Oliver Stewart
RAIB Recommendation Handling Manager

31 March 2023

Mr Andy Lewis
Deputy Chief Inspector of Rail Accidents

Dear Andy,

RAIB Report: Loss of safety critical signalling data on the Cambrian Coast line on 20 October 2017

I write to provide an update[1] on the action taken in respect of recommendation 1 addressed to ORR in the above report, published on 19 December 2019.

The annex to this letter provides details of actions taken in response to the recommendations and the status decided by ORR. The status of recommendation 1 is **'Closed'.**

We do not propose to take any further action in respect of the recommendation, unless we become aware that any of the information provided has become inaccurate, in which case I will write to you again.

We will publish this response on the ORR website on 3 April 2023.

Yours sincerely,

Oliver Stewart

[1] In accordance with Regulation 12(2)(b) of the Railways (Accident Investigation and Reporting) Regulations 2005

Recommendation 1

The intent of this recommendation is to ensure clear and effective instruction is given to staff discharging the client role responsibilities essential for the safe introduction of new and modified high integrity software-based systems. Implementation is expected to take account of RSSB Guidance Note GEGN8650, 'Guidance on high integrity software- based systems for railway applications'.

Network Rail, in consultation with RSSB and the wider rail industry and drawing on existing processes where appropriate, should develop and implement a mandatory safety assurance procedure (and associated guidance) for its client role on projects involving installation and modification of high integrity software-based systems. The process should incorporate relevant best practice from other safety critical industries. It should clearly define the role of the client in each of the following areas:

- clearly documenting its expectation of each supplier as part of the project's overall safety assurance process, including the required safety justifications, documentation and the traceability of safety evidence throughout the project's life cycle;
- selection of suppliers that are competent and capable of delivering a safe system;
- specifying the role of independent safety assessment bodies, such as ASBOs (assessment bodies);
- capturing the need for good engineering safety management, robust configuration management and change control in the contractual requirements;
- defining the required safety integrity of the key safety functions, the operational context and external interfaces;
- the process to be applied when placing reliance on the re-use or adaptation of a system with previous acceptance, or commercial off- the-shelf products;
- working with the supplier to properly understand the safety risks and define the system safety requirements and architecture;
- monitoring the supplier's verification of its design (hardware and software);
- ensuring that the design is suitably validated prior to commissioning;
- audit and inspection by the client;
- the extent of the client's review of independent assessments, and its own consideration of the safety justifications as part of the approval process;
- testing and commissioning of the installed system, and subsequent maintenance; and
- recording and retaining data needed for investigation of safety related failures.

This procedure should be shared with the wider rail industry with a view to it being adopted by other potential clients of high integrity software-based systems, such as train operators and rolling stock owners.

ORR decision

1. The recommendation called for a new procedure to help clients of safety critical software understand their responsibilities properly, to ensure that the delivered product is safe and suitable for the lifetime of the system. Although the recommendation was directed to Network Rail, a procedure was needed that covered the wider sector, including suppliers and contractors, so the work to address it was led by RSSB. The initial draft content was developed by Network Rail and CapGemini, who then worked collaboratively with RSSB and wider industry partners to develop the content of the RIS.
2. RSSB has issued RIS-0745-CCS - *Client Safety Assurance of High Integrity Software-Based Systems for Railway Applications*. The RIS collects the common practices that should already be in use (such as the system lifecycle process from BS EN 50126-1:2017) together in one place, rather than across several industry standards that were used previously. Existing on-going projects should already be using these principles, although the RIS makes it a neater guiding process. Common issues and faults are described in the RIS as a guide for any future project about to begin. The RIS also details what a good assurance process looks like, how to document what has happened through the lifecycle and the importance of competence.

3. Network Rail is bound by a license condition that requires a RIS to be followed, or an equivalent standard. We challenged Network Rail to explain how the RIS was being adopted; how staff competence would be handled; how it would be applied to the whole life of a project; and how it would be applied to existing projects.

4. The RIS has been adopted by the systems engineering group in Network Rail. Network Rail is developing guidance in collaboration with CAP Gemini on how to apply the RIS for small, medium and complex projects. The ASBO forum has been asked for views to feed into guidance. Briefing have also been delivered for small groups of Network Rail staff and suppliers and an industry webinar. The RSSB Asset Integrity Group (AIG) commissioned Limbusa to develop e-learning designed to help raise industry competence in matters relating to the RIS.

5. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Network Rail has:

- taken the recommendation into consideration; and
- has taken action to close it

Status: Closed

Previously reported to RAIB

6. On 18 December 2020 ORR reported the following:

Network Rail have set in motion the actions the recommendation envisages and is working with the RSSB Asset Integrity Group (AIG) to develop an industry wide action plan. AIG is incorporating the existing activities of the former High Integrity Software Group (HISG) as it had already been considering some of the subject areas associated with this recommendation.

AIG is planning to produce guidance to outline the key requirements for companies involved in designing and installing new or modified high integrity software-based systems. The guidance will aim to address the bullet points listed in the recommendation and reference, or consolidate, the existing guidance note GEGN8650 (Guidance on High-Integrity Software-Based Systems for Railway Applications). The guidance is expected to be issued by 3 September 2022.

We considered the recommendation an opportunity to share lessons learned and best practice with other railway infrastructure managers (HS1, HS2, London Underground) and asked those organisations to provide a response.

Update

7. On 4 October 2022 Network Rail provided the following closure statement:

[N205-05] Cambrian
Rec 1 Closure Statem

Previously reported to RAIB

Recommendation 1

The intent of this recommendation is to ensure clear and effective instruction is given to staff discharging the client role responsibilities essential for the safe introduction of new and modified high integrity software-based systems. Implementation is expected to take account of RSSB Guidance Note GEGN8650, 'Guidance on high integrity software- based systems for railway applications'.

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- the extent of the client's review of independent assessments, and its own consideration of the safety justifications as part of the approval process;
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- recording and retaining data needed for investigation of safety related failures.

This procedure should be shared with the wider rail industry with a view to it being adopted by other potential clients of high integrity software-based systems, such as train operators and rolling stock owners.

ORR decision

1. Network Rail have set in motion the actions the recommendation envisages and is working with the RSSB Asset Integrity Group (AIG) to develop an industry wide action plan. AIG is incorporating the existing activities of the former High Integrity Software Group (HISG) as it had already been considering some of the subject areas associated with this recommendation.

2. AIG is planning to produce guidance to outline the key requirements for companies involved in designing and installing new or modified high integrity software-based systems. The guidance will aim to address the bullet points listed in the recommendation and reference, or consolidate, the existing guidance note GEGN8650 (Guidance on High-Integrity Software-Based Systems for Railway Applications). The guidance is expected to be issued by 3 September 2022.

3. We considered the recommendation an opportunity to share lessons learned and best practice with other railway infrastructure managers (HS1, HS2, London Underground) and asked those organisations to provide a response.

4. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Network Rail has:

- taken the recommendation into consideration; and
- is taking action to implement it by 3 September 2022

Status: Implementation on-going. **ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.**

Information in support of ORR decision

5. On 10 August 2020 Network Rail provided the following initial response:

In response to this recommendation, Network Rail has recognised that an industry response needs to be taken to address this recommendation as high integrity software-based systems can be infrastructure and/or train based e.g. trackside and on-board signalling systems.

Network Rail has therefore engaged with the new industry-wide Asset Integrity Group (AIG) established by RSSB to look at how the industry could best respond to this recommendation.

The AIG has agreed to lead on scoping the action plan to address the recommendation. An initial scoping paper (attached) was submitted to the meeting on the 29 July 2020, which received agreement. The paper proposed that a Rail Industry Standard (RIS) be produced to outline the key requirements and guidance for clients involved in designing and installing new or modified high integrity software-based systems. It will seek to address the bullet points listed in the recommendation and reference, or consolidate, the existing guidance note GEGN8650 (Guidance on High-Integrity Software-Based Systems for Railway Applications). Compliance with RISs are a licence condition of Network Rail, train operators and station operators. The requirement to comply with the RIS can also

form part of the contractual requirements for infrastructure and train system suppliers.

RSSB is currently leading the drafting of the 'case for change' proposal (including the business case) to develop the RIS, which will require a sponsoring standards committee. Due to the scope, multiple standards committees will need to be involved, increasing the importance of an efficient and effective project strategy. AIG will be briefed on the progress at the next meeting which is scheduled on 18 September 2020.

As part of the wider industry activities, AIG is also in the process of incorporating the existing activities of the former High Integrity Software Group (HISG) as this is the ideal forum to progress this recommendation.

When RSSB has received confirmation of the approval of the business case and the multi-functional drafting review group has been established, we will be able to provide an update on the planned schedule. This update will be provided by end-November 2020.

As part of this workplan, it is proposed that a desktop review will be undertaken to identify potential failure modes associated with both the procurement process as well as the technical elements of the system themselves. A failure mode could be lack of specification of the parties' responsibilities (e.g. not appointed an independent assessor, incorrect remit, omissions in remit), as well as technical failure modes relating to software and hardware functionality (e.g. memory buffer, requirements for data backup).

As part of wider industry engagement, a CP6 workplan for AIG is under development, including broader engagement throughout the supply chain, including both train and infrastructure elements.

Whilst it may take some time to develop, agree and publish the RIS in response to RAIB Cambrian Recommendation 1, the actions being taken in response to RAIB Cambrian Recommendation 3 will seek to promote greater industry awareness of the potential failure modes through referencing case studies involving high integrity software-based systems. These will include case studies from other safety critical industries.

Evidence required to support closure of recommendation

Publication of the Rail Industry Standard.

6. On 1 December 2020, Network Rail provided the following additional information:

Activities undertaken (up to 30 November 2020)

- *Initial hazard identification sessions held to identify the procurement and technical hazards attended by experienced safety, cyber security and information technology experts.*
- *Presentation to industry AIG on 18 November 2020 to obtain continued industry support for the approach.*

- *Project Manager identified for production of the business case for change for a RIS, and indicative timelines identified for different routes to publication. The case-for-change for a RIS may, depending on Standards Committee feedback, need to be modified to include additional or interim routes to publication.*

- *Two meetings held with Network Rail and RSSB attendees to discuss and outline the proposals for the content to form part of the business case for change n.b. further meetings are planned that include evaluating the optimum approach for alignment for new document with GEGN8650. Alignment of the RIS with ECM regulations and ROGS will be noted, particularly where the OEM is also an ECM.*

Milestones for the remaining action plan

Milestone	***Date***
Produce first draft of more detailed content for proposed RIS identifying key linkages with the existing guidance note	*26 February 2021*
Detailed content for proposed RIS produced in required format following working group review	*30 July 2021*
RIS content finalised by working group	*1 Sep 2021*
Standards Committees review and approve for consultation	*5 Nov 2021*
Consultation completed	*15 Dec 2021*
Produce updated draft, including review of outcome of consultation with working group, and finalise document for approval	*15 Feb 2022*
Standards Committees approve for publication	*15 May 2022*
Publish RIS	*3 Sept 2022 (n.b. an earlier date may be achieved if Standards Committees approve alternative route to publication changes)*

7. On 29 May 2020 HS1 provided the following initial response to recommendations 1 & 3:

The HSl Signalling Environment and Similarities with Cambrian
Apart from the St Pancras area, HS1 operates the widely used TVM430 in-cab signalling system, as used throughout France, Belgium and South Korea on their high-speed lines. The system used on HSl uses an Ansaldo supplied train controls system, known as the Route Control Centre System (RCCS) and TVM430 SEI interlockings,know in the UK as ITCS (Integrated Train Control System).

At St Pancras, HS1 uses ITCS interlockings but conveys movement authorities via Multi-Aspect Colour Light (MACL) signals with supervision/ATP provided by KVB (Kontrole de Vitesse par Balise) located in the '4 foot' and read by trains as they pass over them.

The HSl system shares some basic similarities with the ETCS level 2 system deployed on Cambrian. Both systems incorporate permanent Automatic Train Protection and supervision with in-cab signalling. Both systems were designed and supplied by Ansaldo STS and the interlocking technology deployed on both lines is very similar.

The Cambrian train control system does not have the same level of functionality as HS1's RCCS despite having visual similarities. For example, it does not incorporate ARS (Automatic Route Setting). Also, the Cambrian interlocking does not form part of the overall TSR process.

Despite similarities, there are major differences which are key in understanding the cause of the failure on Cambrian and its inapplicability, in the same manner, as to HS1.

The method of applying a TSR on Cambrian involves the GEST control terminal and server which links directly to the RBC which issues the movement authority, including the TSR, to the trains; HS1 has neither a GEST terminal nor an RBC. For HS1, TSR's are normally commanded via the RCCS and implemented in the ITCS interlocking, which can be remotely and locally applied. The Cambrian TSR function is managed by the additional GEST system.

Having described the key architectural differences, the question arises as the whether the same failure could present on HS1 given a similar scenario.

There are two issues to address in the case experienced on Cambrian Line ERTMS line for HS1:

1. *Are TSR's retained within the HS1 signalling if the system used to apply them (RCCS) is rebooted or*
   powered down and back up again?
2. *Can the indications for TSR's shown on the HS1 RCCS be incorrect after a reboot of the TMS?*

The HS1 RCCS is directly connected to the interlockings which are distributed locally along the length of HS1.

The interlockings convey the movement authority to the train through the rails so, unlike ETCS, no Radio Block Centre (RBC) is needed.

The HS1 signalling system also employs local TSR switch panels in each signalling room, which are spaced approximately every 14km along the line. This allows pre-set TSR's, typically 160km/h and 80km/h, to be physically switched at a panel and padlocked for the duration of the restriction. This directly feeds the interlocking and is not affected should the interlocking be powered down and then back up.

TSR's on HS1, therefore can be applied remotely at the RCCS over a wide area, locally via the switch panel or at St Pancras using the KVB system.

The table below shows the impact of a TSR applied in one of three scenarios on HS1 and provides details regarding their status at the interlocking level and at the control level, i.e. the signaller's display.

The system in use on HS1 for the application, retention and removal of a TSR incorporates three levels:

TSR Type	Detail	Affected by a TMS reboot	TSR indication on signaller's screen
KVB TSR. These TSR's are applied for speeds less than 80 km/h and are combined with a TSR applied on local switching panel in the signalling technical room.	Local TSR applied using KVB a beacon placed in the '4 foot' at the appropriate distance.	Not affected, the TSR beacons remain in place and the local switch is still activated.	Not affected, the TSR are local switches which are directly wired to the interlocking
TSR applied on local panel in signalling room.	TSRs have been applied by maintainers using an Ops instruction at local TSR panels.	Not affected, the TSR are local switches which are directly 'hard-wired' to the interlocking.	Not affected, the TSR are local switches which are directly wired to the interlocking
TSR applied remotely.	Remote TSR applied by the signaller using the RCCS.	Not affected as the TSR's are set within the ITCS interlocking. A reboot of the RCCS will not affect the existing TSR's.	Not affected as the TSR's are set in the interlocking. A reboot of the RCCS will not affect the existing TSR's

Conclusion:

There are no issues with TSRs on HS1 if the RCCS or ITCS is rebooted, as the TSR's are set directly and retained within the ITCS interlocking; this differs significantly from Cambrian which applies TSR's using the GEST terminal and the RBC, neither of which are used on HS1.

When the HS1 RCCS system is rebooted, it is initialised with the complete status of all the signalling field equipment from the ITCS interlocking. This includes any protection and TSRs previously set and memorised in the interlocking. This avoids any discrepancy between the status of the track system and the indication on the signaller's display.

If an interlocking is rebooted, all the remote protections are applied automatically by the interlocking within the area controlled.

8. On 1 July 2020 HS2 provided the following initial response:

The HS2 Safety Strategy and associated Rail Systems Safety Plan defines the system safety activities required to support the creation of the High Speed 2 (HS2) system solution. With respect to the Railway Communication, Signalling and Processing Systems is concerned, HS2, the approach defined therein:

- *complies with the requirements of RSSB Guidance Note GEGN8650 that refers out to BS EN 50128:201, BS EN 50159:2010 and BS EN 50126:1999.*
- *complies with the risk management activities of CSM RA Regulation 402/2013 as amended by Regulation 2015/1136;*

- *The CSM-RA Regulations* ***Error! Reference source not found.*** *and CENELEC standards EN 50129:2018, EN 50126-1 (2017), EN 50126-2 (2017) and BS EN 50128:2011 to develop the HS2 Railway System Safety Case.*
- *supports the production of a suite of generic and specific application safety cases and the associated Safety-Related Application Conditions (SRACs), as defined by BSEN50129, that is developed in accordance with the life cycle mapped out in the Railway Systems Safety Plan;*
- *supports the production of a Safety Justification reports; these are required to be delivered at different stages in the system lifecycle to the HS2 System Review Panel (SRP) for approval prior to proceeding to the next design stage.*
- *ensures that a consistent approach to system safety is adopted for all Railway system and sub-system development activities (where system includes people, product and processes);*
- *The HS2 Head of System Safety, Security and Interoperability sits on the RSSB High Integrity System Group (HISG) and has done since its inception in 2013. As part of this they have been part of the development of GEGN 8650.*

Approach to Safety

Specifically, our approach provides

- *an overview of the systems that comprise HS2, as defined in the suite of System Definitions;*
- *the structure of the Systems Safety management organisation and the related responsibilities will be clearly defined and communicated to all.*
- *the process for thorough and systematic hazard identification, evaluation and risk assessment that will ensure a common approach to the identification of hazards and their elimination or reduction to acceptable levels of risk;*
- *a baseline suite of the safety deliverables required to support the overall HS2 Safety Case, as defined by BS EN 50129 and BS EN 50128, The deliverables being developed in accordance with the life cycle mapped out in Rail Safety Plan; and include Generic Product Safety Case (GPSC), Generic Application Safety Case (GASC) and a Specific Application Safety Case (SASC).*
- *an aligned delivery programme between the respective systems' safety programmes.*
- *A robust Safety Requirements derivation and control process that apportions all HS2 requirements to each sub-system. This will include Tolerable Hazard Rates and where appropriate SIL levels for each function.*
- *Robust requirements traceability using the HS2 requirements management database (DOORS). This ensures:*
    - *the inclusion of all Safety Measures and requirements within the ITT, serving as the basis for verification of the respective system designs with respect to safety (during Tender Review and subsequent delivery).*
    - *formalised links are established between each Safety Measure / Requirement and the associated Hazard Record.*

- *traceability to the source of the Safety Measures and requirements.*

- *the System Safety management controls to ensure that*
  - *hazards and requirements are managed adequately and transferred appropriately from one system owner to another throughout the system life cycle.*
  - *a close interaction between the systems (which includes engineering, operations, maintenance and business change) and System Safety functions is established to ensure that System Safety deliverables are of the required specification and fully integrated into the design.*
  - *the correct supplier is selected to deliver the sub-systems based upon a rigorous review of the response to the ITT*

- *The System Safety approval process that will be supported by provision of evidence to independent Safety Authorities – e.g. evidence of safety requirement validation, verification of Safety-Related Application Conditions and other safety case constraints. This process is addressed in the HS2 Authorisation Plan*

- *Independent Internal and External (e.g. ISA, AsBo, DeBo, and NoBo) Assurance Bodies have be engaged to provide a HS2 Independent Assurance function and provide regular reports to the HS2 SRP.*

Safety Controls

Change Management / Configuration Management

Configuration Management is essential on any safety-critical programme in order to track changes on those items used to achieve or demonstrate safety and the relationships between them. Further details of the arrangements in relation to this will be provided in the HS2 Configuration Management Plan.

Each sub-contractor shall be responsible for implementing their own change management process, with all software and data related changes managed in accordance with BS EN 50128.

It is the responsibility of HS2 to provide appropriate surveillance of the supplier's system safety programmes so that timely management action can be taken as the need arises and programme progress ascertained. This surveillance will involve reviewing System Safety Plans, Safety Analysis and Justifications, and performing Safety Audits.

Supplier Control and Management

Adherence to the requirements specification throughout the life of the project will be controlled through the integration and close co-operation of the HS2 and Supplier Project Teams via the following activities:

- *HS2 supplying the specification to the supply chain with detailed requirements and ensuring that the requirements are understood;*
- *Agreeing the methods and solutions to be used by the specification and generic design teams in order to meet the System Safety requirements;*

- *Agreeing the type, format and schedule of data to be prepared by the specification and generic design teams in support of System Safety activities;*
- *Monitoring of performance of the specification and design through informal day-to-day contact, design reviews and reports; and*
- *Achieving solutions to existing or potential problems and ensuring that the solutions are implemented.*

Safety Auditing

In addition to the System Safety analysis activities, the Systems Safety and Assurance team will undertake a series of safety audits to ensure that, where hazard management is reliant on evidence from other engineering disciplines and System delivery teams, that evidence will be sufficient.

A Safety Audit Plan will be produced and subsequent reviewed and updated regularly in parallel with the System Safety Plan reviews.

The audits conducted by HS2 to correspond to the LoD 1 assurance described in the HS2 Authorisation Plan.

Safety Audits are focused on the high-risk areas of the programme upon which hazard control relies; these will include, as a minimum:

- *Engineering Log records (including Designers' Risk Assessments)*
- *Requirements traceability*
- *Configuration Management (including impact assessment and regression testing, where applicable)*
- *Human Factors*
- *Hazard Management Process*

Risks, Assumptions, Issues and Dependencies (RAID)

The HS2 programme deals with risks, assumptions, issues and dependencies by the use of a RAID Log. This will allow for early identification and communication with the relevant stakeholders for clarification and resolution.

Where any risks, assumptions, issues and dependencies have an impact on system safety, whether it is programme or argument related, then the responsibility for resolving these items will fall to the Safety and Assurance Manager.

Verification and Validation (V&V)

The HS2 Systems Acceptance Plan defines the verification and validation process, roles and responsibilities to be applied across the HS2 Programme with the objective of ensuring that the HS2 Railway, as specified, designed and deployed, will meet the specified requirements.

The output from the V&V activities is a Verification and Validation Matrix (VVM) which is used to plan and track the status of V&V activities against the requirements throughout the programme and programme life cycles. This will include analysis, SAT, FAT, Testing and Commissioning.

This matrix will include the evidence required to verify the system safety requirements.

9. On 27 May 2020 Transport for London provided the following initial response:

Recommendation 1 in the report focused on the importance of a mandatory safety assurance procedure (and associated guidance) for its client role on projects involving installation and modification of high integrity software-based systems.

TfL has robust processes for assurance of the introduction on new software-based systems. These process are based on British Standards, such as BS EN 50126 :2017 (Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)), BS EN 50128:2011 (Railway Applications-Communications, signalling and processing systems-Software for railway control and protection systems) and BS EN 50129:2003 (Railway applications - communication, signalling and processing systems - safety related electronic systems for signalling Railway applications - communication, signalling and processing systems - safety related electronic systems for signalling).

These standards are adopted into TfL's engineering standards, including:

S1538: Assurance

S1201: Signalling & Signalling Control – Approvals

S1198: Signalling & Signalling Control – Installation, test, commissioning and handover

S1199: Signalling & Signalling Control – Operation and Maintenance

S1209: The System Engineering process applied to projects

S1210: Safety Related Software Engineering

These standards, which are supported by more detailed processes, set out TfL and LU's approach to assurance for projects involving installation and modification of high integrity software-based systems. The standards, which are mandatory for LU and our suppliers, also set out the accountabilities and competence requirements involved in this process.

We are currently applying these processes in the introduction of the new signalling system on the District, Hammersmith & City, Metropolitan and Circle lines. This involves detailed assurance at the most senior level in LU and in Thales (the supplier of our new signalling system) to confirm that we receive the appropriate assurances on safety at the relevant decision points.

We have noted the points highlighted in Recommendation 1 of the report and we will review our processes in light of this report to ensure that TfL learns the appropriate lessons from the RAIB report.