Standard Category 1

S1213 A3 Asset Remote Condition Monitoring

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1 Purpose

1.1 The purpose of this standard is to specify the requirements for the design, delivery and management of Asset Remote Condition Monitoring (RCM) systems.

1.2 RCM systems support the efficient maintenance of the transport system infrastructure and provide contextual or background information to enable maintenance staff to make informed decisions.

1.3 The primary drivers behind fitting RCM Assets are to:

a) Optimise Asset availability

b) Achieve optimal maintenance efficiency

c) Optimise mean time to repair

d) Contribute to an Asset-condition (risk) approach to the management of Assets

e) Optimise Reliability

f) Optimise the transport services provided to customers.

2 Scope

This standard applies:

- To new or updated RCM systems for railway and other transport systems
- To RCM systems that monitor the condition and performance of engineering Assets
- Only to RCM systems, not associated (interfaced) systems. A context diagram with system boundaries is produced below (figure 1).

This standard also aligns with London Underground (LU) standard S1042 'Asset Condition Reporting' and defines how the provision of data is used to support the optimal management of Asset maintenance, overhaul and replacement.

Note 1:	RCM consists of 'the recording and subsequent use of Asset data to further business needs' and does not alter or take the place of statutory, safety inspection, testing or safety system monitoring.

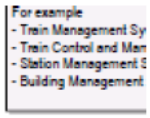

Figure 1 – Context diagram for S1213 Asset Remote Condition Monitoring

3 General requirements for RCM systems

3.1 The concepts, terminology and vocabulary used in the design, delivery, use and management of RCM systems shall be consistent with BS ISO 13372, BS ISO 3300, IEC 60050 and S1218 'Human Systems Interaction - Dialogues and Notifications'.

3.2 The technical requirements of RCM systems, including devices fitted to Assets shall be specified using an authorised Process.

Note 2	Process E0010 'The TfL Corporate Requirements Management Process' provides an approach to this.

3.3 The design and presentation of Alarms and Alerts to users shall comply with the Human systems Interaction – Dialogues and Notifications standard S1218 'Human Systems Interaction - Dialogues and Notifications'.

Note 3:	G0213 'Asset Condition Monitoring, Alarm and Alert Management' provides an authorised Process that meets this requirement.

3.4 RCM software used in railway applications shall be designed and maintained to attain SIL 0 (or equivalent) rating as per BS EN 50128.

Note 4:	RCM systems must not be directly relied upon to support safety-related functions, although they may be considered useful for additional support for efficiency. Where Railway information derived from an RCM is used by people or other systems then the appropriate safety-analysis and mitigation is needed (as per BS EN 50129 and BS EN 50126).

Note 5:	The software "SIL 0" rating is required for the attainment of quality requirements in railway environments, and is not the same as "no SIL". Where a claim of "equivalence" is proposed, it is incumbent on the proposer to demonstrate equivalence. Further information on these requirements is available in S1210 'Safety-Related Software'.

3.5 The design of new or updated RCM systems shall be subject to Reliability, Availability and Maintainability (RAM) analysis on the system as a whole (including impacts on and from interfaced systems and dependencies on communications or other systems) and demonstrate that the resulting system as a whole attains the requisite targets.

Note 6:	It is incumbent on those who are responsible for the specification and delivery of new/updated RCM systems to ensure that the RAM targets are appropriately captured and specified to meet the business and stakeholder needs.

3.6 Components (Assets, sensors, communications) and functions provided by 3rd parties shall be included in the RCM system RAM analysis.

Note 7:	If communications is provided by an existing network then the Reliability of that network is to be incorporated in the analysis.

3.7 The RCM system shall be self-monitoring, diagnose Failures in the RCM system and raise appropriate Alarms so the fault can be rectified. This shall be included in the maintenance plan.

Note 8:	This includes generating and directing Alarms and Alerts to the appropriate user or maintainer, using the same principles in this standard for the monitoring of Assets.

3.8 RCM system Failure modes and effects analysis shall be completed in accordance with BS EN 60812.

3.9 RCM systems shall not compromise or be able to cause Asset Failure or introduce defects in the Asset being monitored or the systems that they are interfaced to.

Note 9:	This includes assurance to the owners and maintainers of Operational Control Systems.

3.10 New or updated RCM systems shall achieve Process maturity level 3 ("standardised") through their life cycles as described in G0213 'Asset Condition Monitoring, Alarm and Alert Management'.

3.11 A defined Process for the analysis of the data captured and the establishment of the condition of the Asset shall be used. The requirements of the Process are to:

a) Specify the data requirements of RCM systems

b) Comply with standard S1217 'Integration of Human Factors into Systems Development'

c) Comply with Standard S1218 'Human Systems Interaction - Dialogues and Notifications'.

Note 10:	G0213 'Asset Condition Monitoring, Alarm and Alert Management' provides an authorised Process that meets this requirement.

3.12 RCM systems and Assets shall be assured in accordance with the LU Assurance standard S1538.

3.13 All RCM equipment shall be registered as an Asset on the company Asset register.

4 Existing systems

4.1 Where an existing RCM system is extended to accommodate additional RCM functionality or new Assets to be monitored, then the resulting RCM system, as a whole, is required to be made compliant with this standard.

Note 11:	An evaluation of each existing Transport for London (TfL) RCM system is required in order to determine compliance against this standard. If any are found to be non-compliant then quantification of those impacts is needed. Cost/benefit analysis can be used to determine the appropriateness of attaining compliance in relation to the whole system needs.

4.2 The expansion or modification of an existing RCM system shall not impact on the Operational Control System (OCS) and the owner of the OCS shall be consulted for all changes that may impact their systems or operations.

5 New systems

5.1 User Requirements (UR) (primary, secondary and tertiary) shall be determined and documented through thorough stakeholder consultation.

5.2 RCM shall be designed to comply with TfL Network cyber security standard S1736 and LU Telecommunications standards.

5.3 The RCM system shall be designed and optimised using the methodology in section 4 of BS ISO 13379 to:

a) Decide the problem

b) Define the user needs

c) Decide if RCM is the right solution

d) Identify and measure only the correct parameters

e) Define the timeliness of access to data for both 'immediate' and 'historic' analysis

f) Design and optimise the RCM system

g) Optimise customer transport service.

5.4 The design should take account of the whole life-cycle of the Asset, including redundancy, obsolescence and removal.

5.5 The RCM system shall be designed to facilitate future expansion without requiring redesign or replacement within the design life of the system.

Note 12:	New RCM systems should have, as a minimum, capability for 50% additional capacity in relation to the number of Assets and sensors that can be monitored without degradation of performance.
Note 13:	New RCM systems should have, as a minimum, capability for 25% spare capacity in relation to interfaces, hardware (Processor and memory), software performance, and communications loading capability.
Note 14:	During design, future requirements need to be estimated based on the Asset Management Strategy (AMS).

6 Human factors

6.1 The End-User Interface (UI) design shall be accepted by representative End-Users throughout the Human Factors (HF) development Process.

Note 15:	LU standard S1217 'Integration of Human Factors into Systems Development' describes the HF development Process.
Note 16:	LU standard S1218 'Human Systems Interaction - Dialogues and Notifications' provides requirements for the specification of UI's.

6.2 Alarms and Alerts shall be presented in a manner that does not task overload End-Users through the UI and described in the Alarms and Alerts Strategy.

6.3 Both Operational and Maintenance Concepts for the RCM system shall be developed and agreed with the End-Users at the concept design stage.

Note 17:	An approved method for completing an Alarm and Alert Strategy is provided in G0213 'Asset Condition Monitoring, Alarm and Alert Management'.
Note 18:	The Category 1 Standard S1217 'Integration of Human Factors into Systems Development' describes how to develop these documents.

7 Data communication

Note 19:	Monitoring of assets in Stations is covered in the communications standards, such as LU standard 1-146 'Station Asset Communications Networks'.

7.1 The ownership of the physical sensors and connections between Asset RCM and those forming the interfacing communications system shall be agreed with the System Owner of the Operational Control systems and agreed with the Maintainer as part of the RCM maintenance plan.

7.2 The encoding of raw data shall follow open source standards / protocols. An interface control document shall be prepared by the Technical Authority and accepted by the Maintainer.

Note 20:	In the event that non open source standards are to be followed (e.g. on grounds of bandwidth, cost, and security) a business case shall be made for non-compliance against a technical risk analysis.

8 Data storage and ownership

8.1 The System Strategy Lead shall determine what RCM data is to become available as part of TfL's open data feeds.

8.2 The data feeds from the RCM system shall be owned and freely available to TfL without restriction (including where 3rd party RCM systems are used).

8.3 TfL shall be able to access and interpret all input and output data in a documented readable format.

8.4 The storage and retention of a RCM system's data shall be agreed and documented at the design stage.

Note 21:	This requires consultation with stakeholders to ensure the immediate and potential future uses of the data is fully considered.

9 Data processing

9.1 Software for data analysis and routine system administrative functions shall be available for all identified users.

9.2 The method for configuring logic and rules for generating Alarms and Alerts shall be agreed at the design stage.

9.3 A specified End-User shall have access to change logic and rules for processing RCM system data.

Note 22:	Use of closed algorithms which are not visible to TfL (colloquially known as 'black box software algorithms') is unacceptable. Where this situation cannot be avoided, sufficient understanding of the output from these algorithms must be provided.

10 Implementation

10.1 The design requirements shall include the provision of appropriate Operations, Maintenance, and Technical manuals accepted by the Operators and Maintainers. These shall include RCM system fault and response actions.

10.2 Training and competence for the operation, management and maintenance of the RCM system shall form part of the requirements capture.

Note 23:	G0213 'Asset Condition Monitoring, Alarm and Alert Management' provides guidance on meeting these requirements.

11 Use

11.1 Alarms and Alerts shall be managed using the Alarm and Alert Management Strategy.

Note 24:	G0213 'Asset Condition Monitoring, Alarm and Alert Management' provides guidance on how this can be achieved.

11.2 In managing responses to Alarms, the workload of End-Users will not exceed their limitations for processing Alarm information, and carrying out timely, accurate and reliable responses to them.

12 Removal and obsolescence

12.1 Where an Asset RCM system has been declared redundant and approved for disposal, the LU Redundant Asset Strategy/Process shall be followed.

Note 25: This disposal Process is currently only available for rolling stock (E0028 'Disposal process for LU rolling stock assets') and is being developed for all other asset groups.

12.2 The management of obsolescence shall be addressed in accordance with the LU standard S1043 'Obsolescence Management' and associated guide G0043 'Obsolescence Management' so as to either; prevent, mitigate or resolve any impacts as a result of obsolescence occurring.

13 Responsibilities

13.1 The Business Sponsor is responsible for determining the business needs and business case justifications for new or updated RCM systems.

Note 26: This includes monitoring of financial and service cost/benefit predictions against actual performance, throughout the life of the RCM.

13.2 The RCM System Strategy Lead is responsible for determining (in consultation with the Sponsor and Technical Authority) whether to extend existing systems or design and deliver new systems.

13.3 The Technical Authority is responsible for ensuring that the requirements of this standard are satisfied.

13.4 The Technical Authority is responsible for authorising technical requirements for new or updated RCM systems, and ensures that technical input from experts (such as Engineering or Technology & Data (T&D)) has been sought and all contributing stakeholders (such as End-Users, Maintainers, interfacing System Owners) have been consulted.

13.5 The Project Manager is responsible for ensuring the appropriate non-technical requirements are specified in relation to implementation of a specific new/updated RCM - including work scope, document outputs, delivery and implementation of systems, transition arrangements, testing, schedules, procurement etc.

13.6 The Project Manager is responsible for ensuring appropriate stakeholder engagement is maintained throughout the delivery of the project and the correct delivery structures (e.g. Pathway) are followed.

14 Supporting information

14.1 This standard should be read in conjunction with the guidance document G0213 'Asset Condition Monitoring, Alarm and Alert Management'.

15 Background

15.1 This standard has been prepared to take account of the following standards:

S1042, S1043, S1210, S1217, S1218, S1538 and 1-146.

16 Environmental considerations

16.1 RCM shall be designed in accordance with standard S1526 'The Assessment and Management of Health, Safety and Environmental Risk'.

17 Person accountable and owner of the document

Name	Job title
Stephen Foot	Head of Asset Condition

18 Definitions

List capitalised terms and their definition. State 'Glossary' if they are from the Glossary of Terms (S1622), or identify the source.

Term	Definition	Source
Alarm	A system response that is prioritised according to the severity of impact on safety, or reliability, and time available to the user in which to fully, or partially, mitigate the impact.	S1218
Alert	A system response with lower priority user action than an Alarm that is prioritised according to time available to the user in which to complete the action.	S1218
Asset	An item of property owned or leased by LUL.	Glossary
Availability	The ability of a product to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided.	BS EN 50126 -1
Business Sponsor	Owner of the strategic business needs in terms of the overall scope, safety, performance, budget, and timing of new or updated End-User services across the transport system.	Glossary
Condition Monitoring	Acquisition and processing of information and data that indicate the state of a **machine** over time.	BS ISO 13372
End-User(s)	Operational staff who have the potential to be affected by the introduction of new equipment or by proposed modifications to existing equipment.	S1217
Failure	Condition in which a system no longer performs the function it was intended to.	IEC 60050 (191)
Maintainability	The probability that a given maintenance action, for an item under given conditions of use can be carried out within a stated time interval when the maintenance is performed under	IEC 60050 (191)

	stated conditions and using stated procedures and resources.	
Notification	A type of system response. There are two types of Notification: Alarm and Alert.	S1218
Operational Control System	A system that impacts on the control of the Operational Railway (defined below)	This standard
Operational Railway	An area which is • within the LU boundary fence alongside the track in the open section • between the tunnel walls alongside the track in tunnel sections • within a - station - signal box - Signalling or Service Control Centre - regulating room - Line Control Office - control and command centre - substation - power control room - depot or stabling sidings.	Glossary
Pathway	TfL management and assurance Process for all project works	This standard
Philosophy	A document that establishes the basic definitions, principles and processes.	S1218
Process	A set of interrelated or interacting activities which transforms inputs into outputs	BS ISO 33001
Project Manager	The person responsible for delivering the project to meet requirements on time and within budget.	Glossary
Redundant Asset	A fixed or moveable asset no longer in operational service which has been declared redundant and which is not intended to be retained for heritage or 'back up' purposes	This standard
Reliability	The probability that an item performs a required function under given conditions for a given time interval.	IEC 60050 (191)
Remote Condition Monitoring	The activity of carrying out Condition Monitoring (as defined above) in a different location to the Asset being monitored.	This standard
Strategy	Documents that define the functional and technical requirements and performance.	S1218
System Strategy Lead	Translates the Business Sponsor needs into a deployment plan for initial delivery	Glossary

	and near, medium and long-term sustainment of systems or services. Owner of the strategic direction of the system or service including delivering against current and future business, operational/user, technical and whole-life needs (including whole-life cost, upgrade, maintenance and obsolescence strategies).	
Technical Authority	Responsible for defining technical specifications encompassing the business, operational, and technical strategic needs. Owner of the technical solution and accountable for major technical change. Responsible for surveillance of function and performance (safety, Reliability, operability etc.) against business and End-User criteria. Empowered to instruct improvement or withdrawal of service where assessed unacceptable to the technical specification.	Glossary

19 Abbreviations

Abbreviation	Meaning
ARM	Asset Management Strategy
BC	Business Case
BS	British Standard
BS EN	British Standard Euro Norm
ISO	International Standardisation Organisation
LU	London Underground
RAM	Reliability, Availability and Maintainability
RAMS	Reliability, Availability, Maintainability and Safety
RCM	Remote Condition Monitoring
SLA	Service Level Agreements
TfL	Transport for London
UI	User Interface

20 References

Document no.	Title or URL
1-146	Station Asset Communications Networks
E0010	The TfL Corporate Requirements Management Process
G0213	Asset Condition Monitoring, Alarm and Alert Management
G0043	Obsolescence Management
S1042	Asset Condition Reporting
S1043	Obsolescence Management.
S1526	Assessment and Management of Health Safety and Environmental Risk.
S1622	Glossary of terms & abbreviations
S1217	Integration of Human Factors into Systems Development.
S1210	Safety – Related Software
S1218	Human Systems Interaction - Dialogues and Notifications
S1736	TfL Network cyber security
BS EN 50126	Railway applications – The specification and demonstration of Reliability Availability Maintainability and Safety.
BS EN 50128	Railway applications - Communication, signalling and processing systems
BS EN 50129	Railway applications - Communication, signalling and processing systems. Safety related electronic systems for signalling
BS EN 60812	Analysis techniques for system Reliability – Procedure for Failure Mode and Effects Analysis (FMEA).
BS EN 61508-1	Functional safety of electrical/electronic/programmable electronic safety-related systems – General requirements.
BS ISO 3300	Photographic grade sodium thiosulphate, anhydrous - Specification
BS ISO 33001	IT, Process Assessment - Concepts & Terminology.
BS ISO 13372	Condition Monitoring and diagnostics of machines – Vocabulary.
BS ISO 13379	Condition Monitoring and diagnostics of machines – Data interpretation and diagnostics techniques – General guidelines.
IEC 60050	International Electrotechnical Vocabulary
	https://www.finance-ni.gov.uk/articles/roles-and-responsibilities-programme-board

21 Document history

Issue no.	Date	Changes	Author
A1	October 2011	New standard introduced in accordance with DRACCT No. 00468.	Chris Welford
A2	February 2016	Standard change, incorporating Alarm and Alert Management in accordance with DRACCT Ref No. 04283.	Santos Bunga
A3	August 2017	Final following work with Technical Strategy in accordance with DRACCT Ref No. 05553.	Mark Cullen