21-019 – Rolling stock compatibility with CCS subsystems

Version:	2.2		
Purpose:	Approval to proceed to consultation		
Authors:	Darren Fitzgerald – Principal Electrical & Systems RST Engineer		
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Lead industry committee:	Rolling Stock Standards Committee (RST SC)	**Date:**	15 February 2024
Supporting industry committee:	Control, Command and Signalling Standards Committee (CCS SC)	**Date:**	08 February 2024
Supporting industry committee:	Energy Standards Committee (ENE SC)	**Date:**	29 February 2024
Supporting industry committee:	Plant Standards Committee (PLT SC)	**Date:**	29 February 2024

Decision

Rolling Stock Standards Committee (RST SC) is asked to:

APPROVE that the proposed new issue of GMGN2694 is consulted on.

In approving the standard for consultation the SC has:

DECIDED that the proposed new issue of GMGN2694 delivers the intentions of the proposal for change.

DECIDED that the proposed new issue of GMGN2694 is in a suitable state for consultation.

The lead SC is asked to:

IDENTIFY any specific organisations or individuals to be included in the consultation.

Control, Command and Signalling Standards Committee (CCS SC) is asked to:

SUPPORT that the proposed new issue of GMGN2694 is consulted on.

In approving the standard for consultation the SC has:

SUPPORTED that the proposed new issue of GMGN2694 delivers the intentions of the proposal for change.

SUPPORTED that the proposed new issue of GMGN2694 is in a suitable state for consultation.

The supporting SC is asked to:

CONSIDER whether they need any further involvement in the project beyond the pre-consultation stage.

Energy Standards Committee (ENE SC) is asked to:

SUPPORT that the proposed new issue of GMGN2694 is consulted on.

In approving the standard for consultation the SC has:

SUPPORTED that the proposed new issue of GMGN2694 delivers the intentions of the proposal for change.

SUPPORTED that the proposed new issue of GMGN2694 is in a suitable state for consultation.

The supporting SC is asked to:

CONSIDER whether they need any further involvement in the project beyond the pre-consultation stage.

Plant Standards Committee (PLT SC) is asked to:

SUPPORT that the proposed new issue of GMGN2694 is consulted on.

In approving the standard for consultation the SC has:

SUPPORTED that the proposed new issue of GMGN2694 delivers the intentions of the proposal for change.

SUPPORTED that the proposed new issue of GMGN2694 is in a suitable state for consultation.

The supporting SC is asked to:

CONSIDER whether they need any further involvement in the project beyond the pre-consultation stage.

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This business case for change has been developed to support standards committees in taking decisions related to changes to standards, it includes an assessment of the predicted impacts arising from the change.

Proposed new document(s)

Number	Title	Issue
GMGN2694	Guidance Note on Rolling Stock Electromagnetic Compatibility with Trackside CCS Subsystems	1

Summary

Background and change

Rolling stock vehicles can cause electromagnetic interference (EMI) in lineside copper cables by electromagnetic inductive coupling. Designing vehicles to limit such coupling into lineside copper cables, using methods such as filtering, is well understood but often physical testing (for example, running a vehicle on the track to check for EMI) is required to demonstrate compliance with RIS-8270-RST Route Level Assessment of Technical Compatibility between Vehicles and Infrastructure.

The electromagnetic compatibility (EMC) Sub-Group (SG) has developed a transfer function, supported by an extensive rolling stock emissions measurement campaign, that models the transverse voltage at the terminus of lineside copper telecommunications (telecoms) cables due to EMI by rolling stock. When introducing new fleets of vehicles to a network, extensive EMC testing is carried out so that the infrastructure manager can be confident that the vehicles do not cause interference with telecoms circuits.

By using a transfer function that models electromagnetic inductive coupling into lineside copper cables, type testing may be reduced as compatibility can be initially confirmed by the transfer function. Also, the risk of the train failing any test is reduced because the effect of rolling stock coupling to lineside copper cables, which results in noise on cables that manifests either as voice communication distortion or as the maloperation of a frequency selective system, such as reed frequency division multiplex (FDM), can be modelled by rolling stock manufacturers at the design stage rather than only discovering a non-compliance once the rolling stock is built.

EMC values, such as interference currents at particular frequencies, are valuable to rolling stock designers as they provide constraints for systems, but they are not given in a single document that is easy to reference. A new guidance note which captures industry good practice and identifies where susceptibility limits are given and how they can be interpreted will be useful.

Industry impact due to changes

Impact areas	Scale of impact	Estimated value £'s
A. Legal compliance and assurance	Medium	£30,000 over five years
B. Health, safety and security	Neutral	No benefit claimed
C. Reliability and operational performance	Neutral	No benefit claimed
D. Design and maintenance	High	£10 million over five years
E. People, process and systems	N/A	-
F. Environment and sustainability	Low	No benefit claimed
G. Customer experience and industry reputation	N/A	-
Total value of industry opportunity =		**£10,030,000 over five years**

The standards change contribution to the total value of industry opportunity				
☐ None or low	☐ Minor but useful	☐ Moderate	☑ Important / essential	☐ Urgent / critical

Detail

1. What are the objectives associated with this change?

Objective 1 – Set out the methodology to develop a transfer function for electromagnetic inductive coupling from rolling stock into lineside telecoms circuits

1.1 Objective 1 – Request for Help 21-REQ-034 submitted by Crossrail in June 2021 outlined the need by industry, voiced through the EMC SG, for a transfer function that facilitates achieving EMC between rolling stock and lineside copper cables.

1.2 Power supply inverters and rectifiers on rolling stock, which convert direct current (dc) to alternating current (ac) and ac to dc respectively, are an example of a common source of electromagnetic emissions due to the way they operate and can introduce transverse voltages into lineside copper cables.

1.3 Transverse voltages in lineside copper cables can affect telecoms cables causing poor quality audio for drivers and signallers when using communication methods such as signal post telephones.

1.4 EMC testing during vehicle type testing prior to entry into service is one way of giving assurance that this will not occur, however this can take several attempts due to several rolling stock systems causing electromagnetic inductive coupling to lineside copper cables and the routes differences on which the vehicles are intended to operate, often necessitating vehicles being tested, tuned and retested.

1.5 A transfer function will allow system designers to refine the settings of power converters and other electronic equipment prior to type testing, resulting in fewer tests needing to be carried out on routes for EMC purposes.

Objective 2 – Provide guidance and identify sources of information relating to rolling stock compatibility with control, command and signalling subsystems

1.6 Achieving EMC between rolling stock and control, command, and signalling (CCS) subsystems from a rolling stock perspective is not presently well specified and methods of demonstrating EMC between the subsystems can vary.

1.7 There are several CCS subsystems which have not had their out-of-band limits characterised and which are known to be susceptible to rolling stock electromagnetic coupling however, the relevant susceptibility information is not generally available, and needs to be defined so that supported susceptibility limits can be determined. Out-of-band refers to frequency ranges outside of the typical operational frequency band of a system which are conversely referred to as in-band limits.

2. How does the content in the standard need to change to achieve the objective?

Objective 1 – Set out the methodology to develop a transfer function for electromagnetic inductive coupling from rolling stock into lineside telecoms circuits

2.1 The new guidance note GMGN2694 will provide a definition and guidance on the methodology to develop transfer function for electromagnetic inductive coupling for use by rolling stock system designers and manufacturers to tune electronic circuits, together with worked examples on its application.

Objective 2 – Provide guidance and identify sources of information relating to rolling stock compatibility with control, command and signalling subsystems

2.2 Guidance on rolling stock EMC with CCS subsystems, together with reference to relevant sources of information will be given, including:

- RIS-0725-CCS 'Electromagnetic Compatibility of Train Detection Infrastructure with Rail Vehicles'
- RSSB research project T1225 (2021)
- BS EN 50121 'Railway Applications – Electromagnetic Compatibility'
- GERT8075 'AWS and TPWS Interface Requirements'
- Network Rail guidance notes (50xxx series) – also known as the 'Industry Data Initiative' or 'IDI' suite of documents
- Guidance to support compatibility with level crossing predictors
- ERA ERTMS document 033281 'Interfaces between Control-Command and Signalling trackside and other subsystems'

3. How urgently does the change need to happen to achieve the objectives?

3.2 This change is not a high priority as it does not impact any current stakeholder projects, however there are benefits in developing this content in a timely manner to support the design of new vehicles.

4. What are the positive and negative impacts of implementing the change?

Justification of impact, scale and quantification for the seven impact areas

A. Legal compliance and assurance

4.1 Vehicle manufacturers, operators and infrastructure managers will benefit from guidance on a rolling stock electromagnetic inductive coupling transfer function through a reduction in the number of EMC test-runs that will be necessary per vehicle type (known as a 'type test' prior to fleet introduction, which includes route compatibility in accordance with RIS-8270-RST 'Route Level Assessment of Technical Compatibility between Vehicles and Infrastructure').

4.2 The cost associated with a type test would include a track access charge, in addition to charges for use of the ac overhead line, and require as a minimum a driver, engineer and technician.

4.3 Network Rail charge two pence-per-vehicle mile for use of the AC overhead contact line, and £3.72 per-vehicle mile for track access charges for four motor and eight trailer units based on default rates. These values are from the Network Rail CP6 Track Usage Price List 22-23.

4.4 For a two-hundred-mile test trip, which is approximately the distance of travelling from Liverpool Lime Street to Crewe via Manchester Airport, the combined Network Rail charge for track access and use of the AC overhead contact line would be in the region of £750 (£0.02 x 200 + £3.72 x 200 = £748)

4.5 The total combined cost of a type test including driver, engineer, and technician at £800 per person, per day is therefore approximately £3,000 (£800 x 3 + £750 = £3,150). If it is assumed that three tests are required to achieve vehicle compatibility with the infrastructure, the cost would be £9,000 per type test per vehicle type.

4.6 If the development and the use of the transfer function were to reduce the number of type tests needed, then for each two-hundred-mile type test not performed, a benefit of £3,000 could be realised. On the basis that one new fleet and one re-tractioned fleet were introduced per year over a five-year period, the benefit would be the equivalent of £30,000 (£3,000 x 2 x 5) excluding administrative costs. There is the potential for industry to save considerably more where the need for multiple type tests is eliminated, but in the absence of data this cannot be quantified.

B. Health, safety and security

4.7 Giving a transfer function to which rolling stock electromagnetic inductive coupling conforms will benefit railway undertakings by demonstrating inductive coupling to lineside copper cables and their associated systems are kept to an acceptable limit from the start of vehicle design. A reduction in interference in telecoms cables will reduce the risk of calls made from lineside telephones being compromised through interference, and the risk of data corruption on lineside frequency selective systems. However, it is considered not to be proportionate to attempt to assign a quantified benefit that could arise as a result of the guidance in GMGN2694 on safety communications as the EMC testing currently undertaken during type testing would reduce the occurrences of such events, whereas use of the transfer function will only improve the efficiency of the type testing process. Therefore, the impact is considered neutral, and no benefit is claimed.

C. Reliability and operation performance

4.8 GMGN2694 will have a neutral impact on in-service reliability and operation and no benefit is claimed.

D. Design and maintenance

4.9 Demonstrating compatibility by testing can be unsatisfactory because the testing outcomes are not known until the very end of the process, at which point expensive hardware has been built and may then require modification if the tests do not demonstrate that EMC has been

achieved. A clear definition of the requirements needed for compatibility which can be used by vehicle manufacturers in the design process which could avoid expensive modifications after the vehicle has been built.

4.10 It has been identified by industry that it would not be unreasonable to consider that one new train design in three will require some sort of modification to achieve EMC before entering service. The approximate cost of a modification could be around £10 million if it is required after the initial design and assembly of the vehicle. It would also add a delay to the introduction of rolling stock whilst the modifications take place. If one new fleet and one re-tractioned fleet of trains were to be introduced per year in GB over a five-year period, then on the basis that one in three will require modification this would be equivalent to a cost of £30 million. If the use of the transfer function were to prevent one fleet of trains from being modified in a five-year period, this would represent a benefit of £10 million. It is considered not to be proportionate to attempt to assign a quantified benefit for costs associated with any delay to fleet introduction as this cost is variable and unknown.

4.11 A reduction in electromagnetic coupling between rolling stock and lineside copper cables may result in fewer complaints logged about interference on telecoms lines that necessitate remedial action by the infrastructure manager. In the absence of data it is considered not to be proportionate to attempt to assign a quantified benefit for any reduction in remedial actions associated with electromagnetic emissions from rolling stock to lineside copper cables and no benefit is claimed.

4.12 A reduction in electromagnetic coupling between rolling stock lineside copper cables may also result in fewer instances of maloperation of frequency selective systems where such systems use a frequency, either analogous or digital, to operate. In the absence of data it is considered not to be proportionate to attempt to assign a quantified benefit for any reduction in remedial actions associated with electromagnetic coupling from rolling stock to lineside copper cables and no benefit is claimed.

E. People, process and systems

4.13 Not applicable.

F. Environment and sustainability

4.14 Train builders that are uncertain on where interference will occur with the infrastructure can unnecessarily add equipment to reduce electromagnetic coupling. This has an environmental cost because it will add weight that will have a carbon impact, however this weight will vary depending on the type and class of rolling stock. It is considered not proportionate to quantify the environmental benefit of the reduction in weight that may be realised by implementing GMGN2694 in the absence of rolling stock weight data.

G. Customer experience and industry reputation

4.15 Not applicable.

5. What is the contribution of this standards change in realising the value to industry opportunity?

5.1 Providing a transfer function to define the relationship between rolling stock electromagnetic inductive coupling and lineside copper cables will help rolling stock designers achieve compatibility. For every new vehicle that enters service a route compatibility assessment takes place at a cost to stakeholders. A transfer function which supports this route compatibility assessment will benefit the whole industry by reducing the need to run test trains, which uses resources from several business functions including operations, train planning, engineering, and resource planning.

5.2 The standards change contribution to the total value of industry opportunity is categorised as important with a value of £10 million over five years.

6. What is the effort required by RSSB to make the change?

6.1 The project will be led by a principal technical specialist from the rolling stock standards team, supported by specialists from the CCS and risk and safety intelligence disciplines, together with a project manager. An industry working group will be established to help develop and review the content.

7. Can RSSB deliver against industry's expected timescales?

7.1 RSSB has identified the resources needed to meet the proposed programme with a completion date of September 2024.

8. How will the industry implement the change?

8.1 The guidance in GMGN2694 will establish a transfer function that is consistent across vehicles designs, which to gain the benefit is intended to be implemented by industry from the start of the design phase.

9. How will RSSB assess whether the change is achieving the objectives?

9.1 Feedback on the application of the standard from industry groups will be sought from industry at the 12-month review and the number of enquiries to the Customer Relationship Manager (CRM) portal can also indicate whether the guidance is achieving its objectives.