with the performance of the network and/or trainborne systems. NRT will monitor RTC data to detect issues with coverage loss.

RUs should be aware that interference from Mobile Network Operators (MNO), specifically O2 and Vodafone, can result in the GSM-R cab radio being blocked from transmitting and/or receiving calls to/from the GSM-R network. This issue is being debated at national level by NRT with the public operators and Government agencies. In such circumstances the GSM-R network infrastructure will appear to be radiating satisfactorily as monitored at the NRT's Stoke Network Management Centre (NMC) (also known as 'Stoke Telecoms Engineering Centre (TEC)'), but in practice the cab radio may not be connected to the GSM-R network.

At such locations, temporary local instructions may be put in place to permit trains to enter service despite having no GSM-R reception where the network appears to be available, where otherwise the train may be declared a failure with a defective cab radio (refer to GSM-R Bulletin 34). RUs should work to resolve these issues with Network Rail.

Some interference issues may occur repeatedly, but not permanently, in a particular area. It is believed this is a consequence of P-MNOs dynamically adjusting the power output of their base station in an area to cater for anticipated peaks in consumer

[2] RTC data is available from NRT but is not yet included in the daily/weekly reports

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demand (for example, major sporting events at the Millennium Stadium in Cardiff). The temporary nature of the interference, when it is due to the P-MNO dynamically adjusting base station strength, makes it difficult to detect and rectify. However, there is evidence of this occurring, particularly in areas that are experiencing high passenger demand in connection with travel to/from a special event.

6.3 Monitoring System Performance

6.3.1 General

GB's GSM-R System Authority will monitor overall system performance using data supplied by NRT. RUs will be expected to supply the System Authority with cab radio reliability data to enable meaningful performance monitoring to be undertaken.

NRT currently manages a GSM-R Systems Group (SG) tasked with monitoring system reliability and identifying trends. The GSM-R Systems Group will eventually transfer its responsibilities to VCAG. In the meantime, the GSM-R SG will report to the SOF.

Siemens is required to prepare a quarterly report including a summary of all equipment return issues and statistical trend data, improvement activities and recommendations, which is issued by Siemens to NRT. NRT undertake routine monitoring using a variety of tools and techniques including remote condition monitoring of assets, operating test trains and conducting structured test routines. This is required by a Network Rail Company Standard NR/L2/TEL/30127 (Ref.12).

Siemens cab mobiles (NR3.1 and above) can be remotely configured by NRT to undertake various network activities to support performance monitoring, including network loading, known as the 'back-cab probe'. By default, cab radios are configured to undertake test calls when in trailing cab mode (no driver's key on) and RUs may be approached by NRT for requests to allow specific supplementary testing to further enhance monitoring.

NRT proposes to install GPS receivers and antenna on a small proportion of the national fleet to assist in network performance monitoring. This will be undertaken as part of a future cab radio upgrade.

RUs have found it beneficial to provide some briefing of Delay Attribution staff in GSM-R operation and faults and failures, to aid their understanding of the causation and resolution of performance issues related to GSM-R.

RUs are encouraged to participate in common interest groups able to share experience across the industry, for example the RDG-run GSM-R Stakeholder Delivery Group (GSDG).

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6.3.2 Performance data

Network Rail has undertaken to supply RUs with performance data (Ref.2 - NCN5) to enable them to monitor GSM-R performance on their services. Currently, this takes the form of Excel spreadsheets distributed by email from the Stoke TEC Performance Team on the following basis:

1. A daily spreadsheet of 'registration rejections' data to aid delay attribution (at RU level).
2. A weekly performance report spreadsheet to aid performance monitoring (at RU level and baselined against national performance).
3. A periodic (4-weekly) national system performance report.
4. In addition, NRT will supply GSM-R train delay closure investigation report forms.

RUs are encouraged to analyse the weekly performance report to determine the following:

a. Success rate for registrations and causal factors for registration rejections (see also GSM-R Bulletins 2, 4, 15 and 21).
b. Locations prone to registration failure and the failure categories.
c. Over-use/incorrect use of 'wild card' for registration.
d. RECs (both genuine and unintentional) and Urgent calls made.
e. DSD alarms (to address spurious alarms – see GSM-R Bulletin 3).
f. Inbound voice calls to cab radios to assess distraction risk – (Note - the data is currently not available on the weekly TOC performance reports but is due to be added).
g. Coverage issues.

The NRT NMC Performance Team Leader maintains a distribution list for all RUs, and operators should supply/maintain their nominations for receipt of these reports via StokeTECPerformance@networkrail.co.uk.

6.3.3 Return To Coverage messages

RTC messages are sent from the cab radio (software version 2 cab radios only - known by their software notation "NR3.x" where x = 1 onwards) to the network infrastructure whenever network coverage has been regained, at any time other than when the radio powers up from no power. Whilst these do not identify where the coverage was lost they do provide details of the cell in which coverage was found. Certain cells will be expected to see RTC messages, such as those abutting a non-covered route.

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Analysis of RTC messages may also identify specific vehicles that may have antenna issues. These will appear as vehicles within a fleet sending a disproportionate number of RTC messages compared to other vehicles in the same fleet operating over the same routes.

6.3.4 Key Performance Indicators that are required to be managed

RUs should determine appropriate KPIs for their operation (where these are not mandated in standards) and manage performance accordingly.

Over-use of the wild card during registration is a particular issue, as, when coupled with errors in entering the head code, it will increase the risk of misrouted calls. This is because the train will not be able to route calls based on the track circuit occupied (see section 8). It can also result in the train being registered with the wrong head code as there is no validation check with the Train Describer.

Locations where the wild card should be used are few and will be identified by 'alias plate' signage, as well as being published in the Sectional Appendix. At other locations, unless agreed by local operations, the signal number should be used as the location code and not the wild card. The NRT weekly data has a specific tab for `wild card used on first registration attempt', and analysis of this data will highlight recurring locations, train head codes etc.

Other issues worthy of monitoring include `wrong cell´ registration rejections, as these indicate locations where the cab radio is camped onto a cell not relevant to the train's actual location. The main risk here is a misrouted REC call, which would neither stop other trains in the vicinity, nor the train not receiving a REC call made in the area (see section 8).

The category of registration rejection titled `Engine number already registered´ reflects a situation where the network believes the cab radio is already registered with a head code when it is not. There are two situations where this may have occurred due to RU actions:

1. The driver has mistakenly stored the head code when taking the key off by pressing the `tick´ button (in which case the registration will automatically deregister after 30 minutes assuming the radio is still powered up and in GSM-R coverage).

2. The cab radio has been rebooted whilst still registered with a head code (in which case the head code will be re-presented on the Drivers Control Panel (DCP)).

In both cases above, the radio is designed to manage the scenario in a controlled fashion and either deregister the retained registration or re-present it to the user who can then manually deregister it, hence the user will not be able to cause a `stuck

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registration´. This category of failure is more likely to be associated with either a network deregistration processing failure, or a cab radio provisioning error where a cab radio is assigned to more than one engine number in the SIM database. This can happen when a radio is removed from one vehicle and later fitted to another vehicle without the proper de-provisioning and provisioning process being followed.

As the daily NRT GSM-R registration spreadsheets are used for delay attribution purposes, it is important to be aware that the 'root cause' analysis may not always be conclusive and may need a sense-check and/or operational input to confirm the conclusion. For example, GSM-R operational data design errors can lead to a `wrong signal´ error being declared (implying the driver entered the wrong signal ID) whereas the system was not designed to expect the correct signal under that circumstance. This is most often revealed at bi-directional platforms or loop lines/sidings with bi-directional signalling, and can be detected by identifying the correct signal for the location based on route maps, signalling plans or the Control Centre of the Future (CCF) (often a quick way to identify this is if the driver is entering an even number but the system expects an odd number of vice versa).

The GSM-R cab radio has the capability of generating a Driver's Safety Device (DSD) Alarm if the DSD is released for 1 minute with the direction controller away from Off. These alarms are sometimes generated accidentally by train crew or maintenance staff; the former often occurs where the vehicle does not have a multi-resettable DSD/Vigilance with associated tone and drivers are in the habit of leaving the master switch in 'Forward' at station stops, and the latter being where brake / DSD test procedures lead to the maintainer not being in the cab when the cab radio DSD alarm sounds. In addition, under certain circumstances DSD alarms can be triggered when coupling/uncoupling multiple unit sets. The significance of these unwanted events is that the alarm will be sent to a signaller who will be required by procedure to make an urgent call back to the cab concerned to determine whether the driver is incapacitated or not. The risk is that routine alarms lead to a `cry wolf´ situation where frequent alarms get ignored, thus risking a genuine alarm being ignored. DSD alarms are detailed in the NRT weekly performance reports. These should be monitored and repeat events addressed by briefings and/or process changes. GSM-R Bulletins 3 and 16 provide further advice on this.

7 Managing Faults and Failures

Due to the complexities of the GSM-R system and the number of interactions needed to support the system operation, system faults/interactions often present themselves to the driver on the DCP or by cab radio behaviour, which on face-value could be misinterpreted as cab radio faults.

External factors such as interference from MNO networks close to the railway may block cab radios from GSM-R coverage and making/receiving calls, registering etc. In such cases the network will appear to be OK and the fault may wrongly be considered in the cab radio.

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7.1 Reporting faults

It is important that drivers provide as much information as possible when a fault or failure occurs with a GSM-R cab radio, whether reported to a signaller or via the RU's company reporting processes. The following list outlines the minimum information needed to allow a technical investigation to be undertaken, without which the task of concluding a 'root cause' investigation may not be possible:

a. Train company.

b. Date, time and location.

c. Train Reporting Number.

d. Unit/Loco number.

e. Nature of fault/failure (e.g. registration failure, misrouted call, loss of coverage etc.).

f. What were you trying to do?

g. What, if any, fault messages were displayed on the cab radio (e.g. `Searching networks, please wait').

h. Details of cab radio behaviour (e.g. dropped call, poor speech quality etc.).

The route for reporting GSM-R faults is via the Network Rail Route Control, via their Fault Management System (FMS). Once in this system, then Stoke TEC will automatically be engaged as required. The RU control is recommended to check that with Network Rail that the reports are received by control and entered in FMS.

There is no formal mechanism for RUs to directly access network logs to enable conclusion of cab radio fault investigations. If a TOC engineer requires such data to investigate a technical fault on a cab radio, then they should phone Stoke TEC for assistance using the same telephone number as is used for provisioning cab radios.

7.2 Initial Response to Faults

The National Rule Book includes the requirements for initially managing a GSM-R cab radio failure.

GSM-R Bulletin 34 provides guidance on managing loss of network coverage or registration in areas known to be affected by MNO interference. NRT manage a process of identifying such sites based on reported problems or monitored data (see below).

If a GSM-R cab radio cannot be registered for any reason but it displays GSM-R GB, indicating that it is attached to the network, it should be assumed that it is operative and capable of sending and receiving calls (including Railway Emergency Calls). GSM-R Bulletin 21 provides guidance on managing registration failures. This includes a call to the signaller which proves the radio communication function. The

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sending and receiving of a REC by an unregistered GSM-R on-board train radio does not affect the receiving of the REC by other trains.

The NMC at Stoke monitors the GSM-R infrastructure 24/7 and will normally be first to identify service affecting issues such as base station failure, loss of Train Describer feeds etc. In these cases, Stoke TEC is required to notify the affected Network Rail Route Controls for onwards advice to operators on the extent of the event, likely duration and functionality affected. Network Rail, in conjunction with Operators, can then determine what steps to take to manage the event. This is further detailed in Network Rail's Control Manual section 5.2 (Ref 10).

A Transportable version of the GSM-R Siemens cab radio is available from Siemens as an alternative contingency in the event of fixed cab radio failure. This retains full functionality of the fixed cab radio with the exception of not having an interface to the DSD or Public Address (PA) systems. The functionality and user interface is identical to the fixed cab radio and hence driver training and competence issues are minimised. The disadvantage of the Transportable Siemens cab radio is its size and battery life (circa 4 hours).

Work is underway to produce an Operational Portable Handheld (OPH) radio for use by drivers, offering sufficient functionality and appropriate user interface to minimise training and competence issues. The OPH is however less powerful (2-watt transmitter) than a cab radio (with an external antenna or the Siemens Transportable cab radio (both 8 watt transmitters), and has a different, less intuitive interface, hence why the separate training and competence regime is required.

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7.3 Fault Types and Symptoms

The main fault categories impacting on RUs are:

- Registration rejections (registration failures);
- Loss of network coverage – including from MNO interference;
- Cab radio software faults – known software faults for each version of cab radio software are detailed in the DAB Incident Resolution Guide document (Ref 1);
- Cab radio hardware failures;
- Unable to connect, dropped and misrouted calls or operational text messages.

RSSB Guidance Note GO/GN3637 states that a cab radio is defective if it is exhibiting one of the following messages/behaviours:

a. (Radio) Failure XX.
b. MT Fatal.
c. Cab Radio Flt.
d. EPROM/RAM Flt.
e. A blank screen.

There are other symptoms of defective cab radios such as loss of GSM-R network coverage due to antenna failure and physical damage but these are not listed in the RSSB Guidance Note.

Registration failures are almost certainly related to network interactions or human error and hence are not a cause of a cab radio hardware or software failure.

In addition to the service affecting faults above, the cab radio may exhibit 'Warning XX' messages which identify a 'non-service affecting fault'. These include issues such as loss of communication with an attached system (e.g. connection to OTDR, ETCS). Drivers are instructed to report these via normal company processes as they do not impact on train service delivery.

Experience in GB and abroad shows that MNO networks (specifically 4G sites) can interfere with GSM-R train radio performance. This manifests itself in blocking the GSM-R network (searching networks) and is also believed to cause other symptoms such as locked cab radios, radio reboots, blocked calls and failed registration attempts. It has been found in practice that a report of a fault in the cab when a driver first starts up the cab, specifically 'searching networks', can in fact have been caused elsewhere during the previous journey, for example, as a back cab.

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NRT have implemented a notification process (GSM-R Bulletin 34) to publicise known locations affected by MNO interference. Such locations should be published in the Weekly Operating Notice (WON). These are locations where the solution involves rework to the GSM-R network, which will require extended time to implement. RUs should be alert to such locations and bring to Network Rail's attention any new locations regularly suffering interference-related symptoms.

The GB Government is working with the European Union (EU) to address this Pan-European issue with interoperable solutions. In the meantime, Network Rail is working with MNOs at sites identified to agree temporary solutions where feasible, or improve the coverage of the GSM-R network where this is not possible. In the long term, it is likely that a new radio transceiver solution will be the solution. The development and trialling of this solution has been funded and is being progressing. This will provide a radio that is complement radio to the new ETSI standard. Funding for roll out to the industry is still to be found. New trains will need to be compliant to the new specification.

RUs are encouraged to implement a clear policy on the use of the cab radio miniature circuit breaker (MCB) to clear an intermittent fault. Resetting the cab radio using the MCB will take around 3 minutes and may exacerbate a delay particularly if the radio is undertaking the action of powering down for example.

7.4 Fault Finding Procedures

Siemens maintain Fault Finding Flowcharts for the cab radio unit (ref 666/HB/86205/001); these are available directly from Siemens. However, it may be necessary to obtain further data from Network Rail to aid fault finding. NRT NMC is custodian of system performance data and monitors the network 24/7. The data is captured in network data logs that provide a wealth of information on what the system is doing. The spreadsheets referred to in 6.1 for performance monitoring are derived from these data logs. For cab radios, the network logs will contain data on all transactions made between the cab radio and the infrastructure, including:

- CT2 (head code) Registration requests (and success or failure cause);
- Deregistration requests (including failure to deregister);
- Cab radio reports (A Normal Location Update (NLU) every time a cab radio transits to a new Location Area Code (LAC), and a Periodic Location Update (PLU) currently every 6 minutes. These events confirm the radio is in communication with the network and is not locked up or blocked by MNO interference);
- Calls made and received;
- Operational text messages made and received;
- DSD alarm details;

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- CT3 (engine number) interrogations (meaning the radio has been powered up from no power);
- CT3 registrations (meaning the cab radio has been provisioned, i.e. set up and registered on the system).

The following two GSM-R Bulletins have been issued to reduce risk of failure:

- Bulletin 20 for handset base installations;
- Bulletin 31 to prevent audio card failure.

7.5 Managing 'No Fault Found'

Returning equipment to Siemens that is suspected of having a fault but actually has no findable fault will incur a `No Fault Found (NFF) charge' in accordance with the Siemens Head Agreement (see 13.2). This is several hundred pounds for a cab radio unit. Furthermore, if the same equipment is returned a second time, then additional investigation costs will be incurred (such as a soak test) if there is still no detectable fault.

The following steps should be taken to reduce the incidence of an NFF occurring:

1. Use the Siemens Fault Finding Flowcharts (note it is not yet established how these will be managed longer term). To note that if a cab radio fault is cleared by a reset of power then the radio will almost certainly return an NFF at Siemens. Specific faults like this are detailed in the flowcharts (e.g. 'Intermittent Failure 01').
2. Consider purchasing or developing a specific GSM-R cab radio test rig (a few products already exist such as NFF rigs and Maintainer Training Rigs (MTR)).
3. Consider that registration failures are unlikely to be caused by a cab radio fault and are normally due to human error or network system interactions.
4. Consider that intermittent warning or failure messages may not be permanently displayed, (i.e. after a reboot the message is no longer present. However, note that intermittent hardware faults may exhibit such symptoms).
5. Consider that the cab radio unit fault log (accessible via the DCP menu or PMU) may show transient transceiver faults which are cleared (Failure 01). A genuine hardware failure 01 fault would result in the radio permanently showing 'Radio failure 01').
6. Consider that `no audio' reports may be the cab loudspeaker or handset and not the cab radio unit.
7. Consider that seeing `Searching networks, please wait' on the DCP could well be due to loss of network coverage or public mobile interference rather than vehicle antenna or cab radio unit faults.
8. Provide detailed reports to Siemens on the Return Material Authorisation (RMA) in order that Siemens can focus better on the probable issue.

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7.6 Returning Equipment for Repair

Siemens offer a repair service for cab radio units, DCPs and Transportable radios, refer to section 13.

Other GSM-R equipment may be returned to the supplier (or designated repairer), e.g. handsets, Uninterruptible Power Supply (UPS).

7.7 DRACAS

To track GSM-R components through their life and enable cab radio reliability to be monitored, RDG's Component Tracker (CT) has been modified to provide fields for GSM-R assets. All GSM-R components with serial numbers can be loaded to CT and faults reported including cab radio failures leading to radio swap outs. At this time, CT is not interfaced to RU legacy systems such as RAVERS, Nexala, and DeltaXV etc.; hence double entry of data is necessary to maintain CT.

CT will be replaced by new industry system 'R2' but until then, RUs should make use of CT as this will enable more accurate national reporting of reliability trends. R2 is scheduled to go live XX and then RU data will transition over 8 months from RAVERs and RSL.

In addition, a national DRACAS is being developed, which will include GSM-R, and will be piloted with ERTMS initially.

7.8 Contingency Plans for Equipment

GSM-R Failures Working Group (FWG) is a sub group of TOM SC and was created following a request from industry for a consistent method by which GSM-R system failures can be managed across the GB main line network. FWG undertook the work and its subsequent outputs, based on safety analysis and modelling by RSSB looking at the risks of failure of on-board and trackside GSM-R radio equipment.

The work showed that for a failure of the on-board radio, risk mitigation can be achieved using a GSM-R Operational Portable Handheld Radio (OPH). The guidance note generated from this work RIS-3780-TOM "Operational Requirements for GSM-R Radio," shows that in the event of a radio failure it does not require the immediate cancellation of a train but imposes a distance to run before alternative arrangements are required. It should be remembered that the OPH's power and functionality will be less than a standard cab radio but detailed risk assessments have shown this is a suitable interim replacement.

In the case of large infrastructure failure, trains can continue to run at a defined speed. However, the risk mitigation would include reducing the service after a set period and imposing a more restrictive blanket speed restriction. The details of when

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these conditions apply can be found in (RIS-3780-TOM). This approach is supported by the risk work and trade unions involved with the FWG.

RIS-3780-TOM has been published to give industry consistent application of the arrangements, and TOCs will need to consider this document when implementing the use of Operational Portable Handheld (OPH) Radios. These are held at strategic locations and the TOC will need to ensure that the OPH Radios are secure and charged.

"Access via a Public–Mobile Network Operator (P-MNO) roaming agreement for GSM-R cab radio is technically possible and NRT are still considering the business case.

8 SIM Database Configuration

NRT manage the Subscriber Identity Module (SIM) database, which should contain a record of all GSM-R fitted vehicles on the network. This database is the source of all reporting of performance, registrations etc., and currently is the only location where system status information is contained, e.g. software version. RUs should ensure that the database accurately represents their fitted fleets; this can be checked by reviewing the `trains' tab in the weekly Excel spreadsheet performance report.

RUs should advise NRT of new build vehicles (which will need to be added to the SIM database), other changes to operator's fleets (cascaded fleets etc.), operator name changes, renumbering of existing vehicles (the unit number is used to dial unregistered trains) and software updates.

There may also be occasions when it is necessary to disable a SIM card to prevent unauthorised access to the GB GSM-R network; for example, if a GSM-R hand-portable is lost or stolen. If an IM or RU suspects a GSM-R device is being misused, or is either lost or stolen, then the GB GSM-R network provider should be notified immediately to mitigate the risk of unauthorised access to the network.

While SIM cards are installed in mobile devices belonging to GSM-R system users, they actually form part of the GB GSM-R network and remain the property of the GB GSM-R network provider. IMs and RUs should return any disabled SIM cards to the GSM-R network provider using a secure means.

9 Access to GSM-R voice recordings

All GSM-R voice calls are centrally recorded. Access to voice recordings can be made by trained and authorised Network Rail employees. RUs may request voice recordings through the Network Rail Local Operations Manager (LOM) or via a Route Operations Control (see GSM-R Bulletin 33). Recordings will be provided in a .wav file format that can be replayed on any PC. Monitoring of GSM-R voice protocols will

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form part of the normal activities of Communications Review Working Groups (CRWG).

10 Managing RECs, Urgent and Misrouted Calls

Railway Emergency Calls (REC) have the potential to cause widespread disruption due to the potential size of the associated Group Call Area. On receipt of a REC, all drivers are required to stop their trains and can only restart once the call has ended and if they are not affected by the emergency.

10.1 Spurious RECs

Spurious RECs, (i.e. an unintended operation of the REC function in error, by accident or deliberately), have potential to cause disruption and can make matters particularly difficult for the signaller if the initiator does not confirm the REC was initiated in error. Managing spurious RECs is an important element as any delays will be attributed to the responsible manager for the facility. Spurious RECs can occur at maintenance locations or in service.

Several initiatives have been made available to RUs to help manage this issue:

- Briefing materials for maintainers, cleaners, shunt drivers, drivers and conductors/Guards (GSM-R Bulletins 1 and 8);
- Labels for driving cabs to warn persons in the cab of the consequences of pressing the REC button (see also GSM-R Bulletin 9);
- Shrouds and flaps to fit around/over the REC button to help prevent accidental initiation;
- Provision of data on REC calls and voice recordings to assist RUs in investigating events;
- RUs will be informed of RECs by the Network Rail Route Control so that investigations can be made in real time (refer to GSM-R Bulletin 30).

Key to managing spurious RECs is awareness of their occurrence, investigation into the circumstances and identification of the root cause. Network Rail Route Operations Control has been requested to notify the appropriate RU for each received REC to enable this investigation to take place promptly.

It helps to explain to users that if a REC is accidentally initiated, they should pick up the handset and speak to the signaller straight away using the PTT button. This can make the difference between a five-minute REC and a one-hour delay.

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10.2 Urgent calls

The latest issue of the Driver Cab Radio User Procedures provides further advice on the use of Urgent calls by drivers as experience has shown several inappropriate uses.

Furthermore, the feature uses the tones and alerts associated with a REC, when received on the signaller's fixed terminal; therefore, overuse of this feature may lessen the impact of a genuinely urgent or emergency situation.

10.3 Misrouted calls

A Misrouted call is an event where the call or operational message made by a driver is routed to a signaller who does not control the location where the train is. There are several scenarios that lead to this type of event:

- The cab radio is working with a cell that does not cover the location of the train. This can be more prevalent at locations near expanses of water where there are rail lines either side of the water, or where two routes are running close by and parallel to each other. An example of this is the route between Felixstowe and Harwich where the trains either side of the estuary can find their way onto cells on the wrong side.
- The cab radio is `uncorrelated' (i.e. it has not been synchronised with the signalling system and hence call routing is based on nominated signaller for the cell). In this case, if there is more than one signal box/panel in that cell then in some cases the call will route to the 'wrong signaller'. Unregistered trains will be uncorrelated, or registered with the wrong head code (forced by use of the wild card);
- The driver uses the 'call signaller' button instead of the phonebook or dialling the signaller's CT7 GSM-R terminal number as displayed on a lineside sign;
- GSM-R Infrastructure equipment failures including TD failure;
- Signal/track circuit failure, in scenarios where a train is given authority to pass a signal at danger, the description will not step past the signal at danger and hence the cab radio will de-correlate until the description is moved forward manually by the signaller;
- Data-fill errors in the GSM-R network data.

The consequences of misrouted calls are:

- Train delays while the driver takes other steps to contact the controlling signaller (e.g. selection through GSM-R phonebook, use of Signal Post Telephone (SPT) or mobile phone);

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- Miscommunication risks;

- The risk that a REC is not set up in the correct location or the train does not receive a REC intended for it. (It is recommended that the driver uses the cab radio phonebook to call the signaller than get out of the cab to use an SPT).

It is important that such events are reported as faults and drivers should report these events through company reporting procedures for onwards escalation with Network Rail as a fault to be investigated. A standardised signaller reporting form to be used by Network Rail is recommended to aid this process and RUs should check that it is being used. Monitoring of 'wrong cell' registration rejections is also a key process to identify the risk of misrouted calls (see section 6.3).

At certain locations, it will be necessary for Network Rail to install lineside signage (CT7 or 12nn signs) that instruct drivers to dial the signaller using the number on the plate. These locations should also be identified in the Sectional Appendix. These signs are required where using the `call signaller' button would route the call to the wrong signaller due to lack of Train Describer function to route the call reliably. In addition, such signs may prevent misrouted calls in some locations.

11 Delay Attribution

The attribution of delays due to GSM-R train radio issues is incorporated into the Delay Attribution Guide (DAG). This is supported by a guidance document, the Incident Resolution Guide (IRG), which provides detail on fault symptoms and root causes to assist in correct attribution. The IRG is managed by a sub-group of the Delay Attribution Board (DAB), and RUs may request resolution of issues not included in the IRG, or where it is believed the IRG requires updating, via the DAB administrator.

A process has been put in place within NRT NMC to manage technical investigations into specific GSM-R delays, where resolution cannot be agreed at Level 1. This Level 2 process is detailed in the IRG (the extracted flowchart is attached as Appendix 1). The outcome of the TEC investigation will be emailed to the Route Performance Manager (see Appendix 2 for sample closure report). Should, following TEC investigations, the RU believe the investigation is still insufficient then the delay can be raised to Level 3 as per the normal delay attribution process.

As part of the above process Stoke TEC email out daily 'registration rejection' spreadsheets which identify, where possible using automated scripts, the root cause of the failure to register. Hence, if a registration issue causes a delay then the cause may be identified from these spreadsheets and reference can be made back to the IRG TEC cause codes. However, the automated scripts are limited in their scope, in several cases returning the symptom rather than the root cause. Further investigation

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may be needed and this can be raised by the Route Integrated Control Centre (ICC) initiating a Fault Management System (FMS) report.
Certain delays will be due to cab radio equipment faults, and hence will not automatically be put into the TEC investigation process. However, RUs may require additional information from TEC to complete their own technical (fleet) investigation. Requests for this data can be made by emailing TEC at GSM-RTrainDelay@networkrail.co.uk

12 GSM-R additional functions to improve Operations and Passenger Information

12.1 Train operator GSM-R terminal including use for provision of Passengers Information During Disruption (PIDD)

A specific train operator fixed GSM-R terminal is available (GSM-R TOC Terminal) that allows train operators to contact cab radios. The TOC Terminal requires a connection to the Network Rail Fixed Telecoms Network (FTN). TOC Terminals can be sourced via NRT.

The TOC Terminal allows a 'contact FT' operational text message to be sent to a registered train (note this requires software version NR3.1 or higher), normal point-to-point voice calls to be made and received, and for the operator to connect to the train's Public Address (PA) system on Driver Only Operation (Passenger) (DOO (P)) trains. (Other non-DOO (P) trains may also have a connection to the PA). The PA interconnect function is particularly pertinent to maintaining up to date passenger information in times of perturbation, thus allowing the driver to focus on his operational tasks.

RUs should implement control procedures to manage the risk of driver distraction due to incoming calls from TOC Terminals. A cab radio software modification is being developed in NR3.6 software to disable the cab loudspeaker for an incoming PA call. The update will be available from end of 2017.

12.2 Other GSM-R functions/issues

How the system can be used:

- Track circuit (berth) triggered broadcast messages to improve operations by advising drivers of operating issues, e.g. defective overhead line equipment.
- Track circuit (berth) triggered broadcast messages to avoid the need to stop and caution trains. This function requires cab radio software at version NR3.5 or higher. There are some broadcasts, covered by the rule book, which may be used to avoid stopping a train to caution the driver.
- General area calls for broadcasting operating information.

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- Defective On Train Equipment (DOTE) requirements – Guidance Note GK/GN0360 identifies symptoms of cab radio failure that are considered to be defective cab radios. DOTE plans should be updated to incorporate GSM-R.

13. Cab Radio Sub-system

13.1 Siemens Cab Radio contracts

Two contracts exist that cover Siemens cab radios:

- The Head Agreement (which RUs are free to use) covers Pay As You Go (PAYG) prices for supply of and repair to Siemens cab radio units and Driver's Control Panels (DCP).
- This contract was negotiated by Network Rail with a view to train operators (and others such as ROSCOs) purchasing services directly from Siemens. A copy of the contract is available from NRT via the nominated Customer Relationship Executive (CRE).

- The 'Additional Support Services Agreement' (ASSA) covers technical support and obsolescence management. This is a contract between Network Rail and Siemens; Contract No. 109287-6.2.2. A copy of the contract is available from NRT via the nominated Customer Relationship Executive (CRE) or equivalent.

13.2 Head Agreement

The Head Agreement covers the supply of Siemens GSM-R cab radio products and spares, and maintenance/repair support. RUs (and other industry parties such as ROSCOs) may purchase goods and services under this Agreement by entering into a contractual purchase order with Siemens. Prices have been set until 31 December 2021, and are subject to an agreed annual price escalation formula. There are no limitations as to which companies in the rail industry may enter into procurement activities with Siemens under this Agreement.

The Siemens' supplied cab radio unit and DCP come with an 18-month warranty from date of shipment. Repaired items cover a similar warranty for the repaired element.

Annexes to the Agreement cover:

- Prices for supply of services and goods;
- Services product list;
- Form of purchase order (call off);
- Scope of works Pay As You Go (PAYG);
- Deed of Novation.

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Daily rates are included for Siemens technical staff on-site attendance rates, should this be required.

The prices include No Fault Found (NFF) incidences; hence activities to filter out NFF before equipment is returned to Siemens should be rigorous. Repaired components carry a 12-month warranty, and an 18-month warranty applies to replacement units.

Siemens has implemented a returns process for the cab radio unit and DCP, which requires the completion of a Reject Material Authorisation (RMA) form to start the process. RUs are encouraged to provide as much detail as possible on the form as to the precise symptoms of the fault to aid diagnosis and reduce NFFs. Once completed and properly packed, Siemens will arrange for collection the following day and operate a turnaround time of 30 calendar days. Urgent Vehicle Standing (UVS) services are available for same day/next day despatch of units but incur premium prices.

Siemens will charge for packaging when returning repaired equipment if the equipment is not returned to them in original type packaging, hence retention of some spare Siemens' packaging is recommended.

An overview of the process is contained in Appendix 3 to this guidance note.

13.3 Additional Support Services Agreement (ASSA)

The ASSA covers the following areas:

- Management of repairs;
- Obsolescence management;
- PMU software updates;
- Technical support on system level faults;
- Retention of knowledge.

The contract is managed by NRT and lasts until 31 December 2021, co-terminus with the Head Agreement. Funding is in place for Control Period 5 (CP5).

As part of this contract, Siemens is funded to manage a 24-hour telephone help desk facility to log and arrange technical support, generally for the next working day.

The telephone support number is 08447 360005 and email address is customer.support.ts@siemens.com

In addition, onsite support is available to support Network Rail system investigations. RUs should make such requests for technical help over and above the Siemens helpdesk via NRT's technology group.

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Siemens are required to maintain records of all equipment repairs on cab radio units and Driver Control Panels (DCP), which shall be made available to train operators in a PC format file on request. Siemens are required to submit details of all repairs to Network Rail on a monthly basis. These records shall be used by Siemens to identify common failure modes, symptoms or issues. Siemens shall also identify patterns of wrongly diagnosed faults and make suggestions on changes to maintenance documentations and training courses.

Siemens are also required to prepare a quarterly report including a summary of all equipment return issues and statistical trend data, improvement activities and recommendations. This report is issued to NRT and will be distributed to RUs initially via SOF.

On request, Siemens will provide each of the RUs with an operator specific period report, covering details of equipment returned, faults found etc. Should this be requested then contact details will be required for period reports to be emailed to.

The ASSA covers software upgrades necessary for interfacing to cab radio hardware; it does not cover software upgrades necessary for other reasons such as functionality changes or compliance with EIRENE changes.

13.4 Miscellaneous Cab Radio Accessories

Multipulse Electronics Limited (www.multipulse.com) supply and repair:

- Holmco handsets (being the approved UK repair centre for GSM-R handsets);
- UPS battery packs;
- GSM-R Radio Test Unit (RTU); The RTU enables pre-testing of Radio, Driver's Control Panel, Handset and UPS as part of fault finding activity and reduces incidences of 'No Fault Found' returns to Siemens;
- GSM-R Maintenance Training Rig (MTR): enables maintainer training on GSM-R trainborne equipment;
- GSMR antenna, loudspeaker, relays and connectors.
-

Multipulse supplied equipment and installation kits come with a 36-month warranty from date of shipment, except for handsets, UPS and antenna which come with a standard 12-month warranty. The Multipulse equipment return process can be found on www.gsmronline.com.

Note - other suppliers of this equipment may exist.

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13.5 Software Updates

Updating cab radio software requires the connection of the Portable Maintenance Unit (PMU) to the cab radio to upload a new version. The upload time depends on how many elements of software need updating but should be in the order of 45 minutes per radio. The Siemens cab radio version 3.4.x onwards contains the capability for updating the application software Over The Air (OTA). However, at the time of writing this Guidance Note, there is no available terminal equipment capable of pushing the update.

The PMU is a laptop onto which specific Siemens software is loaded to enable communication with the cab radio unit and upload of software, text message files and phonebooks. The PMU also allows interrogation of cab radio status (inventory of status e.g. software version, transceiver type and version, CT3 number etc.), access to the cab radio fault log, and the ability to clear the log.

Version control management of cab radio software and PMU software is the responsibility of NRT Technology and Engineering. RUs will be notified of new software releases by the SOF.

13.6 Phonebook Updates

The Siemens cab radio contains two phonebooks:

- RU phonebook – up to 239 entries, contained on the SIM card;
- Network Rail phonebook – up to 1200 entries, contained in hard memory.
-

From time to time it will be necessary to update these phonebooks as external numbers change. Currently there is no remote mechanism to do this so a PMU must be attached to the cab radio to download a new phonebook version.

The RU phonebook contains operator-specific company contact details. The phonebook is created by the RU in an Excel spreadsheet, which is then compiled by NRT into a file that can be uploaded to the cab radio. Entries are displayed on the cab radio in the order by which they are entered into the spreadsheet, (i.e. they are not sorted alphabetically by the cab radio), and hence care should be taken in compiling the list to ensure it is in alphabetical order. However, some TOCs put the most frequently used entries first in order to occupy the top four lines of the display when the phonebook is selected by the driver to avoid searching or navigating a list for the most frequently used numbers. Entries in the train operator phonebook will not work unless they are also contained in a network `permissions' list, so the process of uploading numbers to the cab radio also requires Network Rail to add them to their permitted numbers list. RUs are advised to regularly review the phonebook to ensure the numbers are current.

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It should be noted that the Siemens cab radio does not create 'DTMF' tones used in selecting telephone options on land line exchanges. In this case, separate direct dial numbers will need to be programmed for each of the options required.

The Network Rail phonebook contains entries for all signallers, operational controllers and electrification controllers GSM-R fixed terminals (FT). End users are required to use the phonebook whenever the cab radio is unregistered, but also if they suffer a `misrouted call'.

As re-signalling schemes occur over time, new signalling roles will require additional entries in the Network Rail phonebook and removal of signaller roles that are no longer valid. RUs will need to ensure that GSM-R cab radio phonebook is updated as part of the process and is referenced in the Network Change for clarity.

Again, it is necessary to connect a PMU to the cab radio to upload a new version of the phonebook. RUs will be supplied with new versions of the Network Rail phonebook by NRT annually or specific update for major resignalling.

13.6 Vehicles Fitted with Combined Audio Control Unit (CACU)

Certain vehicles are fitted with a CACU which connects a single handset to a number of different communication systems depending on the system selected. In the case of GSM-R, it has been identified that a point-to-point voice call (Normal and Urgent) will be cut off if an alternative communications system is selected, e.g. cab-to-cab, PA etc. However, RECs are not impacted. RUs should ensure their drivers are aware of this behaviour.

14. Infrastructure Sub-System

The network infrastructure is managed by NRT, being monitored at NRT's NMC. All critical elements of the system are duplicated or provided with diverse routes, so the system has high resilience. Network Rail Routes are responsible for maintenance of the trackside equipment, being commissioned by NMC to investigate and repair faults.
Key functions of the system, such as registration and call routing, rely on what is known as 'operational design' leading to cell data-fill to reflect that design. This is an area where design omissions or errors will affect system performance. In some cases, the operational design requires line-side signage to provide specific instruction to drivers, (e.g. registration alias plates, CT7/12nn dial-up signs and signal number repeater signs where short trains start in long platforms). The design of signage is incorporated into Railway Group Standard GI/RT7033, but there are no specific standards governing when and where to apply the signage.

RUs should be aware that signage may not have been fitted in all cases where it should have been. With time, locations requiring signage may arise and these should

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be raised with NRT (e.g. if a platform is lengthened, or new train service patterns start turning around at locations not used for registration before). RUs need to review changes with Network Rail when signalling or service pattern changes are made.

RUs should be aware that from time to time new GSM-R cells may be needed or new routes may be provided with GSM-R adjacent to existing routes. Such changes are likely to impact on emergency call Group Call Areas as well as introducing a potential risk of radios camping onto the wrong cells.

RUs should also be aware that re-signalling schemes will most likely require a change to the GSM-R operational design. RUs should seek assurances that registration points have been properly considered in the design, any new signage has been identified, any changes to nominated signaller understood, and any automated features (e.g. Automatic Code Insertion) integrated and tested with GSM-R. The Network Change process should be used to ensure this happens.

Re-signalling schemes will also most likely require an update to the cab radio Network Rail signaller (menu-accessed) phonebook held in the cab radio.

From time to time, NRT will require system outages, mainly in localised areas, to undertake system upgrades or essential maintenance. Such outages will be subject to planning rules and will be appropriately published in operating notices to advise train operators.

15. Training and Competence

Trainer, Driver and Guard/Conductor training and refresher packages were developed by the GSM-R project and are now archived on the Opsweb site (www.opsweb.co.uk). This includes an interactive PowerPoint presentation-based training aid.

Training of drivers incurs a 1-day course. Training of trainers incurs a 6-day course, including 1 day on the standard driver training course and 5 days on the simulator functionality, plus course delivery. Rail Operations Development Limited (RODL) has completed many `train the trainer' and end-user courses.
Experience had shown that the cultural shift from NRN was much greater than from CSR to GSM-R. The development of training and support need to take this into account. Implementation best practice is to provide extra support in the form of 'floor walkers' for the first few days.

Full driving cab simulators should contain GSM-R cab radio equipment and `free-play' simulation of GSM-R functionality. Core modules for this functionality have been developed by Corys, Sydac and Krauss Maffei Wegmann (KMW). Further details can be found in the Network Rail project document "Requirements for Integrating GSM-R into Driving Cab Simulators" (Ref 7). RUs should consider the need to further update

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their cab simulators should any future GSM-R cab radio functionality changes take place.

For the roll-out of GSM-R, transportable driver training simulators were developed by Corys and supplied to Network Rail. These Cab Mobile Training Simulators (CMTS) are coming to the end of their useful lives, facing reliability and obsolescence issues, having been used to train some 15,000 end users.

For train operators who do not own full driving cab simulators, NRT is developing a `long term training and competence system'. This will consist of tablets along with a handset that replicate the GSM-R DCP where a trainer can set and develop scenarios. Some operators have also developed an App that can remind staff on the operation of the system and try out scenarios.

Experience has shown that updates to software and registration arrangements at locations does need to be accompanied by the right briefing.

Maintainer training is supported by a modular training package and a physical Maintainer Training Rig (MTR). The MTR is supplied by Multipulse Electronics Limited and consists of a console containing a DCP, handset, loudspeaker and switches to replicate driver's key and DSD. A 'green' cab radio operates with a special SIM card that requires GSM-R network coverage to function but will not permit Railway Emergency Group Calls to be made. Future support for the MTR, and the archiving of maintainer training course material has yet to be resolved.

RUs should consider training other staff who might need to use the GSM-R system, for example staff assisting with incident management and Conductors for reporting delays.

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16. Reference Material

1. Incident Resolution Guide of GSM-R Faults and Failures, IRG Level 2, Delay Attribution Board.

2. Network Change Notice NCN5 – The National Rollout of the GSM-R System in Great Britain, 19 April 2010.

3. EIRENE Functional and System Requirements Specification, European Rail Agency.

4. Guidance on Train Voice Radio Systems, Railway Group Guidance Note GK/RT0694.

5. Rail Industry Standard for GSM-R Train Voice Radio, RIS-0794-CCS.

6. Requirements for Integrating GSM-R into Driving Cab Simulators, Network Rail, FTN/GSMR/PM/PL/021, Issue 3 dated 8.7.2011.

7. Siemens SVR400 cab radio fault finding flowcharts, 666/HB/86205/001, July 2012.

8. GSM-R Bulletins are currently available at www.networkrail.co.uk/gsm-r

9. Network Rail Control Manual NR_L3_OCS_043.

10. GSM-R System Reporting, Monitoring and Key Performance Indicators, Network Rail.

11. GSM-R Air Interface Functionality, Availability, Management and Compliance Validation, NR/L2/TEL/30127.

12. Technical Specification for Interoperability (TSI) for Control Command and Signalling subsystems latest version was adopted by Commission Regulation (EU) 2016/919 published in the Official Journal of the European Union on the 15th June 2016.

13. ETSI Specification for GSM-R radios - ETSI TS 103 328 V1.2.1 (2016-10).

14. DV81/RSCOM 15-60 presents an overview of different aspects of this coexistence, from a regulatory point of view of the coexistent of GSM-R and 3g and 4g mobiles endorsed 06/07/2015.

15. RIS-3780-TOM “Operational Requirements for GSM-R Radio – September 2016.

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17. Abbreviations

CACU	Combined Audio Control Unit
CCF	Control Centre of the Future
CCSSC	Control Command Signalling Standards Committee
CRWG	Communications Review Working Group
CT	Component Tracker
DAB	Delay Attribution Board
DAG	Delay Attribution Guide
DCP	Driver's Control Panel
DOO(P)	Driver Only Operation (Passenger) Trains
DOTE	Defective On Train Equipment
DRACAS	Defect Recording and Corrective Action System
DSD	Driver's Safety Device
EIRENE	European Integrated Railway Enhanced Radio Network
ERA	European Rail Agency
ETCS	European Train Control System
FMS	Failure Management System
FOC	Freight Operating Company
FRS	Functional Requirements Specification
FT	Fixed Terminal
FTN	Fixed Telecoms Network
GCA	Group Call Area
GDSG	GSM-R Stakeholder Delivery Group
IM	Infrastructure Manager
ICC	Integrated Control Centre
IRG	Incident Resolution Guide
KMW	Krauss-Maffei Wegmann
LAC	Location Area Code
LOM	Local Operations Manager
MNO	Public Mobile Operator
MOS	Mean Opinion Score

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MTR	Maintainer Training Rig
NCN	Network Change Notice
NFF	No Fault Found
NIR	National Incident Report
NMC	Network Management Centre
MTBF	Mean Time Between Failures
NRT	Network Rail Telecoms
OEG	Operations Enhancements Group
OPH	Operational Hand Portable
OTDR	On Train Data Recorder
OTA	Over The Air
PAYG	Pay As You Go
PMU	Portable Maintenance Unit
RDG	Rail Delivery Group
REC	Railway Emergency Call
RETB	Radio Electronic Token Block
RFG	Registration Focus Group
RGS	Railway Group Standard
RICC	Route Integration Control Centre
RIS	Rail Industry Standard
RMA	Reject Material Authorisation
ROC	Route Operations Control
RODL	Rail Operations Development Limited
RoSCo	Rolling Stock Operating Company
RSSB	Rail Safety and Standards Board
RTC	Return to Coverage
RTU	Radio Test Unit
RU	Railway Undertaking
RWG	Reliability Working Group
SIM	Subscriber Identity Module
SG	Systems Group
SOF	Service Operations Forum

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SRS	System Requirements Specification
SSA	Support Services Agreement
TD	Train Describer
TEC	Telecoms Engineering Centre
TOC	Train Operating Company
TT	Trouble Ticket (Remedy)
UPS	Uninterruptible Power Supply
UVS	Urgent Vehicle Standing
V&TC SIC	Vehicle & Train Control System Interface Committee
VCAG	Vehicle Communications Advisory Group
WON	Weekly Operating Notice

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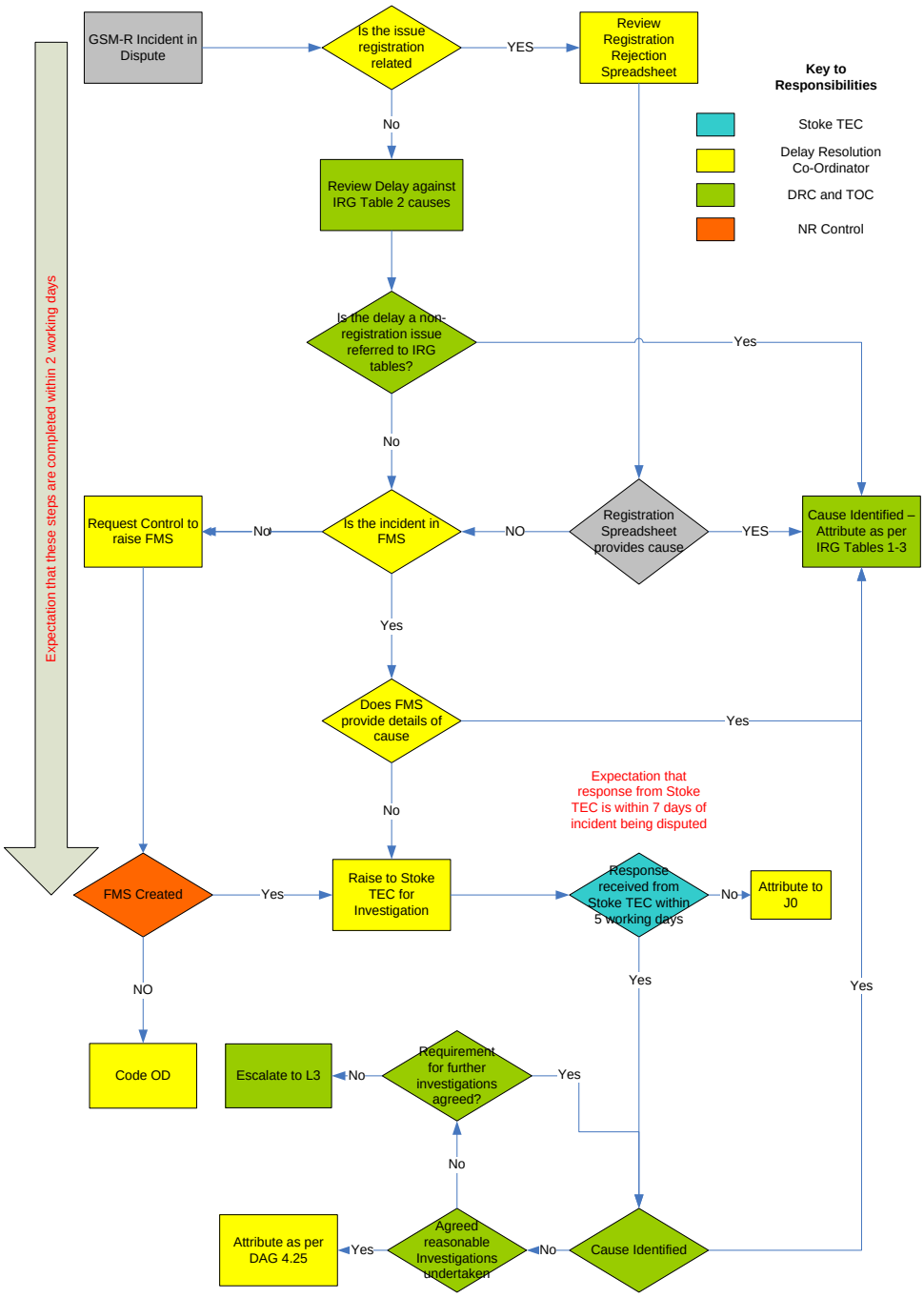
APPENDIX A

PROCESS FLOW CHART FOR DEALING WITH DISPUTED GSM-R DELAYS (Extracted from Ref 1)



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APPENDIX B

EXAMPLE NRT GSM-R DELAY INVESTIGATION CLOSURE REPORT

NRT Investigation Summary Form

Date/Time of Incident	Route	Operator	Cab S/W Version
02/04/2014 21:23	Wales	Arriva Wales	V1 - 2.6

TT Ref:	146549	FMS Ref:		Initial DAG Code	TG	Fault Priority	P3
TRUST Ref:	448444	CCIL Ref:					

Reported Details

2F64 driver could not log in

NRT Investigation Summary

Lack of information in TRUST made it unable to investigate 2F64 further.
Unit 865469 registers in Barry Station at 20:39 on 02/04/2014
Unit 865469 deregisters at Pentre Beach Station at 22:27 on 02/04/2014
An OSP was made at 21:23 to 2M68 from Unit 865469 and was replied by Cardiff TAFF to wait.

Next Action / Clear Details

No network or radio issues found in both 2F64 and 2M64 cases / close TT

FIP Guide and Steps:		FIP Ref:	85202

Systems / Network Elements Checked

Cab Mobile Activity:	Yes
GSM-R Radio Coverage:	Yes
GSM-R Network Equipment:	Yes
FTN Network Equipment:	Yes
GSM-R System Log Files:	Yes

IRG Code	IRG Fundamental Cause
NFF	It is the conclusion of this investigation that no fault could be identified that related to the telecommunications network opertated by Network Rail.

Date/Time NRT Investigation Completed	IRG NR/Operator Cause
03/04/2014 13:20	Unknown

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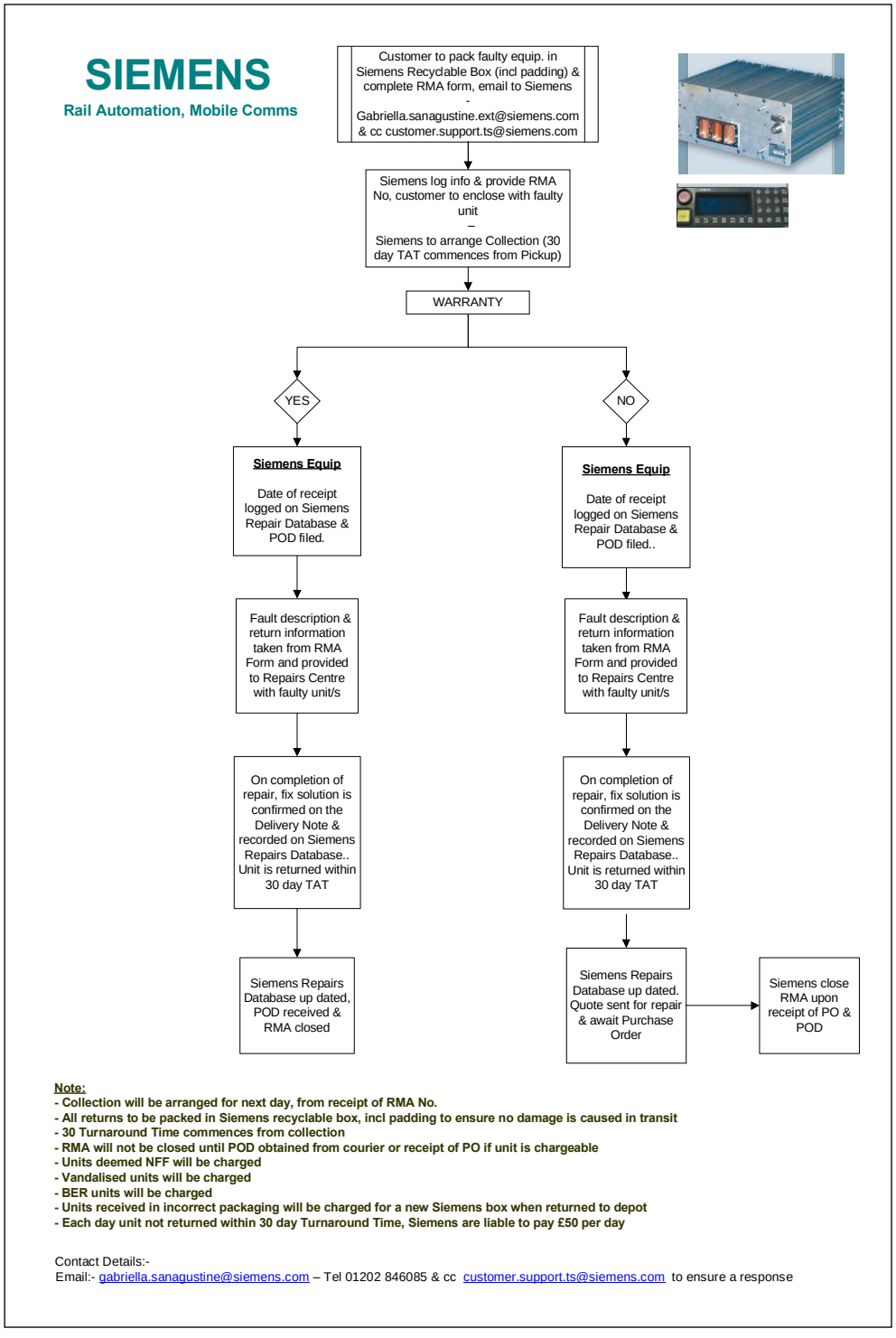
APPENDIX C

OVERVIEW OF SIEMENS' MATERIAL RETURNS PROCESS



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APPENDIX D

CHECKLIST OF TRAIN OPERATOR RESPONSIBILITIES AND ACTIVITIES

Item	Activity	Done?
Performance monitoring	Advise NRT of contact for receipt of daily, weekly and period performance reports/data	
	Set appropriate company KPIs	
	Brief delay attribution staff on IRG	
	Identify resource to conduct analysis of supplied performance data to monitor issues such as registration failure, excessive wild card used, misrouted calls, RTC, DSD alarms etc.	
	Review period performance report for trends	
RECs	Implement proactive measures to reduce risk of spurious RECs	
	Process in place for identifying and investigating spurious RECs	
Cab mobile	Obtain copies of Siemens cab radio Head Agreement and Additional Support Services Agreement	
	Request Siemens provide period report on company equipment returns	
SIM database	Conduct periodic check of ‘trains’ tab in weekly data to check SIM database entries	
	Set up process for amending SIM database entries if vehicle renumbering takes place, or new/cascaded vehicles obtained	
Fault management	Brief drivers and control staff about reporting GSM-R faults and essential data	
	Include GSM-R in DRACAS processes	
	Provide reliability data to GSM-R Reliability Working Group	
	Determine requirement for contingency radio (OPH or Transportable)	
	Implement an NFF process to filter out system issues and consider procuring RTU (NFF rig)	

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Item	Activity	Done?
Operating procedures/processes	Update DOTE	
	Review and action GSM-R Bulletins	
	Implement a process to maintain cab radio operator phonebook entries up-to-date	
	Implement a process to obtain cab radio Network Rail phonebook updates	
	Consider outputs of OEG	
	Consider procuring a Train Operator GSM-R Terminal (TOC Terminal)	
Training and Competence	Implement long term user and maintainer training and competence systems and processes	