

Category 2 Standard

S2506 Automatic train control

(Formerly E7052)

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1. Purpose

- 1.1 The purpose of this Standard is to define the requirements for automatic train control systems. This standard applies the concepts of the safety signalling philosophy as described in E7001 (Safety signalling philosophy) to automatic train control systems.

2. Scope

- 2.1 This Standard applies to the system functions and performance criteria for automatic train control systems, and describes their expected complete system lifecycle. This standard applies to fixed block and moving block methods of signalling.
- 2.2 Application design and specific configuration issues are not covered by this standard and shall be described in project-specific specifications.
- 2.3 This engineering standard replaces E7052 A6.

3 Requirements

3.1 General requirements

- 3.1.1 The automatic train protection braking curve algorithm shall be developed to ensure the train remains within the safety limits.
- 3.1.2 The automatic train operation sub-system is responsible for the driving function of the train, incorporating motoring, coasting and service braking and stopping at stations. All functions of the automatic train operation must be capable of being over-ridden by the automatic train protection where functions are shared and a more restrictive state is demanded by the automatic train protection subsystem. Safety functions shall be allocated safety integrity levels (SILs) in compliance with BS EN 50126/8/9.
- 3.1.3 Both train stationary position and roll-back movement shall be detected vitally and the latter shall be dealt with such that it does not cause an unsafe condition.
- 3.1.4 The signalling system shall embody full automatic train control. Manual intervention by train operators shall only be required in exceptional circumstances in the event of equipment failure, emergencies or for train operator familiarisation purposes.
- 3.1.5 The system shall not depend on mechanical tripping devices to achieve the fail-safe signalling protection. The system however may have to interface with mechanical automatic train protection systems.
- 3.1.6 Trains shall be signalled in the normal direction of travel. Where there is a requirement to signal trains in the reverse direction it shall be easy to implement and train operations shall have the same level of automatic train protection as in the normal direction. When driven from the rear cab controls, the position of the front cab operator vigilance device shall be monitored by the automatic train protection system and emergency braking commanded if the device is released.
- 3.1.7 The operating mode of the train shall only be selectable by the train operator or depot staff. At each station stop train operator intervention will be required to commence the next inter station run.
- 3.1.8 The automatic train control system shall be able to generate a limited amount of fault information on rolling stock and ground based automatic train protection/automatic train operation equipment and transmit this to the Service Control Centre.

- 3.1.9 The signalling system shall enforce train safety and control through the automatic train protection and automatic train operation sub-systems.
- 3.1.10 The system shall be capable of operating within cast iron, concrete or brick lined tunnels and on open sections on viaducts, embankments and in cuttings with a fourth rail conductor system supplying 630 Volts DC (nominally).
- 3.1.11 The system shall be capable of operating with a three rail 750V DC (nominally) system, as used by Network Rail, on sections of the Underground where joint running occurs. The system shall also be compatible with lines paralleled by routes with 25 kV 50Hz AC overhead electrification.
- 3.1.12 The train shall be equipped for operation in three distinct operating modes for consistency with other automatic train control systems used on London Underground. These are discussed in the next 3 sections.
- a) "Automatic control" mode shall enable the train to operate fully automatically, the only train operator inputs required shall be the giving of permission for the train to start after a station stop and the door operation (closing of the doors);
- b) "Protected Manual" mode shall provide a method of operation whereby the train operator can drive to speed and distance information that is presented via the automatic train protection system which ensures that the safety speed limits are not exceeded;
- c) "Restricted manual" mode of operation shall provide a method of operation whereby the trains speed is limited to a low speed.
- 3.1.13 The system shall maximise the signalled service capacity (typically 36 trains per hour), subject to the limits imposed by civil speed restrictions, achievable train speeds and station stop times.
- 3.1.14 The automatic train protection system shall determine the exact position of trains. The automatic train protection system shall ensure compliance to speed limits and ensure trains proceed in a safe manner.
- 3.1.15 Where any form of platform edge door is installed, the automatic train protection system shall ensure that the train will not proceed in auto or manual mode unless a signal has been received from the system that the platform edge doors are closed.
- 3.1.16 The specified performance throughout the life of the system shall require no adjustments, following the initial setting-up of the system to maintain the optimum performance. If adjustment is required this shall be minimised by the design.
- 3.1.17 The system shall be designed to minimise the possibility of any incorrect connection of the system or its sub-systems.
- 3.1.18 The system shall be designed such that any single failure of the system or sub-systems cannot produce a wrong-side failure condition.
- 3.1.19 Electronic components shall not be used under the train car body without appropriate compartmentation.
- 3.1.20 Train stopping accuracy shall be at least as accurate as ± 1.0 metre under automatic train operation for 99.9 % of station stops.
- 3.1.21 Train stopping accuracy under automatic train operation shall be compatible with platform edge doors where these are provided, and at least as accurate as ± 0.5 metres for 99.9 % of station stops at these locations.

3.2 Electromagnetic compatibility

- 3.2.1 Reference shall be made to standards S1196, Signalling and Signalling Control – Concept and Requirements.

3.3 Automatic train protection

- 3.3.1 The automatic train protection system shall provide the fundamental safety control of train movement throughout the line. The control system shall continuously detect the presence of all trains and continuously compare the actual train speed with the safety speed limit applicable at that time to the section occupied by that train.
- 3.3.2 The automatic train protection system shall be designed to ensure that in the event of a failure of any sub-system, the system shall continue to meet its safety requirements.
- 3.3.3 The resolution of the maximum safe speed and the target speed shall allow sufficient different speeds in any appropriate combination to meet the full requirements of the signalling performance and flexibility required.
- 3.3.4 The automatic train protection system shall enable a zero speed to be commanded. If communication between the train borne and wayside equipment is lost for more than a prescribed time interval (determined by the design and safety analysis), the emergency brake shall be applied.

3.4 Automatic train operation

- 3.4.1 The automatic train operation system shall have the capability of transmission between track-side and train over the entire length of the line. The transmission of data shall be continuous.
- 3.4.2 For areas equipped with automatic train control the wayside signals, where fitted, shall have the capability to display the following aspects:
- a) stop;
 - b) automatic train control proceed, if required for headway purposes;
 - c) all trains proceed.
- 3.4.3 The automatic train operation system shall be capable of transmitting full details of the train on which it is installed such as train set number, crew identification and train destination.
- 3.4.4 The automatic train operation system shall be designed to operate the train within the constraints of the automatic train protection system. The automatic train protection system shall override any decisions made by the automatic train operation system that could compromise the safety of train movements.
- 3.4.5 The automatic train operation system shall hold the train's service brake 'on' whenever the train is stationary.

3.5 Speed detection

- 3.5.1 Diversity of speed detection shall be maintained by the use of a minimum of two fully independent tacho-generators (on different axles) for each driving cab.
- 3.5.2 The automatic train protection system shall vitally calibrate the train wheel diameter.