RAIL SAFETY AND STANDARDS BOARD

DRAFT

Rail Industry Standard
RIS-2712-RST | Issue 1.2 | March 2024 | Draft 1c

On-Train Camera Monitoring Systems

This document sets out requirements for the installation and use of modern camera systems for the purposes of recording, storing, and accessing video data on rolling stock. It contains guidance on methods to protect the camera systems and data storage from physical or cyber unauthorised access, and British Transport Police evidential requirements.

Published by **Rail Safety and Standards Board**

Rail Industry Standard
RIS-2712-RST
Issue: 1.2 **Draft:** 1c
Date: March 2024

On-Train Camera Monitoring Systems

Synopsis

This document sets out requirements for the installation and use of modern camera systems for the purposes of recording, storing, and accessing video data on rolling stock. It contains guidance on methods to protect the camera systems and data storage from physical or cyber unauthorised access, and British Transport Police evidential requirements.

Published by RSSB

Issue record

Issue	Date	Comments
One	07/03/2020	Original document.
1.1	05/03/2022	Addition of section 2.11.4 as guidance on storing the recorded video data on the cloud. Addition of a new term, "cloud" in the Definitions section. Amendment to guidance 2.6.1.6, removing the reference to focal length when considering a camera's field of vision.
1.2	02/03/2024 [proposed]	Updated following RAIB report 02/2023 "Train driver struck by a train near West Worthing Middle Siding, West Sussex, 1 February 2022" recommendation two.

Revisions have been marked by a vertical black line in this issue.

Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
RIS-2712-RST - On Train Camera Monitoring Systems - Issue 1.1	All	02/03/2024 [proposed]

Supply

The authoritative version of this document is available at www.rssb.co.uk/standards-catalogue. Enquiries on this document can be submitted through the RSSB Customer Self-Service Portal https://customer-portal.rssb.co.uk/

Contents

Part 1 Purpose and introduction

1.1 Purpose

1.1.1 This document sets out requirements for the function, design and control of all on-train camera monitoring systems except for driver controlled operation (DCO) cameras.

1.2 Scope

1.2.1 This standard includes all on-train camera monitoring systems for passenger rolling stock.

1.2.2 This standard sets out requirements and guidance for rolling stock operators, suppliers, manufacturers, and maintainers relating to on-train camera systems.

1.2.3 The on-train camera systems include:

a) Forward and rear facing cameras.
b) Passenger saloon cameras.
c) Pantograph cameras.
d) Track debris cameras.

1.2.4 Where specific on-train camera systems have not been explicitly listed above, general requirements and guidance can still be applied.

1.2.5 This document does not set out requirements or guidance for camera systems designed to monitor the driving task.

1.2.6 This document does not include requirements for cameras at exterior doors on passenger vehicles. The requirements for these and other DCO cameras are set out in RIS-2703-RST.

1.2.7 Requirements for camera systems for plant are set out in RIS-1530-PLT and BS EN 14033-3:2017 Annex D.

1.3 Application of this document

1.3.1 Compliance requirements and dates have not been specified because these are the subject of internal procedures or contract conditions.

1.3.2 If you plan to do something that does not comply with a requirement in this RIS, you can ask a Standards Committee to comment on your proposed alternative. If you want a Standards Committee to do this, please submit your deviation application form to RSSB. You can find advice and guidance on using alternative requirements on RSSB's website www.rssb.co.uk.

1.4 User's responsibilities

1.4.1 Industry experts representing railway industry stakeholders are involved in the process for settling the content of documents which are prepared in accordance with the procedures set out in the Railway Standards Code and Manual.

1.4.2 Users of documents published by RSSB are expected to be competent or should take specialist advice before following or applying any practices or principles contained within them and are reminded of the need to consider their own responsibilities to ensure safe systems of work and operation, health and safety at work and compliance with their own duties under health and safety legislation. While documents published by RSSB can be used to help inform and devise safe practices and systems of work, their content has not been designed or prepared for:

a) reliance by any specific person or organisation;
b) application or use in all possible operational or working environments.

1.4.3 No representation, warranty, guarantee, confirmation or other assurance is given or made (whether expressly or implicitly) that compliance with all or any documents published by RSSB is sufficient in itself to ensure safe systems of work or operation or to satisfy such responsibilities or duties.

1.4.4 Users and duty holders remain responsible at all times for assessing the suitability, adequacy and extent of any measures they choose to implement or adopt and RSSB does not accept, and expressly disclaims, all and any liability and responsibility except for any liability which cannot legally be limited.

1.5 Structure of this document

1.5.1 This document sets out a series of requirements that are sequentially numbered. This document also sets out the rationale for the requirement, explaining why the requirement is needed and its purpose and, where relevant, guidance to support the requirement. The rationale and the guidance are prefixed by the letter 'G'.

1.5.2 Some subjects do not have specific requirements but the subject is addressed through guidance only and, where this is the case, it is distinguished under a heading of 'Guidance' and is prefixed by the letter 'G'.

1.6 Approval and authorisation of this document

1.6.1 The content of this document will be approved by Rolling Stock Standards Committee on the 07 December 2023 [proposed].

1.6.2 This document will authorised by RSSB on the 05 January 2024 [proposed].

Part 2 Requirements for on-train camera monitoring systems

2.1 General guidance for on-train camera systems

Guidance

G 2.1.1 BS EN 62676-4:2015 contains useful guidelines for the application of video surveillance systems.

G 2.1.2 On-train camera systems can provide useful evidence for instances where there is a safety risk or performance issue.

G 2.1.3 The incident data recorded by camera systems can be transferred for off-train analysis where there is no immediate impact to operational performance, but an investigation is required. Examples of such investigations can include:

a) Safety issues:

   i) Public trespass on the railway.
   ii) Level crossing incidents.
   iii) Near misses or staff incidents, for example track workers failing to clear the line adequately or acknowledging the driver.

b) Accidents:

   i) Derailments.
   ii) Collisions.
   iii) Infrastructure investigations.

c) To view the condition of track and overhead contact line (OCL) equipment.
d) Monitoring flooding after heavy rainfall / snow.
e) Rolling stock incidents:

   i) To view the condition of passing trains.

f) Criminal activity:

   i) Cable theft.
   ii) Vandalism.
   iii) Violence against person(s).
   iv) Sexual offences.

g) Platform incidents:

   i) To view activity on platforms during station pass through.

h) Non-urgent access to recorded data for engineering, maintenance and training purposes.

G 2.1.4 Examples of scenarios that require immediate access can include:

a) Major incidents, for example terrorist / chemical attack.
b) Signal aspect monitoring – for reconciling signal passed at danger (SPAD) events.
c) Resolution of signalling irregularities.
d) Fatalities – identifying suicides or otherwise.

G 2.1.5 The data recorded by the forward-facing camera systems can also be used for cab simulators and route knowledge training.

G 2.1.6 Infrastructure managers can use the data recorded by the forward-facing camera system for surveying specific areas of infrastructure such as viewing the condition of the track and OCL system.

G 2.1.7 It is good practice for the on-train camera systems to be capable of streaming video images to off-train camera systems when and where connectivity permits. For example, this could be used by the British Transport Police (BTP), or the operator to assess incidents quickly.

2.2 Camera type

2.2.1 Use of digital cameras

2.2.1.1 On-train camera monitoring systems shall use digital cameras.

Rationale

G 2.2.1.2 Digital cameras are better equipped than their analogue equivalents to integrate with other rolling stock technologies such as the use of network video recorders (NVR), Global Positioning System (GPS) signals, and permit real-time viewing capabilities, where connectivity allows.

Guidance

G 2.2.1.3 An example of a digital camera is an Internet Protocol (IP) camera.

G 2.2.1.4 A network video recorder (see section *2.12*) can be used to record on-train data from IP cameras.

G 2.2.1.5 Unlike analogue cameras, digital cameras do not need to be directly connected to a digital video recorder (DVR) to record the video data.

2.2.2 On-train camera system activation

2.2.2.1 The on-train camera systems shall switch on automatically whenever a driver enables a driving cab and that cab is made active or when the train is powered up.

2.2.2.2 The systems shall remain active while the cab is enabled.

2.2.2.3 The on-train camera systems shall not permit manual intervention by the driver or other persons that would prevent the system from operating as intended.

Rationale

G 2.2.2.4 All activities on the train are to be recorded when it is operational.

G 2.2.2.5 On-train camera recording is to begin without manual activation by the driver.

G 2.2.2.6 A loss of on-train recording would be a hindrance to investigations if on-train camera systems are deactivated by manual intervention.

Guidance

G 2.2.2.7 Additional features can be included to improve the functionality of on-train camera systems. For example, a delayed power-down feature whereby the camera systems continue recording for 10 to 20 minutes after cab deactivation can be included.

G 2.2.2.8 Consideration can be given for any or all on-train camera systems to resume recording indefinitely even after the cab has been deactivated. For example, the forward-facing camera's continued recording can allow images of events, such as trespassing at a depot, to be recorded. It is good practice to consider the amount of additional storage space that will be used because of recording outside the periods of regular train operation.

2.2.3 Data connections

2.2.3.1 Data connections to the camera systems shall be adequately protected from vibration.

2.2.3.2 The data connection cables shall not be supported by the connector body alone.

2.2.3.3 The data cables shall be securely clamped to the video recorder enclosure or adjacent cable management system.

2.2.3.4 The installation of terminations shall not be undertaken on the rolling stock.

Rationale

G 2.2.3.5 The connector ends can be damaged over time if unsupported.

G 2.2.3.6 Damaged connector ends can result in a loss of data transfer.

Guidance

G 2.2.3.7 The provision of slack in data cables can prevent forces being exerted into data connectors, which may result in damage to the data connector or the port it is connected to.

G 2.2.3.8 BS EN 61373:2010 sets out procedures for shock and vibration tests for equipment on rolling stock.

G 2.2.3.9 BS EN IEC 62847:2023 sets out requirements for the use of data connectors.

G 2.2.3.10 Physical data connections from the camera to the video recorder can include the use of M12 connectors.

G 2.2.3.11 M12 connectors are better at withstanding shock so they can be used as an improved alternative to RJ45 connectors.

G 2.2.3.12 It is good practice for terminations, including cable screening, to be undertaken in the factory prior to delivery and train installation. Experience from one train operating company (TOC) has revealed several reliability issues attributed to poorly terminated cable screening and connectors.

2.2.4 Ingress protection

2.2.4.1 As a minimum, externally mounted camera installations on rail vehicles shall meet the ingress protection requirements of IP56 as defined in BS EN 60529:1992+A2:2013.

Rationale

G 2.2.4.2 Externally mounted cameras can be susceptible to damage from particulates or water.

G 2.2.4.3 Likelihood of water ingress from 'powerfully jetting water' can be high due to washing / cleaning procedures. An example would be cleaning methods used to remove graffiti from rail vehicle bodies.

Guidance

G 2.2.4.4 Consideration can also be given to protecting external cameras from impacts.

G 2.2.4.5 It is good practice to include regular camera checks as part routine of maintenance.

G 2.2.4.6 This can include checking and cleaning of externally mounted cameras.

G 2.2.4.7 Consideration can be given towards the usage of self-cleaning fluids on externally mounted camera installations.

G 2.2.4.8 Enclosure designs that incorporate fans for cooling purposes follow best practice which includes filtering or meshing to prevent ingress from dust particles.

2.3 Image quality

2.3.1 Guidance on image resolution

Guidance

G 2.3.1.1 Section 6.7 of BS EN 62676-4:2015 contains information on the size of an object on the display screen and its relation to the operator task.

G 2.3.1.2 Section 7.2 of BS EN 62676-4:2015 contains information on the selection of image resolutions and relationships between screen size, pixel size, and viewing distance.

G 2.3.1.3 The selection of image resolutions can be based on the application on rolling stock.

G 2.3.1.4 Higher resolution images can have greater clarity compared to images with lower resolution. However, this can be dependent on other factors such as the image ISO and shutter speed.

G 2.3.1.5 The 'Common Intermediate Format' (CIF) was designed to be a format which will allow easy conversion for use with PAL or NTSC standard display cameras. The resolution for CIF is 352 x 288 pixels.

G 2.3.1.6 A 'standard definition' image resolution for 4CIF (D1) is 704 x 576 pixels.

G 2.3.1.7 A typical 'high definition' image resolution is 1920 x 1080 pixels.

G 2.3.1.8 An example of a higher video resolution is '4K', which has a resolution of 3840 x 2160 pixels.

G 2.3.1.9 Higher video resolutions can generate higher quality images but can require more storage space.

G 2.3.1.10 High resolution images can make it easier to identify persons or objects due to its enhanced clarity.

2.3.2 Guidance on image colour space

Guidance

G 2.3.2.1 Consideration can be given to the use of CMYK or YCbCr colour space in addition to standard RGB colour space.

G 2.3.2.2 This can permit the use of machine vision in the future for image analytics.

G 2.3.2.3 CMYK is a colour model which stands for cyan, magenta, yellow and black.

G 2.3.2.4 YCbCr is a form of colour space used in video electronics.

G 2.3.2.5 'Y' carries luma (brightness or luminance) and synchronisation information.

G 2.3.2.6 'Cb' is the blue-difference component.

G 2.3.2.7 'Cr' is the red-difference component.

2.3.3 Application of recorded images

2.3.3.1 The images recorded by the on-train camera systems shall be capable of being reproduced as still images.

Rationale

G 2.3.3.2 Good quality still images provide clearer and sharper images which can be used as evidence in investigations.

G 2.3.3.3 High resolution images can be zoomed in to areas of interest to gain more information. Examples of this include identifying a person of interest or object.

Guidance

G 2.3.3.4 The purpose of output video images can be categorised as follows, in increasing quality levels:

- Detect.
- Observe.
- Recognise.
- Identify.

G 2.3.3.5 Detect – When reviewing images investigators can ascertain with a high degree of certainty whether or not a person is present and are able to track their movements throughout the area covered by the camera. When viewing live images, detection quality images can also provide an overview for crowd monitoring.

G 2.3.3.6 Observe – A field of view that enables the observation of several individuals, whilst providing basic detail of the individuals concerned (e.g. colour and style of clothes) and the activities taking place.

G 2.3.3.7 Recognise – When reviewing images investigators can say with a high degree of certainty whether or not an individual shown is the same as someone they have seen before. This can be used to recognise a suspect in custody or compare a person against an identification quality picture from another source or location. These images are also used to ascertain detail of an activity taking place.

G 2.3.3.8 Identify – Picture quality and detail sufficient to enable the identity of an individual to be established beyond reasonable doubt, for example to support a prosecution.

G 2.3.3.9 Consideration can be given for the on-train camera system to be capable of recognising objects. This can include the recognition of objects on the track, in the passenger saloon area, or the overhead contact line (OCL) system.

G 2.3.3.10 Consideration can also be given for the size of objects to be measured based on the still images. For example, this can include distances between lineside infrastructure and vegetation.

G 2.3.3.11 For images recorded by the forward-facing camera, consideration can be given to the use of technologies which can allow it to identify and differentiate between on-track personnel and trespassers. For example, the system could recognise the orange colour of high-visibility clothing or pattern recognition of the reflective high-visibility bands. In the event of near misses, this system could allow personnel to be identified quickly.

2.4 Guidance on image recording rate

Guidance

G 2.4.1 The image recording rate for each separate on-train camera system can be selected based on its function and recording purpose.

G 2.4.2 For example, a higher image recording rate can be specified for the forward-facing camera systems as images can change rapidly when the train is in motion.

G 2.4.3 It is possible for a lower image recording rate to be selected for the passenger saloon camera system as scenes are not expected to rapidly change.

G 2.4.4 Section 9.2 and Annex D of BS EN 62676-4:2015 contains guidance on image recording rates.

G 2.4.5 Table D.1 of BS EN 62676-4:2015 sets out suggested image recording rates based on locations, activity and risk level.

G 2.4.6 Consideration can be given for the selection of image recording rates based on the recording purpose.

G 2.4.7 Higher frame rate videos can occupy more space on the storage media compared to videos with a lower frame rate.

Note: The term 'storage media' is used in this standard to refer to any form of data storage medium for the recorded video. This can include hard disk drives (HDDs) and solid-state drives (SSDs).

G 2.4.8 Calculations and consideration for recording images at high frame rates can be undertaken.

G 2.4.9 Video with at least 60 frames per second (fps) is considered to have a high frame rate. For the forward-facing camera system, higher frame rates can be considered for trains that operate at high speeds.

G 2.4.10 The following can be considered: to obtain an image 'slice' at every metre, a train travelling at 60 mph (equivalent to 26.8 m/s) will require an image recording rate of 27 fps.

G 2.4.11 As an extension to the example above, for a train travelling at 60 mph, a forward-facing camera with an image recording rate of 12 fps will only obtain an image every 2.2 m. At 100 mph (44.70 m/s), with the same image recording rate of 12 fps, this is equivalent to obtaining an image every 3.72 m. 12 fps has been used here as it is quite common in current industry 'off-the-shelf' equipment for this to be the maximum possible image recording rate.

G 2.4.12 Consideration can be given to have increased or variable image recording rates for trains travelling at higher speeds.

G 2.4.13 For example, a frame rate of at least 60 fps can be considered for trains operating at high speeds to provide enhanced video; however, this may increase the amount of storage space required.

2.5 Light levels

2.5.1 Day and night-time operation

2.5.1.1 Cameras shall be capable of recording images over a light range of 0.002 lux to 10,000 lux.

2.5.1.2 On-train camera systems shall be capable of automatically switching between capturing images in a 'day' mode and ‘night’ mode, if equipped with such a feature.

Rationale

G 2.5.1.3 Environmental light levels can affect the quality of images captured by on-train cameras.

G 2.5.1.4 Under bright conditions, images can appear to be washed out, resulting in a loss of information.

G 2.5.1.5 Capturing images at night-time can be difficult due to low levels of light.

G 2.5.1.6 In Great Britain, there are a considerable number of days in the year where darkness falls around 4 pm and the sun does not rise until 8 am. This means that a significant proportion of train operation occurs in dark conditions.

Guidance

G 2.5.1.7 10,000 lux is the illuminance at full daylight. Note that this is not under direct sunlight.

G 2.5.1.8 Light levels under thick clouds, sunrise, or sunset conditions can be at around 1 lux.

G 2.5.1.9 Night-time conditions can be considered to have an illuminance less than 1 lux.

G 2.5.1.10 0.002 lux includes light levels down to a moonless clear night. This also covers heavy storm scenarios.

G 2.5.1.11 One method to record images under low-light conditions is to increase the camera's ISO setting. Some cameras can have a dynamic ISO adjustment to compensate for rapidly changing light levels while the train is in motion, for example passing from bright sunlight to shadow.

G 2.5.1.12 However, increasing the ISO value can result in grainier images with reduced overall image quality. For example, there can be a loss in facial features which demote the image quality from "identify" to "observe".

G 2.5.1.13 Consideration can be given to the use of automatic or fixed ISO values suitable to the application. This can prevent motion blur or shake while minimising noise as a larger ISO value may result in more noise being present in an image.

2.5.2 Guidance on rapid light changes

Guidance

G 2.5.2.1 It is good practice for camera systems to be able to adapt to light changes within 1 s to avoid extended periods of under or overexposed images.

G 2.5.2.2 Trains can enter and exit tunnels multiple times per journey.

G 2.5.2.3 This is a primary source of rapid change in light levels during daytime operation.

G 2.5.2.4 When a train exits a tunnel in the daytime, camera systems require time to adjust from the low-light condition to the high-light condition. During this period, images can appear washed out due to the sudden change in light levels.

G 2.5.2.5 This can be considered a loss of information where no useful images can be obtained.

G 2.5.2.6 For forward-facing cameras, consideration can be given for a response time of 1 s or less. A train travelling at 60 km / h will cover a distance of 16.7 m in 1 s. As an example, for a camera system that reacts in 1 s, there may be a loss of images for 16.7 m at tunnel entry and exit.

G 2.5.2.7 Consideration can be given to the use of the forward-facing camera to recognise changes in light conditions so that this information can be fed to other cameras down the train to compensate for impending changes in light levels. This could reduce the effect of rapid light changes.

2.6 Field of view

2.6.1 On-train camera coverage

2.6.1.1 The technical specification for each camera installation shall define the field of view required.

2.6.1.2 Cameras shall be adjustable to provide different fields of view.

Rationale

G 2.6.1.3 Different camera systems on a train can have different viewing requirements.

G 2.6.1.4 It is good practice to have a camera system that is capable of recording images in the complete field of view to prevent blind spots.

Guidance

G 2.6.1.5 Cameras with short focal lengths may result in images with distortion towards the edges of the image. Image processing software can be used to remove effects of distortion.

G 2.6.1.6 An example of distortion caused by using cameras using short focal lengths is the fisheye effect. A camera with a viewing angle of 33° has a 30 m visible distance. A camera with a viewing angle of 18° has an 80 m visible distance. This does not guarantee that all objects or persons will be clear in all specified visible distances above.

G 2.6.1.7 Multiple cameras can be used to provide a complete view of the required environment.

G 2.6.1.8 It would be good practice to allow camera adjustments in three dimensions.

G 2.6.1.9 A f-number is the ratio of the camera system's focal length to the diameter of the clear aperture. It dictates the amount of light that is allowed through the aperture. A low f-number is the result of a large aperture – which allows a lot of light through but results in a shallow depth of field. A high f-number allows less light through but increases the depth of field. A shallow depth of field could result in the foreground and / or background being out of focus (i.e. blur). A higher depth of field could result in more of the foreground and background being in focus. However, a high f-number (i.e. small aperture) could require higher ISO values to be used, potentially resulting in grainier images, if post-processing is insufficient.

G 2.6.1.10 Consideration can be given to the selection of an f-stop value that delivers a moderate aperture and moderate depth of field. F-number values resulting in apertures permitting a very large or very small amount of light through, with extremities in depths of field, are not considered to be as useful in this application.

2.6.2 Blind spots

2.6.2.1 On-train cameras shall be positioned to minimise blind spots in the required field of view.

Rationale

G 2.6.2.2 Events can occur in blind spots and this would be detrimental when the images are used in an investigation, if alternate camera views are not available.

G 2.6.2.3 For example, multiple on-train cameras can be used in the passenger saloon to increase coverage and minimise blind spots.

Guidance

G 2.6.2.4 On-train camera views can overlap to monitor attempts to tamper with other cameras.

G 2.6.2.5 Additional cameras can be positioned to reduce blind spots and provide overlap.

2.6.3 Guidance on viewing angle and focal length

Guidance

G 2.6.3.1 The field of view for each camera is a function of the camera's focal length and image sensor size.

G 2.6.3.2 A short focal length will give a wide field of view but can result in distortion at the sides of the image, causing a fisheye effect.

G 2.6.3.3 A long focal length will cause images to appear closer, but this creates a narrower field of view.

G 2.6.3.4 The viewing angle can also depend on the size of the camera's image sensor, with a larger sensor giving a wider field of view.

G 2.6.3.5 Railway undertakings can seek additional guidance from suppliers to determine solutions to requirements.

2.7 On-screen information

2.7.1 The recorded video shall display the following minimum information (metadata) on the screen during playback:

a) Train ID.
b) Date.
c) Time.
d) Camera ID.

2.7.2 The on-screen information shall not obstruct or obscure the main viewing area of the recorded video.

2.7.3 The text on the screen shall be legible under all light conditions and backgrounds.

Rationale

G 2.7.4 It is good practice to have essential information immediately and legibly presented during playback.

G 2.7.5 It is good practice to be able to read vital information displayed during playback.

G 2.7.6 This will eliminate ambiguity, especially if the recorded video is used as evidence during an investigation.

G 2.7.7 Evidence presented to court should have date and time information.

Guidance

G 2.7.8 The recorded video can include other metadata that is not immediately displayed on the screen during playback.

G 2.7.9 The playback system can be configured to display the required metadata on demand on the screen or beside the recorded images.

G 2.7.10 The train's headcode can be used to identify the train / service. This and other information can be automatically obtained from other onboard train systems.

G 2.7.11 Additional information which could be displayed can include:

a) Train speed.
b) GPS coordinates.
c) Driver ID.
d) Event trigger, if present.

G 2.7.12 Examples of event triggers can include the activation of a passenger alarm or 'driver events' such as the application of the emergency brake.

G 2.7.13 The on-screen information can be placed in corners of the screen to minimise obstruction to the main viewing area during playback.

G 2.7.14 It is good practice for the on-screen text to be legible under any condition. For example, the on-screen text may be presented against a permanently black or white background so that it is consistently clear. An option to enable or disable the display of text on the recorded video can allow the complete image to be viewed.

G 2.7.15 An alternative consideration can include the use of text that is able to actively adapt to changing backgrounds. For example, in clear daylight, the text shown in the video as recorded by the forward-facing camera may be black. However, as the train enters a tunnel, consideration can be given for the text to automatically switch to white and then return to black when the train exits the tunnel to maintain legibility throughout.

2.8 Video files

2.8.1 Guidance on unique filenames

Guidance

G 2.8.1.1 Video files have unique filenames to prevent data files being overwritten due to repeated filenames.

G 2.8.1.2 Each filename may incorporate the date and time to prevent duplicate filenames from being created.

G 2.8.1.3 An example of a filename is: YYYYMMDD-HHmmss-CameraID-Headcode

G 2.8.1.4 Each camera can be given a unique identifier.

G 2.8.1.5 As an example, each camera ID can incorporate the vehicle number followed by the camera’s unique identifier.

2.8.2 Guidance on file creation

Guidance

G 2.8.2.1 Consideration can be given for individual data files to be created every time the cab is activated.

G 2.8.2.2 For example, a video file with a unique recording start date and time in its filename can be created to assist with file identification and reduction in risk of filename duplication.

2.8.3 Video file features

2.8.3.1 The file structure of the recorded data shall allow:

a) Selection of recorded images based on the entry of specific operational parameters;
b) The correct time stamping on recorded images; and
c) Identification of main recorded events.

2.8.3.2 If video files are sub-divided, there shall be no loss of video data.

Rationale

G 2.8.3.3 It is good practice to have a logical file structure for video files.

G 2.8.3.4 A structured file creation system is crucial to allow precise and quick access to video files. The rail vehicle's identity will allow the vehicle's diagram records to be traced to a particular service.

G 2.8.3.5 This could be achieved by using a coding plug or dongle that incorporates the rail vehicle's details.

Guidance

G 2.8.3.6 Specific operational parameters can include time, train and car identification.

G 2.8.3.7 Consideration can be given for the on-train camera system to be connected to other train systems so that events can be recorded.

G 2.8.3.8 Examples of main recorded events can include: train starts and stops, automatic power control, automatic warning system (AWS), train protection and warning system (TPWS), cab activation, emergency brake demand, passenger emergency alarm activation.

2.9 Date and time

2.9.1 Date and time display

2.9.1.1 The date and time displayed shall relate to the recording of the original live image and not any subsequent data handling.

Rationale

G 2.9.1.2 Having the date and time displayed on the playback system provides clear and immediate information of the recorded event.

G 2.9.1.3 When video data is used as evidence in investigations, time is critical to determine when an observed event occurred, or whether any event occurred within a specific timeframe.

G 2.9.1.4 This will provide evidence that the video data has not been altered, tampered with or corrupted in any way.

G 2.9.1.5 This will allow consistent timelines when viewing the recorded data.

Guidance

G 2.9.1.6 It is good practice for the date and time information to be clearly displayed on any playback system.

G 2.9.1.7 The date and time can be placed in corners of the screen to minimise obstruction to the main viewing area during playback.

G 2.9.1.8 Consideration can be given for the use of text which is able to actively adapt to changing backgrounds.

2.9.2 Date and time format

2.9.2.1 Date and time formats shall be specified in an international format such as Coordinated Universal Time (UTC).

Rationale

G 2.9.2.2 An inconsistent format can cause confusion.

G 2.9.2.3 For example, where a standardised date format is not followed, 2018-06-07 could be incorrectly interpreted as 6 July 2018, rather than 7 June 2018. To minimise the risk of error, a consistent format is recommended.

Guidance

G 2.9.2.4 An example of a date and time format can be: YYYY-MM-DD HH:mm:ss.

G 2.9.2.5 Where:

YYYY	Year
MM	Month
DD	Date
HH	Hour (based on a 24-hour format)
mm	Minute
ss	Second

G 2.9.2.6 One benefit of using the convention above is that unique filenames can be automatically generated.

G 2.9.2.7 BS ISO 8601-2:2019 contains information and guidance for representing dates and times.

2.9.3 Guidance on time source

Guidance

G 2.9.3.1 Consideration can be given for the on-train camera to obtain time information from the train's clock.

G 2.9.3.2 Where a train time system is not present, consideration can be given for the on-train camera system to obtain time via the internet for UTC or GPS satellites. Do note that there is a difference in time between GPS and UTC.

G 2.9.3.3 Where multiple camera systems or multiple video recorders are present on a train, the time for each system or recorder can be obtained from the train's central timing system. This feature provides time synchronisation for when data is reviewed, where differing time stamps on recordings may result in lost or unclear evidence.

G 2.9.3.4 It is good practice for the on-train camera system clocks to be synchronised with the train's time at periods of low activity. An example of this may be 0200 hours when the train is at a depot.

G 2.9.3.5 Where trains are networked or have the capability to 'dock' with external servers when stabled, timings for recording can be aligned to the external IT export network.

2.9.4 Daylight saving

2.9.4.1 On-train systems shall be capable of automatically adjusting the recorded date and time in conjunction with changes due to daylight savings.

Rationale

G 2.9.4.2 Clocks in the UK change twice a year.

Guidance

G 2.9.4.3 Consideration can be given for the on-train camera systems to synchronise times with the train's time to reduce the risk of time mismatch.

G 2.9.4.4 It is good practice to check that the train's system clock correctly applies the conversion of daylight savings and vice versa when this occurs.

G 2.9.4.5 Consideration can be given for maintenance staff to check that the time has been correctly adjusted as part of maintenance.

2.10 Guidance on location

Guidance

G 2.10.1 Where GPS data is available, consideration can be given to incorporate the data stream into the video files' metadata.

G 2.10.2 The train's location can be useful in aiding the investigation of events or for additional information.

G 2.10.3 For example, in events where the train infringes or fouls infrastructure, video evidence can be used in conjunction with the location data to assist with investigations.

G 2.10.4 An example of the train's location information can be in the form of GPS coordinates.

G 2.10.5 GPS information can be obtained from other on-train systems.

G 2.10.6 Alternatively, the on-train camera systems could have an independent GPS antenna to record this information.

G 2.10.7 Where GPS coordinates are obtained from other systems, consideration needs to be given to the difference in time between satellite systems and times on Earth (e.g. UTC).

G 2.10.8 GPS signals can be lost at times due to infrastructure such as tunnels. When the GPS signal is restored, it is good practice for the camera systems to resume recording under normal conditions. Consideration can be given to indicate where GPS signals were absent in the data.

G 2.10.9 The train's location can be used as a trigger for the on-train camera systems to automatically perform actions. For example, if the train is in a depot, the camera system can be triggered to transfer its data to the wayside as part of its scheduled uploading.

G 2.10.10 Using GPS data, the camera system can change its image recording rate if it is stationary in a train station. Note that this can work together with a speed signal trigger.

G 2.10.11 If an independent GPS is present for the camera systems, the antenna will require line of sight to satellites, so a suitable location to place the antenna is on the roof of the train.

2.11 Data storage and capacity

2.11.1 Duration

2.11.1.1 The on-train camera system shall be capable of recording and retaining data for a period of 31 days, unless otherwise explicitly agreed with the respective British Transport Police (BTP) authority, without compromising the quality of data.

Rationale

G 2.11.1.2 The BTP have specified requirements that on-train video data be retained for 31 days as it can be used as evidence in investigations.

Guidance

G 2.11.1.3 This requirement is consistent with the police evidential requirements set out in Section 5.2 of "Output requirements from Video Systems", v1.7 by the BTP.

G 2.11.1.4 Assuming that 31 days of video data is stored on the train, this is equivalent to 558 hours of recording based on 18 hours of recording per day.

G 2.11.1.5 Section 10 of BS EN 62676-4:2015 sets out guidelines related to calculating the amount of storage space for video data. It is good practice to undertake calculations to demonstrate that sufficient data storage space for the video data has been provided to accommodate data for the required period.

G 2.11.1.6 Rail undertakings can contact recording system manufacturers to supply calculators for data storage space requirements.

G 2.11.1.7 Consideration can be given to the use of solid state drives (SSD) instead of hard disk drives (HDD) as SSDs have better resistance to vibration due to the lack of internal moving parts. At the time of writing, initial costs of SSDs are considerably more than HDDs, however, the whole-life cost of using SSDs versus HDDs has been shown to be closer.

2.11.2 Overwriting

2.11.2.1 The camera systems shall be configured so that the stored images are not overwritten until the storage capacity of the recorder is full.

2.11.2.2 If the recorder is full and overwriting of older video data is required, the video files shall then be overwritten on a 'first in / first out' basis.

Rationale

G 2.11.2.3 If data were to be overwritten, there could be a higher likelihood for the older data to have been backed up, compared to newer video data.

Guidance

G 2.11.2.4 It is good practice to undertake calculations to minimise the risk of overwriting required data.

2.11.3 Guidance on video file encryption

Guidance

G 2.11.3.1 Consideration can be given to encrypting the video data files when they are in transit i.e. when the data has been physically removed or downloaded from the train.

G 2.11.3.2 Multiple levels of data encryption can be considered for implementation.

G 2.11.3.3 For example, the entire volume on a storage device can be encrypted to prevent unauthorised access. An example of such software is Bitlocker.

G 2.11.3.4 If access is permitted to the storage media, encryption of the specific video data files provides another layer of protection against unauthorised access.

G 2.11.3.5 Specific software with authorised credentials can be required to access the video data.

2.11.4 Guidance on Cloud storage

Guidance

G 2.11.4.1 Recorded video data can be stored on the cloud.

G 2.11.4.2 Data storage on the cloud can be purchased or leased from third-party providers.

G 2.11.4.3 It is good practice to check that the data files that have been successfully and completely uploaded without corruption before deleting the data files from local sources such as the train or depot.

G 2.11.4.4 Consideration can be given to the use of one-time passwords for authorised personnel to access recorded data stored on the cloud.

G 2.11.4.5 Cloud-based storage technologies can offer increased flexibility for short and long term storage space and duration. For example, additional data storage devices may be required if there is no longer sufficient space to transfer the data from trains onto systems based at a depot.

2.12 Recording video

2.12.1 Use of video recorders

2.12.1.1 The video data shall be saved onto a video recording system.

2.12.1.2 Data shall be recorded in a digital format.

Rationale

G 2.12.1.3 Having video data stored in a digital format allows the data to be handled more effectively through modern technologies.

G 2.12.1.4 Digital video recorders can be more secure using encryption.

Guidance

G 2.12.1.5 Multiple cameras can write data onto one or more network video recorders (NVRs).

G 2.12.1.6 Consideration can be given to saving the video data on more than one NVR as this automatically creates a backup on the train.

G 2.12.1.7 Consideration can also be given to the use of Redundant Array of Independent Drives (RAID) technology as a method of improving resilience. At RAID 1, the recorded video data can be written to two storage devices, producing a form of backup.

2.12.2 Video recorder enclosure design

2.12.2.1 The video recorder enclosure shall incorporate a power on and fault indicator.

Rationale

G 2.12.2.2 The power status and presence of a fault needs to be made clear to any authorised personnel accessing the enclosure.

G 2.12.2.3 The video recorder enclosure houses the storage devices that contain the recorded video files.

G 2.12.2.4 The video recorder enclosure also houses the computer system that communicates with the cameras.

Guidance

G 2.12.2.5 Consideration can be given for how the video recorder enclosure will be kept cool when assembled in the train. For example, vents in the technical cupboard can allow air to flow through and keep the video recorder within operational temperatures.

2.12.3 Video recorder fault status

2.12.3.1 The video recorder shall inform authorised personnel of fault(s) when they occur.

2.12.3.2 Video recorder faults shall be made available through the train's control and management system (TCMS).

2.12.3.3 When docking is available, fault reports (where present) shall be exported off the train for maintenance purposes.

Rationale

G 2.12.3.4 If a fault is present, the authorised personnel need to be informed so that corrective action can be undertaken before the train enters service.

G 2.12.3.5 If the video system has a fault, data might not be recorded, and this can hinder investigations due to a lack of evidence.

Guidance

G 2.12.3.6 When a fault occurs, the operator (for example, a maintainer or driver) can be informed via the TCMS.

G 2.12.3.7 Faults can also be recorded via remote condition monitoring.

G 2.12.3.8 A fault indication can also be transmitted via the driver's monitors in the cab.

2.12.4 Video recorder enclosure location

2.12.4.1 The video recorder and its enclosure shall be positioned within the rail vehicle body so that it is protected in the event of a collision.

2.12.4.2 The video recorder shall be installed in a location that can be accessed by crew or maintenance staff only.

2.12.4.3 The video recorder shall be fixed to the rail vehicle and housed in a secure robust enclosure designed to prevent damage from vandalism.

2.12.4.4 The video recorder enclosure shall be designed to prevent access from unauthorised personnel.

2.12.4.5 The video recorder enclosure shall permit easy removal, replacement and maintenance of the video recorder and its data storage by authorised personnel.

Rationale

G 2.12.4.6 In the event of a collision, data can be lost or damaged if the enclosure for the video recorder's structural integrity is compromised.

G 2.12.4.7 The video recorder is important equipment which contains information that can be used as evidence in the event of an investigation.

G 2.12.4.8 It is crucial that the video recorder is protected against access from unauthorised persons and damage caused in the event of a collision.

G 2.12.4.9 Unauthorised persons gaining access to the video recorder can cause damage or remove the storage media.

Guidance

G 2.12.4.10 The active video recorder can be located in intermediate vehicles or at the 'rear' which can offer a higher chance of preserving the video recorder in the event of a head-on collision.

G 2.12.4.11 Using the Class 345 units as an example, two NVRs are present on a unit at each end. The 'rear' NVR used to record video data is at the end opposite to the forward-facing camera.

G 2.12.4.12 GMRT2100 sets out requirements for the rail vehicle structures including elements that interface with passengers and traincrew. It is good practice to check that the on-train camera systems comply with the requirements set out in GMRT2100.

2.13 Event triggers

2.13.1 Guidance on event trigger activation

Guidance

G 2.13.1.1 Event triggers can be a useful mechanism to indicate where image recording rates can be increased or decreased, depending on the situation.

G 2.13.1.2 The image recording rate can be increased upon the activation of the emergency brake, passenger alarm or pantograph automatic dropping device (ADD) so that more information could be collected as evidence for the event.

G 2.13.1.3 Consideration can be given for the use of a 'pre-record' or buffer feature for video systems. This allows a predetermined length of video to be recorded at the higher image recording rate before the trigger event.

G 2.13.1.4 When the event is cleared, the high recording rate is no longer required, and the video system can return to recording at its default image rate.

G 2.13.1.5 Index markers (tagging) can be used to rapidly search and identify the images during subsequent analysis of the recorded data.

G 2.13.1.6 Train systems and driver actions that could be used as incident inputs can include the operation of the emergency brake, hazard light switch, warning horn, or pantograph ADD.

G 2.13.1.7 Operation of the emergency brake whilst the train is moving, including initiation by the driver or trainborne systems such as AWS, TPWS, or ETCS can be used as an appropriate trigger for incident recording.

G 2.13.1.8 The camera system can be designed to be capable of differentiating between emergency brake applications that occur when the train is moving and ignore those that occur whilst the train is stationary, for example when carrying out brake tests.

G 2.13.1.9 Prolonged use of the warning horn by the driver could signify an incident situation such as trespassers or track staff failing to acknowledge a warning.

G 2.13.1.10 It is good practice for the forward-facing camera system to be capable of differentiating between the normal operation of the horn, which does not need to be recorded, and the prolonged sounding of the warning horn as an alarm.

G 2.13.1.11 An 'incident event button' can be operated by the driver to trigger the forward facing camera system to switch to incident mode and begin recording at the higher recording rates.

G 2.13.1.12 An indicator can be provided to give feed back to the driver to show when the recorder is operating in incident mode.

G 2.13.1.13 The effects on driver workload can be considered where an incident event button is provided.

G 2.13.1.14 Operation of the ADD equipment potentially indicates a disturbance in the pantograph to OCL interface. The forward-facing camera system may capture the circumstances leading up to and after the operation of the ADD.

2.13.2 Event marker

2.13.2.1 If an event trigger occurs, an index marker (tag) shall be placed in the video file.

Rationale

G 2.13.2.2 The event marker can allow investigators to quickly and clearly study images of the event.

Guidance

G 2.13.2.3 This can be particularly helpful if the video file is continuous with no clear indication or quick access to the event.

2.13.3 Post-event trigger

2.13.3.1 If triggered, camera systems shall return to their default image recording rates when the event is over.

Rationale

G 2.13.3.2 When the event is over, there is a reduced need for video cameras to record at the triggered rate. It is important for the reversion to occur automatically for the following reasons:

a) Where a higher image recording rate has been activated, the video file will occupy more storage media space than necessary.
b) Where a lower image recording rate has been activated, the video footage might not contain enough data, resulting in lower quality images (e.g. jitter) when reviewed.

Guidance

G 2.13.3.3 There is no guidance associated with this requirement.

2.14 Guidance on video codec and standards

Guidance

G 2.14.1 Consideration can be given for the video recorders to utilise industry-standard video formats such as H.264.

G 2.14.2 H.264 is a commonly used video compression standard for recording, compression, and distribution of video content. One benefit of using this format is that it can produce good quality video at lower bit rates compared to previous standards such as MPEG-2, and H.263.

G 2.14.3 A benefit of using H.264 can include better video compression without loss of quality.

G 2.14.4 Video data recorded using the H.264 codec can enable the use of video analytics in the future.

G 2.14.5 By having an industry-standard video format, video files can be read on third-party systems. For example, the BTP can access the video files using the H.264 codec when supplied by a train operating company without the need for additional software.

G 2.14.6 If it is intended to source video cameras and forward-facing camera systems from different suppliers, then it will be necessary to define the system interface. One example to aid compatibility is the use of the Open Network Video Interface Forum (ONVIF) software standard.

Part 3 Specific camera systems

3.1 Forward-facing camera

3.1.1 Forward-facing camera installation

3.1.1.1 A forward-facing camera system shall be installed in each driving cab.

3.1.1.2 The forward-facing camera system shall continue to record images for a minimum of ten minutes following cab deactivation.

Rationale

G 3.1.1.3 Forward-facing camera systems support incident and accident investigations and can also support infrastructure and rolling stock fault analysis where video playback provides evidence of the fault that occurred, for example, evidence for Signals Passed at Danger (SPAD).

G 3.1.1.4 Forward-facing camera systems that stop recording as soon as the cab is deactivated may result in crucial evidence being undocumented, such as the accident investigated in RAIB report 02/2023.

G 3.1.1.5 A time duration of a minimum of ten minutes is included in the requirement in clause *3.1.1.2* which takes into account the time it can take a driver to:

a) Deactivate a cab
b) Gather their belongings
c) Exit the vehicle, which may be through a corridor to the rear of the driving cab
d) Make their way along an authorised walking route (AWR) that may result in them taking an unusual route around the vehicle before exiting to the front of the train.

Guidance

G 3.1.1.6 Although forward-facing cameras are typically only record images from the active cab, it can be useful for forward-facing camera systems to also record images in non-active cabs so that events at the rear of the train can be reviewed.

G 3.1.1.7 Requirement *3.1.1.2* sets out a minimum time period for a camera system to record images following cab deactivation, however greater time periods, or continuous recording of images, can provide constant monitoring of the railway environment and support investigations such as those related to trespass incidents at depots.

G 3.1.1.8 The requirement in clause *3.1.1.1* has been set out so that it can be applied to:

a) New rolling stock; and
b) Existing rolling stock as good practice.

3.1.2 Forward-facing camera field of view

3.1.2.1 The forward-facing camera shall be capable of recording images that include the viewing envelope for a seated driver as set out in GMRT2161 issue 2.1, clause 2.1.1, as a minimum.

Note: The following clauses have been renumbered, but the text remains unchanged.

3.1.2.2 The forward-facing camera shall capture the view of the track (at rail height) at 5 m beyond the coupling plane for vehicles subject to frequent coupling and uncoupling activities (case a).

3.1.2.3 The forward-facing camera shall capture view of signals positioned 5 m beyond the coupling plane at all heights between 1.5 m and 6 m above rail level and at all lateral positions between the right-hand rail through to 2.5 m to the left of track centreline (case b).

3.1.2.4 This view for both cases (a and b) shall be visible from the same point.

3.1.2.5 The forward-facing camera shall be able to identify overhead signals at a height of 6 m above rail level as well as at track level.

3.1.2.6 The forward-facing camera shall be capable of identifying the aspect of the signal.

Rationale

G 3.1.2.7 The forward-facing camera's purpose is to record images as seen by the driver and can be used as evidence during the investigation of events.

Guidance

G 3.1.2.8 Where clauses *3.1.2.2* to *3.1.2.4* refer to case a and case b, these cases can be found in BS EN 16186-1:2014+A1:2018, which is referred to in GMRT2161 issue 2.1, clause 2.1.1.

Note: The following clause has been renumbered, but the text remains unchanged.

G 3.1.2.9 For vehicles that are not fitted with a central gangway, the lateral view can be 2.5 m both sides of the track centreline.

3.1.3 Forward-facing camera positioning

Note: The following clauses have been renumbered, but the text remains unchanged.

3.1.3.1 The forward-facing camera and lens assembly shall be orientated to record landscape views.

3.1.3.2 The forward-facing camera and lens assembly shall be positioned in the cab behind the windscreen or externally in an enclosure on the end of the vehicle.

3.1.3.3 The camera shall be positioned as close as possible to the driver’s sightlines without disrupting the driver's view.

3.1.3.4 The installation of the camera, lens assembly and its housing shall not impede replacement of the cab windscreen.

3.1.3.5 Interfaces with the rail vehicle’s control systems shall be provided so that the forward-facing camera system can determine if it is located at a coupled cab location.

Rationale

G 3.1.3.6 The purpose of the forward-facing camera is to record images that are in front of the train as seen by the driver, as a minimum.

G 3.1.3.7 The images from the forward-facing camera can be used as evidence for investigation of events.

Guidance

G 3.1.3.8 The forward-facing camera can be fitted with a lens that has automatic gain control or an aperture with a fast, dynamic response to deal with rapid changes between sunlight and dark conditions.

G 3.1.3.9 Consideration can be given for the use of a camera with high dynamic range (HDR), electronic shutter, and fast response times to changing light conditions.

G 3.1.3.10 Consideration can be given for the forward-facing camera to have an increased image recording rate as its view will be rapidly changing as the train travels.

G 3.1.3.11 The forward-facing camera system will be recording moving images in contrast to those camera systems used to monitor a rail vehicle's interior where most of the images are stationary relative to the camera.

G 3.1.3.12 For coupled units, consideration can be given for the forward-facing camera to record at a reduced image recording rate. The images captured can be used as evidence of unauthorised persons obtaining access to cabs, which may cause disruption to operations.

3.2 Pantograph

3.2.1 Pantograph camera field of view

3.2.1.1 The pantograph camera shall be capable of recording images of the pantograph and the OCL.

Rationale

G 3.2.1.2 The video recordings from the pantograph camera can be used as evidence in pantograph - OCL events to determine cause.

Guidance

G 3.2.1.3 The pantograph camera system is installed in a harsh external environment and may be pointed towards the sun, and requires the capability to produce clear images under these conditions.

G 3.2.1.4 Where a pantograph is unidirectional during principle operation, it is good practice for the camera to be placed in the lead direction of travel i.e. 'upwind'. This can make cleaning of the camera to be less onerous and can reduce damage to the camera in the event of an incident. For example, there are two pantographs on a Class 390 unit and the 'leading' pantograph is used under normal operation. Therefore, the location for the pantograph camera on the Class 390 can be determined based on its normal operating conditions.

G 3.2.1.5 The pantograph camera is particularly likely to be exposed to rapid changes in light levels.

G 3.2.1.6 Consideration can be given to reduce effects of rapid light changes as the pantograph camera might be pointed directly into the sun during certain times of day.

G 3.2.1.7 Pantograph cameras can get dirty from displaced carbon dust. It is good practice to check that the dust does not obscure the required vision.

G 3.2.1.8 Consideration can be given for the use of products to create a hydrophobic layer to prevent water from accumulating on the external cover of the camera. This could improve visibility under rainy conditions. An example of such a product is Rain-x.

G 3.2.1.9 Other solutions to prevent water accumulation at the external cover of the camera can include the use of air curtains, revolving windows that pass under a soft scrub pad, or wipers.

G 3.2.1.10 It is good practice for the lenses to undergo regular cleaning to maintain image quality.

G 3.2.1.11 Consideration can also be given to mounting the cameras 'upwind' of the pantograph to minimise the impact from pantograph residual deposits.

3.3 Track debris

3.3.1 The track debris camera shall be capable of recording images of the track in front of a moving train and the adjacent areas including the six foot, ten foot, or cess.

3.3.2 If infrared illumination is to be used, the infrared wavelength shall be above the wavelength visible to the human eye.

3.3.3 If infrared illumination is to be used, the selected camera and lens systems shall be compatible with the wavelength deployed.

Rationale

G 3.3.4 The track debris camera requires capabilities to produce clear images of track sections in front of trains regardless of speed and environmental conditions.

G 3.3.5 The track debris cameras tend to be installed at a low height on a vehicle, therefore will be subject to harsh conditions and rapid changes in light.

G 3.3.6 Infrared illumination could appear as red signals and this could cause confusion when viewing the recorded video, if visible to the human eye.

Guidance

G 3.3.7 A track debris camera might not require colour capabilities as its main function is to identify debris and other objects at low levels.

G 3.3.8 A higher frame rate may be required to identify objects or debris.

G 3.3.9 The track debris camera may be positioned in a hostile area of the train and could come into contact with foreign objects.

G 3.3.10 Track debris cameras with a 'self-cleaning' lens are available, which supports capabilities for capturing images continuously.

G 3.3.11 Consideration can be given to the inclusion of an infrared mode for the track debris camera to enable the detection of infrastructure defects through additional analytical software.

3.4 Passenger saloon

3.4.1 Guidance on passenger saloon camera coverage

Guidance

G 3.4.1.1 Sections 6.6 – 6.8 of BS EN 62676-4:2015 contain considerations and guidance related to fields of view.

G 3.4.1.2 Considerations can include the object size – in this case, it may be important to be able to identify passengers in the saloon.

G 3.4.1.3 Multiple cameras can be used to fulfil the coverage set out by the operator.

G 3.4.1.4 When deciding on the position of cameras, it is good practice to minimise blind spots caused by internal vehicle structures such as the passenger information system and grab rails.

G 3.4.1.5 If wide angle cameras are used, consideration can be given to minimise the effect of image distortion (fisheye effect) at the sides of the image.

G 3.4.1.6 It is good practice for the passenger saloon camera system to be linked to the alarm system. This can allow events to be tagged for future review.

G 3.4.1.7 Additional information regarding the activation of the passenger alarm can also be added to the video file's metadata.

G 3.4.1.8 Passenger saloon camera placements can vary depending on the interior layout of vehicles.

G 3.4.1.9 Consideration can be given to interfacing with other onboard control systems or driver alarms, where appropriate.

Part 4 Data management and security

4.1 Data access

4.1.1 Under normal operation circumstances, the recorded data shall be accessible remotely without the need to attend the train in person.

4.1.2 By exception, if a visit to the train is required to download the recorded data, it shall only be made accessible to authorised personnel.

4.1.3 The ID of the authorised person accessing or downloading the video data along with the date and time of the access shall be recorded.

4.1.4 The camera systems shall be capable of downloading video data by connection of an external device.

4.1.5 The on-train camera system shall also be capable of immediate playback on the rail vehicle by authorised personnel using an external device or Human Machine Interface.

4.1.6 The video recorder shall be capable of a full or partial download of data to the external device.

Rationale

G 4.1.7 Accessing the recorded data through the involvement of BTP or other authorised personnel can be time consuming.

G 4.1.8 This could cause delays in obtaining the recorded data which could then impede investigations.

Guidance

G 4.1.9 When specifying a new on-train camera monitoring system, it is good practice to include the BTP in the process so that systems can be checked for compatibility or quick access when recorded data is requested.

G 4.1.10 It is good practice to allow the on-train data to be accessed wirelessly through the use of Wi-Fi or Bluetooth connectivity.

4.2 User interface and controls

4.2.1 Recorded data files shall be easily replayed on standard computer systems such as Microsoft Windows.

4.2.2 If a time difference exists, this shall be clearly displayed on the user interface.

4.2.3 For remote video data access, the data shall be accessed through a user portal that does not rely on proprietary systems to function.

Rationale

G 4.2.4 Clear, straightforward controls for download and playback can simplify the task of reviewing the video file.

G 4.2.5 There can be instances where images will be accessed by authorised personnel directly on the train.

G 4.2.6 This can occur as part of maintenance to check that the on-train camera and recording systems are functioning correctly.

Guidance

G 4.2.7 It is good practice to make the images accessible to a wide range of users.

G 4.2.8 It is good practice for the controls to adopt a standardised format. For example, the controls could include play, pause, rewind, fast forward, and export functions, as a minimum.

G 4.2.9 Consideration can be given for the inclusion of a seeker bar to enable the operator to skip to a particular instant in the video file.

4.3 Wayside uploading

4.3.1 Where equipped, on-train video systems shall upload recorded video data to an off-board server automatically.

Rationale

G 4.3.2 Uploading tagged video data when the train is in a depot or at select locations is an effective way to provide data resilience and assist both the rail operator and BTP.

Guidance

G 4.3.3 An example would be for the video to be uploaded when an emergency brake application is made.

G 4.3.4 The train can also upload the recorded data when it is stationary in a depot. This can be done through geofencing – where a virtual geographic boundary can be defined using GPS or radio-frequency identification (RFID).

G 4.3.5 Video data can be uploaded wirelessly. Examples of wireless connections include Wi-Fi or through subscription to a mobile data service.

4.4 Storage Media

4.4.1 Storage media removal

4.4.1.1 The video recorder shall incorporate removable physical storage media.

4.4.1.2 Storage media that have been removed from the video recorder shall be playable / readable in a different machine and not electronically tied to the original recorder.

Rationale

G 4.4.1.3 The purpose for allowing for the removal of storage media is to minimise intrusion and disruption for the continued operation of the on-train camera monitoring system.

G 4.4.1.4 For authorised personnel, e.g. the BTP, to remove a storage media device should be a last resort, as this can prevent duplicates from being made or shared externally while the investigation is ongoing.

Guidance

G 4.4.1.5 Consideration can be given to the provision of spare modules / caddies so that any storage media can be replaced after an incident thus enabling the video recorder to continue functioning.

4.4.2 Storage media transit

4.4.2.1 In the rare event where a storage device is removed, transit cases shall be provided for transportation and storage.

4.4.2.2 The transit case shall be shut and secured during transportation.

4.4.2.3 The transit case shall be capable of holding sufficient quantities of storage media devices to replace those in the video recorders for the camera systems in the train formation.

4.4.2.4 The transit case shall be capable of protecting the storage media devices from damage due to shock when dropped from a height of at least 1 m from the ground during transportation.

4.4.2.5 When shut and secured, the transit cases shall be watertight.

4.4.2.6 When shut and secured, the transit cases shall protect the storage media devices from static electricity.

Rationale

G 4.4.2.7 It is good practice to protect the storage media device when it is removed. This action may be required for rapid access to the video files for investigations or evidential requirements.

G 4.4.2.8 Storage media devices, like most electronic devices, can be damaged due to physical impacts (e.g. drops), water, or static electricity.

G 4.4.2.9 Damaged storage media devices can cause the data to be lost, corrupt, or inaccessible.

Guidance

G 4.4.2.10 To provide protection for the storage media devices, they can be mounted in modules / caddies.

G 4.4.2.11 Consideration can be given to the number of storage media devices present on a train so that the caddy can be designed to safely carry an optimum number of storage media devices at any time.

G 4.4.2.12 The storage media devices can be secured in the transit cases with cushion or padding.

G 4.4.2.13 Video storage media devices can be damaged if dropped or mishandled. This can cause the video files to be corrupted, lost or inaccessible. A drop height of 1 m is representative of a typical carrying height.

G 4.4.2.14 There could be multiple storage media devices on a train which need to be removed or exchanged. Having a carrying case with capacity to carry multiple storage media devices can assist the maintainer's task.

G 4.4.2.15 Consideration can be given to potential damage to the storage media devices caused by water, static electricity or physical impacts.

4.5 Guidance on evidential requirements

Guidance

G 4.5.1 Authorised personnel likely to require access to the forward-facing camera system recorded data, either on the rail vehicle or after the data has been downloaded, can include:

a) Railway undertaking designated staff;
b) Network Rail designated staff;
c) BTP personnel;
d) ORR designated staff;
e) RAIB designated staff; and
f) Health and safety representatives.

G 4.5.2 Railway undertakings can develop operational procedures in conjunction with Network Rail, BTP and other relevant bodies to permit viewing access of the forward-facing camera system data by their authorised personnel.

G 4.5.3 In the event of a major incident, the BTP can request the railway undertaking to provide authorised personnel to assist in the mass download of camera system data.

G 4.5.4 In the event of a terrorist, chemical or biological incident it is unlikely that railway undertaking authorised persons will be permitted access unless appropriate training has been undertaken.

G 4.5.5 BTP technicians (Digital CCTV Retrieval Team) have received training to allow them to attend major incidents. It is suggested that railway undertakings provide training for the BTP technicians on their video camera systems.

4.6 General security requirements

4.6.1 The camera systems shall not be directly accessible to unauthorised persons attempting to access the camera systems and video files.

4.6.2 The on-train camera systems shall incorporate the use of usernames and passwords, as a minimum, for all authorised personnel attempting to access the camera systems or the video files.

4.6.3 Computers, when configured as a portable access device, shall not be capable of accessing any of the system settings on the video recorder or be capable of editing or deleting data from the video recorder.

Rationale

G 4.6.4 It is good practice to restrict access to the on-train camera systems to authorised personnel only.

G 4.6.5 This can prevent unauthorised users changing camera settings or tampering the recorded images.

Guidance

G 4.6.6 The BS IEC 62443 series standards and PD CLC/TS 50701:2021 set out requirements and guidance for system security and associated security levels. It is good practice for the contents of this document to be implemented when designing the on-train camera monitoring system.

G 4.6.7 It can be assumed that third-party individuals might not have received any training on accessing the camera system or downloading the recorded video data.

G 4.6.8 Consideration can be given towards changing passwords on a regular basis.

G 4.6.9 It is good practice for passwords to contain a mix of upper and lower-case letters, numbers, and special characters as this can form a strong password. It is good practice to have a security system which recognises that upper and lower-case letters are different.

G 4.6.10 Consideration can be given to staff from third party organisations to access the on-train camera system using their own computers.

4.7 Guidance on access policies

Guidance

G 4.7.1 Different levels of access permissions can be established to limit access to the on-train camera systems depending on the roles or responsibilities of authorised personnel.

G 4.7.2 An example of a list of levels and associated permissions is as follows:

a) Level 1: Access to view video data only.
b) Level 2: Access to view and download video data only.
c) Level 3: Access to view, download and change on-train camera and video recording settings.

4.8 Guidance on data protection and rights

Guidance

G 4.8.1 The following documents can be read in conjunction with this guidance:

a) Home Office Scientific Development Branch (HOSDB) and Association of Chief Police Officers for England & Wales (ACPO) guidance HOSDB CCTV Operational Requirements Manual 2009 Publication No. 28/09.
b) BTP publication: Output Requirements from Video Systems version 1.7, dated 2/2/2018.
c) Surveillance Camera Code of Practice (Home Office) June 2013. The Code of Practice places certain requirements on 'Relevant Authorities', of which British Transport Police has volunteered to be classified in this manner, however the remainder of the Industry are not classified in that way.
d) National Rail & Underground Closed Circuit Television (CCTV) Guidance Document. Version Issue Four. Issued by RDG's Policing & Security Implementation Group. Date: October 2015.

G 4.8.2 Prior to commissioning systems, operational requirements and specifications should be aligned to best practice specific to the data protection act and GDPR, where appropriate.

G 4.8.3 Where guidance is available from government agencies (Home Office or Defence Science and Technology Laboratory (DSTL)), this should be used in system design and validation.

G 4.8.4 Consideration can be given to the use of technology that can allow the blurring or censorship of persons' recorded faces. As part of this technology, faces can be unblurred by the BTP or authorised personnel as part of an investigation, where necessary.

Definitions

Auto dropping device (ADD)	No definition.
Automatic Warning System (AWS)	A system that gives train drivers in-cab warnings of the approach to signals, reductions in permissible speed and temporary/emergency speed restrictions, and to apply the brakes in the event that a train driver does not acknowledge cautionary warnings given by the system within the specified time. Source: *GERT8075*
British Standards (BS)	No definition.
closed circuit television (CCTV)	A television system in which the video signal is not publicly distributed but is monitored, primarily for surveillance and security purposes. The monitoring may be undertaken by an operator in real time, or recorded for later analysis in the event of an incident. Equipment that is used for remote monitoring and supervisory purposes, usually at a station platform or level crossing.
Cloud	computer storage available over the Internet
Driver Controlled Operation (DCO)	A method of working where the train driver is in control of the opening and closing of the train's doors.
European Standards (EN)	Europe-wide standards that help in developing the single European market for goods and services in all sectors. The intention of ENs is to facilitate trade between countries, create new markets, and cut compliance costs.
European Train Control System (ETCS)	The signalling, control and train protection part of the European Rail Traffic Management System designed to provide interoperability and standardisation across European railways.
GDPR	General Data Protection Regulation 2018.
Global Positioning System (GPS)	A type of Global Navigation Satellite System (GNSS), originally deployed by the USA for military use but now available for civil use. It consists of 24 satellites that orbit the earth and provides location and time information, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites.
Great Britain (GB) [geographical]	No definition.
Ingress Protection (IP)	Ingress Protection as set out in *BS IEC 60529*.
International Organization for Standardization (ISO)	No definition.
Internet Protocol (IP)	No definition.
Office of Rail and Road (ORR)	The independent safety and economic regulator for Britain's railways.
Radio Frequency Identification (RFID)	A method of storing and retrieving data via electromagnetic transmission to a radio-frequency-compatible integrated circuit.

Rail Accident Investigation Branch (RAIB)	No definition.
Rail Delivery Group (RDG)	No definition.
Rail Industry Standard (RIS)	No definition.
Rail Safety and Standards Board (RSSB)	No definition.
signal passed at danger (SPAD)	Any occasion when any part of a train proceeds beyond its authorised movement to an unauthorised movement; 'unauthorised movement' means to pass: a) A trackside colour light signal or semaphore at danger, order to STOP, where an Automatic Train Control System (ATCS) or train protection system is not operational b) The end of a safety related movement authority provided in an ATCS or train protection system c) A point communicated by verbal or written authorisation laid down in regulations, or d) Stop boards (buffer stops are not included) or hand signals, But excludes cases in which: e) Vehicles without any traction unit attached or a train that is unattended run away past a signal at danger, or f) For any reason, the signal is not turned to danger in time to allow the driver to stop the train before the signal.
Train Control and Management System (TCMS)	The on-board software that provides some train controls and monitoring functionality.
Train Protection and Warning System (TPWS)	A system mitigating Signals Passed At Danger and non-respect of permissible speeds.
UTC (Coordinated Universal Time)	No definition.
ACPO	Association of Chief Police Officers
BTP	British Transport Police
CIF	Common Intermediate Format
CMYK	Cyan, Magenta, Yellow, Black
DSTL	Defence Science and Technology Laboratory
DVR	Digital Video Recorder
fps	Frames per second

HDD	Hard disk drive
HOSDB	Home Office Scientific Development Branch
ID	Identity
IT	Information Technology
LED	Light Emitting Diode
NVR	Network Video Recorder
ONVIF	Open Network Video Interface Forum
SSD	Solid-state drive
YCbCr	Luma; Blue-difference chroma component; Red-difference component.

References

The Standards catalogue gives the current issue number and status of documents published by RSSB: http://www.rssb.co.uk/railway-group-standards.

RGSC 01	Railway Group Standards Code
RGSC 02	Standards Manual

Documents referenced in the text

Railway Group Standards

GMRT2100	Requirements for Rail Vehicle Structures
GMRT2161	Requirements for Driving Cabs on Railway Vehicles

RSSB documents

RIS-1530-RST	Rail Industry Standard for Technical Requirements for On-Track Plant and their Associated Equipment and Trolleys
RIS-2703-RST	Driver Controlled Operation (DCO) On-Train Camera/Monitors (OTCM)
RIS-2747-RST	Functioning and Control of Exterior Doors on Passenger Vehicles

Other references

BS EN 60529:1992+A2:2013	Degrees of protection provided by enclosures (IP Code)
BS EN 61373:2010	Railway applications. Rolling stock equipment. Shock and vibration tests
BS EN IEC 62847:2023	Railway applications. Rolling stock. Electrical connectors. Requirements and test methods
BS IEC 62443 series standards	Security for industrial automation and control systems.
BS ISO 8601-2:2019	Date and time. Representations for information interchange. Extensions
BS EN 16186-1:2014+A1:2018	Railway applications - Driver's cab. Part 1: Anthropometric data and visibility.
PD CLC/TS 50701:2021	Railway applications. Cybersecurity.
BS EN 14033	Railway applications. Track. Rail bound construction and maintenance machines. General safety requirements
BS EN 62676-4:2015	Video surveillance systems for use in security applications. Application guidelines

Other relevant documents

BTP publication: Output Requirements from Video Systems version 1.7, dated 2/2/2018.

Home Office Scientific Development Branch (HOSDB) and Association of Chief Police Officers for England & Wales (ACPO) guidance HOSDB CCTV Operational Requirements Manual 2009 Publication No. 28/09.

National Rail & Underground Closed Circuit Television (CCTV) Guidance Document. Version Issue Four. Issued by RDG's Policing & Security Implementation Group. Date: October 2015.

Surveillance Camera Code of Practice (Home Office) June 2013. The Code of Practice places certain requirements on 'Relevant Authorities', of which British Transport Police has volunteered to be classified in this manner, however the remainder of the Industry are not classified in that way.