Appendix 1

Office of Rail and Road

Goal-setting Principles for Railway Health and Safety

Additional factors to be considered for operation of passenger trains in GOA4, Unattended Train Operation configuration

Draft discussion document

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Version M

Additional factors to considered for operation of passenger trains in GOA4 be Unattended Train Operation configuration

The Goal-setting Principles for Railway Health and Safety (GPRHS) are fundamental to all railway systems. While they are primarily based around the concept of a train operated by a human driver* moving on a railway controlled by signallers they nonetheless remain applicable to the operation of passenger trains in Grade of Automation GOA4 Unattended Train Operation (UTO) configuration. Paragraphs 2) and 6) below explain the various grades of automation.

For a railway conceived, designed, built and operated on or converted to GOA4, the functions normally provided by a human train operator or driver and a signaller are replaced by a digital system of interacting hardware and software systems which together must achieve an outcome at least as good as a human train operator/driver and signaller.

Consideration should also be given to how other matters indirectly addressed by the presence of human operator/driver such as noting track defects, infrastructure failures or severe weather conditions will be fulfilled, perhaps by on-train detection systems or alternative checking mechanisms.

ORR has held informal discussions with selected metro railway operators as they consider progress towards higher level grade of operation (GOA) systems above GOA1. This work has led ORR to develop several additional factors for consideration for GOA4 UTO passenger train operation. These additional factors are intended to compliment ORR's Goal-setting principles for railway health and safety (GPRHS)

This appendix to GPRHS sets out these further considerations to be made in applying the GPRHS in relation to a GOA4 fully automatic railway system carrying passengers. It must be ***read in addition*** to the existing principles.

*Throughout this document the term 'driver' is used for all roles where a human being on the train controls the movement of a train, regardless of the terminology that might be used by any particular railway or the other roles undertaken by that person when not driving a train.

Determining the most appropriate Grade of Automation (GPRHS Principle 1)

1) There are four recognised 'Grades of Automation' associated with train operation as set out in **International Standard IEC 62267- Railway applications – Automated urban guided transport (AUGT) – Safety requirements.**
This is replicated in BS EN 62267:2009.

2) Reliance on operations staff reduces as the GOA level increases and the system assumes responsibility for more functions.

Grades of Automation Summary

On-sight train operation	Non-automated train operation	Semi-automated train operation	Driverless train operation	Unattended train operation
TOS	**NTO**	**STO**	**DTO**	**UTO**
GOA0	**GOA1**	**GOA2**	**GOA3**	**GOA4**

3) Britain has a small number of metro railways - London Underground, Docklands Light Railway, Tyne and Wear Metro, SPT Glasgow Underground. Nonetheless between them they carry broadly the same number of passengers annually in normal (pre-covid) years as the mainline railway. Of these, London Underground and SPT Glasgow Underground were both initially developed in the late 1800's as wholly human operated (manual) systems - what would now be classed as GOA1. In the 1980s the Tyne and Wear metro was developed as a manual system, and Docklands Light Railway was introduced as a 'driverless system', expressly designed for driverless operation and having a capability for unattended operation (i.e. although developed before IEC 62267 and GOA classifications, it nominally aligns with GOA3 but could in terms of technical capability and if required, operate in unattended mode).

4) More recently, Glasgow Subway, operated by Strathclyde Partnership for Transport (SPT), has undertaken extensive work to upgrade its underground system. Features include a new automated signalling system, a new operational control centre, new trains, and upgraded stations including platform edge barriers. The upgrade programme aims to provide, once completed, unattended train operation (UTO) capability amongst other developments. These features illustrate the development in thinking and risk control arrangements since the introduction of the original DLR system in 1987.

5) In determining the appropriate GOA level, a comprehensive assessment of risk must be undertaken as required under the Railways and Other Guided Transport Systems

(Safety) Regulations 2006 (ROGS) regulation 19 and under the Management of Health and Safety at Work Regulations 1999 (MHSW) Regulation 3, considering the Principles of Prevention set out in Schedule 1 of MHSW.

6) This risk assessment should consider how and to what extent the 'Basic Functions of train operation' as detailed in IEC 62267 Table 1 (see below from BS EN 62267:2009), are fulfilled by a train driver, a train attendant, or the system alone without reliance on operations staff, to ensure safe operation of the train; together with the technical and operational controls that must necessarily be deployed in accordance with the Principles of Prevention set out in Schedule 1 of MHSW to ensure safety.

IEC 62267 Table 1 (© BSI & IEC)

Basic functions of train operation		On-sight train operation TOS GOA0	Non-automated train operation NTO GOA1	Semi-automated train operation STO GOA2	Driverless train operation DTO GOA3	Unattended train operation UTO GOA4
Ensure safe movement of trains	Ensure safe route	X (points command/ control in system)	S	S	S	S
	Ensure safe separation of trains	X	S	S	S	S
	Ensure safe speed	X	X (partly supervised by system)	S	S	S
Driving	Control acceleration and braking	X	X	X	S	S
Supervising guideway	Prevent collision with obstacles	X	X	X	S	S
	Prevent collision with persons	X	X	X	S	S
Supervising passenger transfer	Control passenger doors	X	X	X	X or S	S
	Prevent injuries to persons between cars or between platform and train	X	X	X	X or S	S
	Ensure safe starting conditions	X	X	X	X or S	S
Operation of the train	Put in or take out of service	X	X	X	X	S
	Supervise the status of the train	X	X	X	X	S
Ensuring detection and management of emergency situations	Perform train diagnostic, detect fire/smoke and detect derailment, handle emergency situations (call/evacuation, supervision)	X	X	X	X	S and/or staff in OCC

NOTE
X = responsibility of operations staff (may be realised by technical systems).
S = realised by technical system.

Factor for consideration for full GOA4 UTO operation of passenger carrying trains

The fundamental areas in which GOA4 UTO operation provides for a digital 'system' to replace the decision of a signaller, or a train operator (driver) are set out below together with the primary GPRHS principles to which they relate.

- Starting and stopping (GPRHS Principles 3,5 & 6)
- Opening and closing of train doors (GPRHS Principles 3 & 6)
- Handling of emergencies (GPRHS Principles 5 & 6)
- Operation of GOA4 trains within depots (GPRHS Principle 3)
- Additional factors to be considered (GPRHS Principles 2, 3, 5 & 6)

GOA4 UTO Factors for train handling

GOA4 UTO Factors for starting and stopping (GPRHS Principles 3,5 & 6)

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 3.2, 5.1, 6.5 & 6.8

Starting

7) A GOA4 train entering into UTO service that is given permission to move by the signalling system shall not be capable of such movement unless and until:

   a) a positive signal of confirmation to move is received by the operating system that confirms there are no outstanding emergency alarm activations and

   b) a positive signal of confirmation that it is safe to move is received by the operating system from the on-board train control system (NB: This will include any on-board emergency alarm activations, and all external doors are proven closed and locked).

8) A GOA4 train in UTO service that is given permission to move away from a platform by the signalling system shall not be capable of such movement unless and until a positive signal of confirmation to move is received by the operating system that:

   a) there is no outstanding emergency alarm activation

b) each and every train door through which passengers have access & egress is proved closed, locked, and clear of obstruction

c) no obstacle is detected either:

i) along the entire length of the gap between train and platform or on the track ahead of the train

OR

ii) if the platform is fitted with Platform Edge Doors [PED] (or an equivalent means of protecting the platform-train interface from obstacles), that no obstacle is located between the train and the PEDs, or on the track ahead of the train

OR

iii) by equipment for detection of trackside obstacles (if fitted)

d) such detection of obstacles at the Platform Train Interface (PTI) shall operate while any part of the train is adjacent to the platform from which a train is departing.

e) where such detection at a platform is activated and any part of the train remains within a platform the train shall automatically make an emergency brake application and an alarm shall activate in the control room and the system shall not permit a following train to enter that platform until

i) the reason for the activation of the detection system has been recorded by an authorised person and

ii) the system has been reset by a person designated under the system to carry out such an action and the reasons for the reset are recorded and

iii) a positive signal of confirmation that it is safe to move is received by the operating system from the on-board train control system.

9) When stopped on the network at a position other than in a station platform, a GOA4 train in UTO service that is given permission to move by the signalling system shall not be capable of such movement from a stationary position unless and until a positive signal of confirmation that it is safe to move is received by the operating system from the on-board train control system.

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 6.6

Stopping

Derailment

10) A GOA4 train in UTO service (or entering into service from a depot) under the control of a system rather than a human being shall be capable of detecting any derailment of its running gear and shall automatically apply the brakes (under emergency condition if required) to bring the train to a stop.

Obstacle detection

11) Where and to the extent necessary for safety a GOA4 train in UTO service shall be capable of detecting trackside obstacles at or above the height of the rail head in its forward direction of travel that may endanger the train; and have systems that will automatically apply the brakes (under emergency condition if required) to bring the train to a stop upon detection of such an obstacle.

12) The equipment for detection of trackside obstacles shall adjust its forward detection capability in relation to the speed and braking capability of the train such that braking can be initiated early enough to ensure safety so far as is reasonably practicable. (i.e. the trackside obstacle detection shall operate further in advance of the train as the train speed increases)

13) Any train stopped by activation of either obstacle detection equipment while line-running or when departing a platform may only be authorised to continue following reactivation by an appropriately authorised person.
The person authorised to take such decisions shall independently record that the source of obstacle detection brake activation is known and resolved, and that it is safe to continue ***before*** authorising train movement.

GOA4 UTO Factors for operation of doors (GPRHS Principles 3, & 6)

Opening doors

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 3.2, 6.3 & 6.9

14) The doors of a GOA4 train in UTO service may only be enabled for opening (other than in an emergency situation) when the train is stationary, correctly berthed in a station platform and the brakes are applied.

15) A GOA4 train in UTO service must be equipped with systems that confirm this state before doors can be enabled for opening.

Closing doors

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 6.3 & 6.9

16) Where a platform is fitted with PEDs, the PEDs shall open before the train doors open and close after the train doors close.

17) If either PEDs or the train doors of a train in service are obstructed, and not closed and locked, it shall not be possible for the train systems that enable movement to be activated or reset either automatically or by human intervention, in a manner which permits the train to move. Movement should remain inhibited until the obstacle is no longer detected and train doors, and PEDs if fitted, proven closed and locked.

18) If either PEDs or doors of a train in service are obstructed following activation of the door closing cycle, the system, shall be configured to stop the door closing sequence and reset to a doors-open condition.

19) It shall not be possible for the starting process of the train to be activated or reset either automatically or by human intervention in a manner which permits the train to move during this reset period.

20) After a defined number of attempts at reset by the door close process, an alarm shall be raised, and the doors shall remain open until reset by an authorised person. The authorised person shall independently record the cause of the failure of door closing and that it is safe to continue ***before*** closing the doors and reactivating the train.

GOA4 UTO Factors for management of on-train passenger safety
(GPRHS Principle 1,3, & 6)

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 1.1, 3.2, 6.2 & 6.4

Ride quality

21) The determined acceleration and deceleration rates for a GOA4 train in UTO, and the rate of change of those rates, should avoid endangering the people (or goods) carried, or vehicles and their couplings. Braking rates should conform to those in BS EN 13452-1:2003 “Railway applications. Braking. Mass transit brake systems - Performance requirements”.

Passenger communications

22) For a GOA4 train in UTO, passengers shall be able to communicate directly via an on-train communications system with those in control of the train in the event of an emergency on the train.

Provide appropriate passenger information

23) Consideration should be given to the required passenger information in UTO, its content and optimum presentation including consideration of the needs of passengers with auditory and visual impairment.

24) Passengers should be made aware of the procedures in place to manage their safety in the event of an emergency.

GOA4 UTO Factors for handling of emergencies (GPRHS Principles 5,6)

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 5.2, 5.3, 6.2, 6.3, 6.4 & 6.5

25) Two sources of emergency activation shall be provided for:

a) Train systems emergency activation (TSEA):
Where the train's systems identify a safety critical fault or failure this should be automatically reported to the control centre. The railway operator should have in place rules, standards and procedures that enable authorised controllers to make decision on the appropriate actions to take. These may include for example taking the train out of service at the next appropriate opportunity, or bring the train to an immediate stand and arranging for passenger recovery.

b) On-train/on-platform Passenger emergency activation (PEA) – whether train outside station or at stationary at a platform

i) On-train Passenger emergency activation (PEA): train outside station
Where there is operation of a PEA on-train it shall cause the train operating system to stop the train in the next station to allow the PEA to be dealt with by controllers in accordance with the operators' rules, standards, and procedures.

ii) On-platform Passenger emergency activation (PEA): train stationary in platform
If the train is stationary in the platform activation of a PEA shall cause the train to be held in the platform until overridden / reset by controllers in accordance with the operators' rules, standards, and procedures.

iii) On-platform Passenger emergency activation (PEA): no train in platform
If an on-platform PEA is operated when there is no train in the platform, activation shall cause the next train entering the platform to do so at reduced speed to ensure that, so far as is reasonably practicable, the obstacle detection system of the train shall have sufficient time to bring the train to a halt prior to colliding with any obstruction.

c) On-train/on-platform Passenger emergency activation (PEA): Train leaving (but still in platform)

(i) If any part of the train is in the platform, activation of an on-platform or on-train PEA shall cause the train control system to stop the train (even if the train comes to rest outside the platform) until overridden / reset by controllers in accordance with the railway operators' rules, standards, and procedures.

GOA4 UTO Factors relating to operation of a train without any on-train staff (GPRHS Principles 6)

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Section 6.4

26) A GOA4 Train in UTO service (with no on-board member of staff from the operator on the train in an official capacity) shall, throughout its entire journey for passenger carrying purposes, be directly contactable by voice by a controller into all passenger carriages. Passengers shall also be able to initiate contact with a controller directly from all passenger carriages.

    The train shall be equipped with equipment and systems that monitors this functionality and shall initiate a TSEA if it is not functioning in any carriage forming the consist.

27) Where a GOA4 UTO system operates in GOA4 it shall be clear to any controller that GOA4 UTO mode of operation is active.

GOA4 UTO Factors relating to operation of GOA4
Trains in depots and sidings (GPRHS Principles 3)

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Section 3.7

Depots and sidings solely operating GOA4 trains

28) People shall be restricted from and not be permitted uncontrolled entry into, a depot or sidings area in which GOA4 trains can move in automatic mode.

29) Authorised walking routes and appropriate site-specific training shall be delivered to provide safe access to trains by staff.

30) Where staff are required to attend a GOA4 train in a GOA4 depot or siding area where trains can move automatically, this shall only be permitted where;

   i) **for access within a train (for example internal cleaning activity),** train movements on the track and train to be attended are inhibited

   ii) **for access to the exterior of a train, or to the track area,** train movement is inhibited on that track and on the tracks adjacent to where the staff will be.

31) The means used to prevent train movement shall be of a sufficient Safety Integrity Level (SIL) to reduce risk of injury so far as is reasonably practicable due to automatic activation of a GOA4 train.

Mixed Depots and sidings

32) GOA4 trains in automatic mode shall collectively be physically segregated from the non GOA4 trains in depots and sidings which operate both modes.

33) The principles set out for “depots and sidings solely operating GOA4 trains” shall apply in the physically segregated GOA4 part of a mixed depot or siding.

GOA4 UTO Additional factors to be considered (GPRHS Principles 2,3,5,6)

To be read in conjunction with Goal-setting Principles for Railway Health and Safety Sections 2.2, 3.3, 3.7, 5.1, 5.2, 6.1 & 6.3

Line availability validation

34) The railway operator shall confirm the line availability of the railway for safe passage of UTO trains before commencing daily operations in UTO, and after an incident that could affect the safe passage of UTO trains. This could be achieved by:

a) Daily operations
Where a GOA4 system is in UTO operation other than continuously over a 24-hour period, a non-passenger-carrying train shall be operated throughout the entire length of the line for the purpose of determining that the line is clear of obstacles and is fit for operational use. Arrangements should be in place to ensure safety during the sweep process, such as if an obstacle is detected or line damaged.

b) Post incident
A non-passenger-carrying train shall be operated through the section of line in which the incident occurred for the purpose of determining that the line is clear of obstacles and is fit for operational use

Management of low adhesion

35) A GOA4 UTO system shall be designed to detect and manage circumstances of low adhesion.

Action in event of a GOA4 system stalled train / loss of traction supply / control system failure

36) In the event of loss of traction supply / failure of the control system / stalled train; a predetermined plan shall be implemented allowing either a ‘limp home’ configuration to be activated or for recovery or evacuation of the train to be initiated.

37) The action shall be in accordance with a predetermined set of timings such that passengers are not obliged to remain for extended periods of time and unable to leave a non-moving train.

38) Communications between the control centre and all train carriages on the network shall remain functional in these circumstances to support passenger management. This facility shall remain for a minimum period consistent with the operators’ estimated

worst case incident management timings.

Self-Evacuation by passengers from a GOA4 system failed train

39) Trains operating on a GOA4 system must be equipped with door sensors capable of alerting controllers to unauthorised door opening.

40) Unauthorised door opening to an extent capable of allowing a person to pass through the opening must cause the train to come to an emergency stop and the electrical supply to be discharged. A train with a train door so activated may not be restarted without on-train intervention by an authorised person.

Train Fire issues

41) Activation of an on-train fire alarm on a train operating in a GOA4 UTO shall cause an alarm to be raised to controllers and the relevant on-train CCTV to immediately appear upon the controller's screen.

42) Consideration shall be given to the means of prompt evacuation and escape for passengers on a GOA4 in UTO operation.

Station emergency issues including fire

43) In the event of a station emergency for a system operating in GOA4 UTO, controllers shall be able to initiate a skip-stop process to prevent trains from stopping in the station and exposing passengers to potential harm.

Emergency train recovery

44) Recovery of a failed train on a GOA4 system may be by:
    a) Driving by an on-train operator using an in-train accessible console that provides vision of the track ahead of the train and limited to a pre-determined maximum operating speed.

    b) By remote operation from a control room by a trained operator provided with a clear vision of the track ahead and travelling at reduced speed.

    c) By assistance provided by a recovery train; the driver of which has a clear view of the track ahead of the train being recovered.

Operation in the presence of track workers

45) Where trains are operating in GOA4 UTO track workers shall not be permitted trackside.

46) A train operating under GOA4 UTO shall not be permitted to continue operating in UTO mode in the presence of person on the track.

Prevention of unauthorised access to GOA4 systems

47) Where and to the extent necessary for safety, unauthorised access to the infrastructure shall be prevented where it is used by GOA4 trains operating in UTO mode.

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