	RSD Internal Guidance	RIG-2008-10
Global System for Mobile Communications – Railways (GSM-R)		

Date of issue/ last review	1st August 2016	**Date of next review**	31/07/2020
RIG postholder/owner		Stephen Williams Control, Command and Signalling	
RIG cleared by		Stephen Williams, Senior Engineer, Control, Command and Signalling	
RIG type		Policy ☐ Information ☒ Procedure ☐	
Target audience	RSD ☒ RPP ☒	Policy ☐ Inspectors ☒ Admin ☐	

Keywords	**GSM-R, TELECOMMUNICATIONS, RADIO SYSTEMS**
Summary	The purpose of this RIG is to provide Inspectors with background information on the features of, and issues associated with the Global System for Mobile Communications – Railways (GSM-R) now completely installed on the national rail network. Detailed and technical queries should be directed to Control, Command and Signalling engineers.
Original consultation	HMRI – Brian Ellis, Mike Smith, Stephen Williams, Stan Hart, Tom Whitehead Domestic Policy – David Morris Stakeholder Engagement – Keith Atkinson ORR – Ian Maxwell, Michael Haizelden
Subsequent consultation (reviews only)	ORR – Brian Ellis, Stephen Williams

Detail

INTRODUCTION

1. The Global System for Mobile Communications – Railways (GSM-R) is a communications system developed under a European Union initiative to provide a digital bearer (carrier) for data and voice communication in railway applications. It is the mandated radio bearer for use with levels 2 and 3 of the European Train Control System (ETCS) within the European Rail Traffic Management System (ERTMS). It is a mobile, cellular system in the same manner as the familiar Global System for Mobiles – Public (GSM-P).

2. In addition to its role within ERTMS, GSM-R has now replaced the previous voice radio communications systems used on the national network that included the National Radio Network (NRN), Cab Secure Radio (CSR) and the Strathclyde Manning Agreement (SMA) radio system in Scotland.

3. GSM-R is now in use on HS1 for domestic and international passenger and freight traffic. Work on the international border between the GB network and the French GSM-R network via Eurotunnel has now been completed. The transition area between the two networks in either direction to and from the Channel Tunnel is located on HS1 for non-stop traffic and at Dollonds Moor for stopping freight traffic.

4. An exception on the national network where GSM-R is not fitted is the RETB lines (West Highland and Far North) in Scotland where a VHF radio on new operating frequencies is now commissioned.

5. GSM-R provides for direct and secure driver – signaller communications with additional functionality over and above legacy systems. An example is the “railway emergency call” that when generated by a driver or signaller, provides a stop message to all trains within a signallers control area, without affecting trains on geographically close but physically separated lines.

6. The national GSM-R project was established in 1999 by Railtrack in order to install the system across the network in association with the move to ERTMS. The project as delivered has been subject to substantial alteration from its original specification partly as a result of recasting the timetable for ERTMS delivery and the more wide spread use of GSM for public use that has caused a number of issues with interference and required more cells to improve GSM-R coverage quality than originally planned.

7. Cab mobile installation is complete on all existing fleets and new vehicles are supplied fitted with GSM-R cab voice radios.

WHAT IS GSM-R & HOW DOES IT OPERATE?

Technical

8. GSM-R is a cellular mobile communications system that extends GSM-P (mobile phone) technology to be suitable for railway applications. This is achieved by use of additional algorithms in the data structure.

9. Effectively GSM-R may be considered as a 2G cellular mobile phone network selected and specified long before the current developments in mobile technology were envisaged. 3G/4G are now the accepted generations in use on public GSM systems across the UK and in this respect the lower radio frequency powers employed by GSM-R and the narrow bandwidth allowed within the public 900MHz frequency band makes GSM-R more susceptible to interference from public systems in part due to government policy (GSM coverage everywhere and the “connected train”). This is a recognised concern across Europe and the European Commission through their Communications Directorate are attempting to address.

10. GSM-R is expected to remain as the main bearer for railway communications for the foreseeable future. Developments in specifications are extending the capability of GSM-R by use of GPRS and EDGE technology which increases the call capacity of the existing system.

11. Initial work is already underway for the replacement of GSM-R in the longer term and for the UK this probably means beyond 2030 by which time the UK equipment will have been in use for up to 25 years. The Long Term Evolution (LTE) project is being managed by the European Rail Agency on behalf of the European Commission and this looks at emerging technologies and proposes that the replacement secure communications system for railways should be independent of specific technologies.

12. As a cellular system GSM-R requires a transmission network (delivered by the Fixed Telecommunications Network (FTN) Project) to join the Base Station Controllers (BSC) to the System Control and Network Management Centres in order for calls to be routed across the network and to allow for access to and from other telephone based communications systems.

13. The system consists of over 3000 cells, specifically aligned to the rail network. Masts are generally 15m or 29m and exceptionally higher where topography or existing masts dictate conditions.

14. **System components –** Infrastructure – Each base station site has a Re-locatable Equipment Building (REB) that houses the GSM-R base station and associated control equipment, a battery charger

and batteries and line interface frames for copper and fibre cables to interface the base station with the FTN network. The radio mast is provided adjacent to the REB.

15. Mobile –A cab mobile produced by Siemens is mounted in each cab of each locomotive or train. The radio head is usually mounted in the space vacated by the previous cab radio. The radio enables a driver or signaller to make point to point (1:1) calls. There is a facility for the signaller to initiate "group" calls to call every train currently in his operational area and replies from a driver are heard by other drivers in that area. A railway emergency call (REC) can be initiated by either a driver or signaller. A high priority call facility is provided on the cab mobile via a yellow button for drivers to call a signaller if there is a need to immediately report something that does not require all trains to be stopped by the use of the REC. There is also a facility to generate a very limited number of text messages such as "I am waiting at the signal" or "call signaller". Signallers can pre-record messages (for example to warn of low adhesion conditions) to be broadcast at regular intervals or associated with a "berth" track circuit when a train approaches a particular signal section.

16. The FTN and GSM-R network controls are managed at a TEC (Telecommunications Engineering Control) located on LNW route / territory, with a disaster recovery site on Great Western.

WHY GSM-R?

17. As the mandated "class A" radio bearer, adoption of GSM-R was a necessary outcome of the UK decision to adopt ERTMS with ETCS Level 2. However it also serves to address latent problems with the now legacy radio communications systems.

18. Recommendation 25 of the Joint Inquiry into Train Protection Systems chaired by Lord Cullen and Professor Uff in 2000 states: *"The selective fitment of GSM-R radio in advance of ETCS fitment to trains should be considered. For this purpose lines should be identified for the early fitment of ground and track equipment, to be followed by train-borne equipment."*

19. At the Ladbroke Grove Rail Inquiry, submissions were made by the industry to Lord Cullen indicating the desirability of a uniform system of radio communication for improving communications in a number of areas, including urgent messages between signallers and train drivers. These were borne out in Inquiry recommendation 51 which states: *"There should be a national system of direct radio communication between trains and signallers."*

20. Before privatisation the railway owned and operated its own private telephone network. In 1994 the railway telephone network, including transmission systems, was privatised and leased back to the railway to use the facilities as they had previously. The network was not new

then and has since become not only older, but more difficult to maintain. Little investment had been made in upgrading, other than provision of some modern telephone exchange equipment.

21. It became apparent in the late 1990s that the existing fixed and radio communications networks could not meet the system requirements for the railway in general, and GSM-R in particular. Railtrack/Network Rail embarked on a project to provide a transmission network that would sustain railway operational communications into the future. This developed into the FTN (Fixed Telecommunications Network) project and the concurrent GSM-R project. The scale of these projects is evident in that when combined they are the biggest project on the network.

22. The legacy radio systems, NRN and CSR were approaching the end of their useful life with most being in existence since the early/mid 1980s. Due to international agreements the Telecommunications Regulator (Ofcom) changed licence conditions for land mobile radio resulting in the withdrawal of Network Rails license to operate on NRN frequencies south of the Severn Wash line in December 2012 and with further license withdrawals across the UK following across the whole network by the end of 2016.

23. When implementation of GSM-R in the UK was first proposed it was expected that ERTMS would be provided across much of the mainline network by 2008. Hence, in order to comply with European directives, it was envisaged that GSM-R would be installed for the European Train Control System (ECTS), to data radio bearer standards.

24. There have since been significant delays to ERTMS implementation in the UK, as a result of technological and economic factors. These have resulted in widespread ERTMS deployment not likely to commence until around 2021, with some routes not being fitted until after 2035. GSM-R is therefore at this stage not widely required as a data bearer and is designed and installed as a “voice only” radio system except for the Cambrian Line where the system acts as the radio bearer for ETCS level 2 data and for Thameslink and Crossrail from Paddington to Heathrow where ETCS data will be required.

25. Implementation of GSM-R remained necessary in order to replace the ageing existing voice radio communications systems and reduce the risk associated with accidents such as the derailment and collision at Ais Gill in 1995.

THE GSM-R PROJECT

26. The project was led by a cross industry Programme Control Board (PCB), a high level industry management forum controlling the

whole venture. Since the initial project completed the on-going management of the system falls to Network Rail Telecoms.

27. The project aimed to complete implementation of GSM-R as a voice radio system by end of March 2014 but due to difficulties with commercial agreements, software issues and emerging issues with interference from public GSM the closure of the network change notice (NCN5) has not yet been achieved.

Human factors

28. The cab mobile man-machine interface (MMI) design was subject to stringent testing and the display type, including legibility in all lighting conditions has been addressed as well as form, function, position and tactile characteristics of buttons and switches. There are two types of MMI for signal box use and these were also subjected to ergonomic studies.

Operational rules

29. A cross industry forum chaired by RSSB was established to resolve the issues for the operation of GSM-R as the main means of communication between signallers and drivers. The latest version of the Railway Industry Standard is RIS-0794-CCS

30. The “Operational Concept” document was accepted by the industry and included all of the valid scenarios thought to be required to operate GSM-R. Each scenario was been exhaustively tested and from those, the operational rules and necessary changes to the Rule Book have emerged.

Operator training

31. Training of staff to use the system was an integral part of the project. A training needs analysis was developed and accepted by the industry. A training strategy put in place that provided the necessary levels of training supported by printed material specifically designed for each type of user of the system. Training simulators for drivers and signallers are in place for use across the network.

ORR INVOLVEMENT

Monitoring the project

32. In the HSE report on the 1995 accident at Ais Gill, HMRI indicated that it would continue to monitor the development and implementation of plans by Railtrack to improve and develop the radio system beyond basic provision of non-secure NRN links.

33. ORR attended the GSM-R PCB and was represented on the Operational Assurance Group, the RSSB lead forum to address

operational issues that arose during implementation and on-going use of GSM-R.

34. A number of inspections have taken place for both GSM-R and FTN projects and at the TEC and disaster recovery site. The inspections continue to satisfy the statutory requirements of the Interoperability Regulations to ensure that projects that are Authorised to be Placed in Service continue to adopt the maintenance procedures in place and that the Technical File is maintained up to date.

35. ORR has taken enforcement action in relation to the provision of suitable earthing for GSM-R installations where thefts have occurred. GSM-R equipment remained the responsibility of the project until it is taken into service with the agreement of the local Telecoms Maintenance Engineer (TME), now network management, faulting and maintenance activities are provided by Network Rail Telecommunications (NRT). If Inspectors become aware of issues concerning site maintenance and electrical compliance they should seek the advice of Control, Command and Signalling (CCS) team.

Action
(optional)

Inspectors are asked to note the content of this RGD, as background material when dealing with GSM-R issues. The RGD will be periodically updated, but Inspectors are advised to contact Brian Ellis, Head of the CCS team for confirmation of the latest position.

Requests for technical assistance should also be made to the CCS team.