



BSI Standards Publication

# Railway applications — Automated urban guided transport (AUGT) — Safety requirements

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### National foreword

This British Standard is the UK implementation of EN 62267:2009. It is identical to IEC 62267:2009. It supersedes DD IEC/PAS 62267:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/9, Railway Electrotechnical Applications.

A list of organizations represented on this committee can be obtained on request to its secretary.

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**Railway applications -  
Automated urban guided transport (AUGT) -  
Safety requirements  
(IEC 62267:2009)**

Applications ferroviaires -  
Transports guidés  
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Exigences de sécurité  
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Bahnanwendungen - Automatischer  
städtischer schienengebundener  
Personennahverkehr (AUGT) -  
Sicherheitsanforderungen  
(IEC 62267:2009)

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**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
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## Foreword

The text of document 9/1261/FDIS, future edition 1 of IEC 62267, prepared by IEC TC 9, Electrical equipment and systems for railways, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62267 on 2009-10-01.

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Annex ZA has been added by CENELEC.

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## Endorsement notice

The text of the International Standard IEC 62267:2009 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61508	NOTE	Harmonized in EN 61508 series (not modified).
IEC 62128-1	NOTE	Identical to EN 50122-1:1997.
IEC 62236	NOTE	In Europe, the series EN 50121 applies.
IEC 62279	NOTE	In Europe, EN 50128 applies.

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## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Where a standard cited below belongs to the EN 50000 series, this European Standard applies instead of the relevant International Standard.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 62278	2002	Railway applications - Specification and demonstration of reliability, availability, maintainability and safety (RAMS)	EN 50126-1 + corr. May	1999 2006
IEC 62290-1	- <sup>1)</sup>	Railway applications - Urban guided transport management and command/control systems - Part 1: System principles and fundamental concepts	EN 62290-1	2006 <sup>2)</sup>
IEC 62425	- <sup>1)</sup>	Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling	EN 50129	2003 <sup>2)</sup>

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<sup>1)</sup> Undated reference.

<sup>2)</sup> Valid edition at date of issue.

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## INTRODUCTION

This International Standard is a generic guideline providing recommendations to assist railway authorities and safety regulatory authorities to define safety requirements appropriate to AUGT systems. The generic requirements recommended in this standard are based on the experience gained from AUGT systems already in operation. Safety requirements for each specific application, however, can only be defined from the results of a risk analysis, taking into consideration the conditions in which the AUGT system is to be set up and based on the risk acceptance principles prevailing in the local environment. The standard applicable for conducting a mandatory and comprehensive risk analysis of an AUGT system is IEC 62278 (RAMS).

In view of the diversity of the technical solutions that may be adopted for new AUGT systems and the diversity of operational conditions, the list of generic hazardous situations considered in this standard should be regarded as a minimum list. The requirements for a safeguard as described in this standard are intended as minimum requirements in case a specific safeguard is applied to mitigate the related hazardous situation. However, the specific risk analysis may show that some requirements of a chosen safeguard should be modified to take into account some specific conditions. Each specific design of the new AUGT system and each aspect of the specific topographic, environmental, social or legal environment of the new AUGT system can also generate new hazards and therefore may require additional safety requirements. A specific hazard analysis to identify additional requirements or requirements to be modified is therefore always a necessity.

This standard, therefore, does not and could not prescribe any specific means that could, without a fail, mitigate risks arising from hazardous situations. Rather, it identifies a list of foreseeable hazardous situations, derived from the elementary consideration that functions assumed by the driver and staff in conventional systems are replaced in AUGT systems by automated functions or other safeguards. It is the purpose of this standard that this list of hazardous situations should be carefully considered during the risk analysis carried out for any new AUGT system.

In addition to generic hazardous situations, this standard also describes possible and widely implemented safeguards that the specific risk analysis may well show to be adapted to the specific application.

It should be noted that not all hazardous situations identified in the context of one or other of the large number of different AUGT systems already in operation in the world have necessarily been covered in this standard. Nor would it have been necessarily helpful. Neither could this standard describe all the possible safeguards demanded by each and every specific application.

This standard does not require that a safeguard be put in place for every generic hazardous situation identified. This is because often, the risk associated with a hazardous situation may be assessed as tolerable without the need for a safeguard. According to IEC 62278, it is the responsibility of the railway authority, in agreement with the Safety Regulatory Authority having jurisdiction, to decide on the tolerability of each risk and on the necessity of a specific safeguard, taking into account their specific risk acceptance criteria and legal requirements that are applicable for the specific AUGT application.

## RAILWAY APPLICATIONS – AUTOMATED URBAN GUIDED TRANSPORT (AUGT) – SAFETY REQUIREMENTS

### 1 Scope

This International Standard covers high-level safety requirements applicable to automated urban guided transport systems, with driverless or unattended self-propelled trains, operating on an exclusive guideway.

This standard only deals with the safety requirements needed to compensate for the absence of a driver or attendant staff who would otherwise be responsible for some or all of train operation functions (see Table 1), depending on the level of automation of the system (see shaded areas in Table 1 and see 3.1 for a definition of the different grades of automation).

The requirements of this standard are restricted to transports systems as defined in Clause 5 and to DTO and UTO as defined in 3.1.4 and 3.1.20, respectively (see the shaded areas in Table 1).

Table 1 – Grades of automation

Basic functions of train operation		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
Ensuring 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	S	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 passengers 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
Operating a train	Put in or take out of operation	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 system).						
S = realised by technical system.						

This standard does not specifically look at security issues. However, aspects of safety requirements may apply to assuring security within the transport system.

NOTE The definitions of “security” and “safety” are given by IEC 62278.

Application of this standard is subsidiary to the responsibility of the transport authority and the safety regulatory authority (see IEC 62278) and to the specific laws and decrees applicable within the prevailing environment (economic, social, political, etc.) where the transport system is located, taking into account:

- social risk acceptance in different cultures or different national legal regulations (e.g. SHOREI, BOStrab) or principles (e.g. GAME, ALARP);
- laws and decrees in different states;
- special or different requirements specified by the safety regulatory authority or by an independent assessor in charge of the specific application;

- the responsibility for "safe operation" by the transport authority.

This standard does not apply to the following types of transport systems, unless specifically required by the Transport Authority:

- APMs (Automated People Movers) operating entirely inside a privileged environment such as an airport, a commercial centre or a leisure resort;
- amusement rides and roller-coasters, generally featuring a single station so that passengers board and alight the system at the same location;
- intercity and mainline train services, generally operating in a rural environment on part of their routes;
- cable-driven systems;
- systems featuring electronically guided vehicles with optical sensors, magnetic sensors, or similar devices/systems.

This standard is not concerned with risks arising during works for construction, installation, modification and dismantling of a system.

This standard is not concerned with pre-existing DTO or UTO systems (see definitions in 3.1) that were designed before this standard took effect.

In the case of upgrading an existing transport system to a DTO or UTO system, the risks associated with the existing system are outside the scope of this standard. However, this standard and the risk analysis process described are relevant for the additional subsystems and possibly for the transition process itself. Therefore, the application of the standard is at the discretion of the safety regulatory authority.

In the case of extending or modifying an existing DTO or UTO system in operation, this standard applies only if the change is significant as determined by the safety regulatory authority. However, the risks due to the relationship with the unchanged parts of existing systems (e.g. rolling stock, traction power supply, signalling and platforms) should be taken into account.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62278:2002, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

IEC 62290-1, *Railway applications – Urban guided transport management and command/control systems – Part 1: System principles and fundamental concepts*

IEC 62425, *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling*

## 3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

### 3.1 Terms and definitions

#### 3.1.1

##### **Automated Urban Guided Transport**

##### **AUGT**

system featuring driverless or unattended train operation (as defined below) with self-propelled, guided vehicles, operating on an exclusive guideway

#### 3.1.2

##### **conventional system**

system operated in TOS, NTO or STO

#### 3.1.3

##### **doors closed and locked**

doors are considered as being in a closed and locked state if they cannot be opened by passengers

#### 3.1.4

##### **Driverless Train Operation**

##### **DTO**

train operated with operations staff present on board the train but not accelerating or braking and not responsible for observing the guideway in front of the train and stopping the train in case of a hazardous situation. Safe departure of the train from the station, including door closing, is either the responsibility of operations staff or of the technical system

#### 3.1.5

##### **exclusive guideway**

guideway intended to be used only by one transport system without interference with other types of transport systems

#### 3.1.6

##### **grade of automation**

automation level of train operation resulting from sharing responsibility for given basic functions of train operation between operations staff and technical system

#### 3.1.7

##### **guideway clearance**

pre-defined space around the track defined relatively to the track and such that trains in motion cannot, while under operating conditions, come into contact with persons or property fully outside this space

#### 3.1.8

##### **Non-automated Train Operation**

##### **NTO**

train operation where the driver (i.e., train operator) is in the front cabin of the train observing the guideway and stopping the train in case of a hazardous situation. Acceleration and braking are controlled by the driver in conformance with wayside signals or cab-signalling. The signalling system supervises the activities of the driver. This supervision may be discrete, semi-continuous or continuous. Safe departure of the train from the station, including door closing, is the responsibility of the operations staff whether on board the train or on the station platform

#### 3.1.9

##### **On Sight Train Operation**

##### **TOS**

train operation where the driver has full responsibility and no technical system is required to supervise his activities. However, points (switches) and single tracks can be partially supervised by the system

**3.1.10****Operations Control Centre  
OCC**

centre from which operation of the line or the network is supervised and managed

**3.1.11****passenger cabin**

part of the train used for carrying passengers

**3.1.12****passenger transfer area**

area of the platform directly adjacent to the guideway clearance intended for the passage of passengers during transfer between the platform waiting area and a train

**3.1.13****passenger transfer door**

train door which provides access for passenger transfer between the passenger cabin and a station platform; can also be used as an emergency exit in cases of hazardous situations (e.g. fire, hazardous fumes)

**3.1.14****platform track**

area of track located in a station in front of the platform (see Figure 2)

**3.1.15****platform waiting area**

area of platform where passengers wait for approaching trains, separated from the guideway clearance by the passenger transfer area

**3.1.16****safety space**

area beside the guideway clearance where persons can shelter and not be endangered by moving trains

**3.1.17****Semi-automated Train Operation****STO**

train operation where operations staff is located in the front cabin of the train observing the guideway and stopping the train in case of a hazardous situation. Acceleration and braking is automated and the speed is supervised continuously by the system. Safe departure of the train from the station is under the responsibility of the operations staff, whether on board the train or on the station platform

**3.1.18****transfer area**

area where the transfer of a train between automated and non-automated areas is made

**3.1.19****transport authority**

entity which is responsible for safe and orderly operation of a transport system

NOTE For safety aspects, the term “transport authority” is equivalent to the term “railway authority” as used in IEC 62278.

**3.1.20****Unattended Train Operation****UTO**

train operated without any operations staff on board (all functions are the responsibility of the technical system)

**3.1.21****zero speed status**

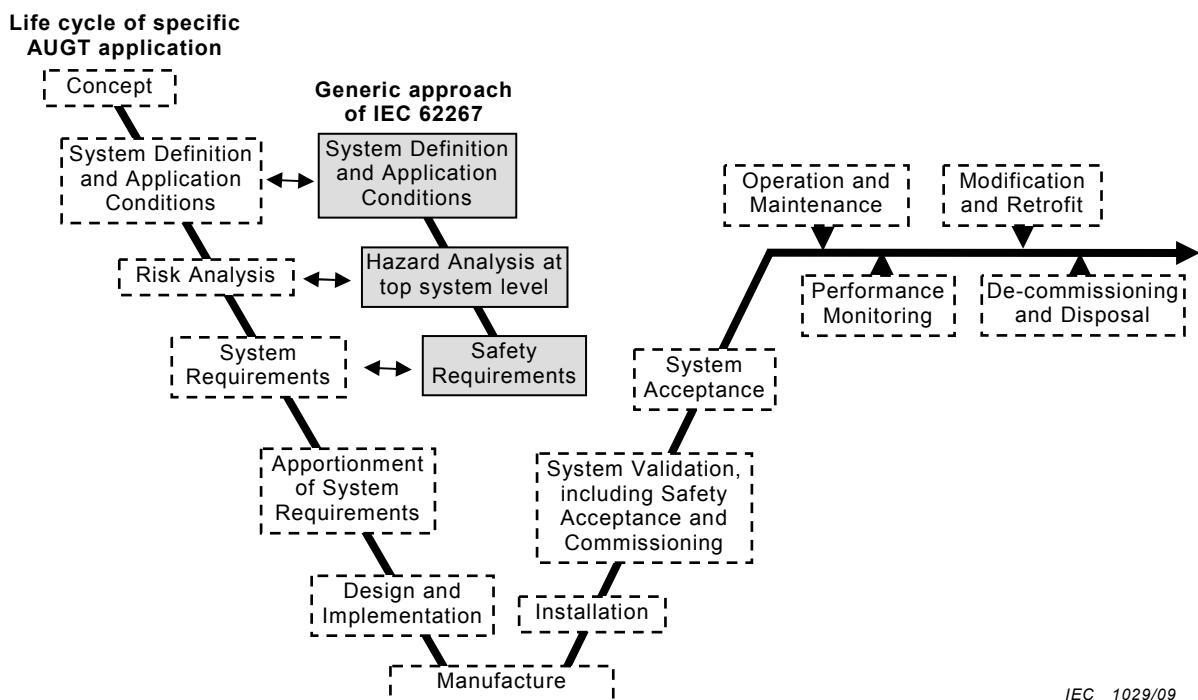
safety-related information indicating that the speed of the train is below a pre-defined limit whereby the system considers the train as stopped

**3.2 Abbreviations**

ALARP	As Low As Reasonably Practicable
AUGT	Automated Urban Guided Transport
DTO	Driverless Train Operation
GAME	Globalement Au Moins Equivalent (French safety principle meaning “globally at least equivalent”)
GOA	Grade Of Automation
NTO	Non-automated Train Operation
OCC	Operations Control Centre
SRA	Safety Regulatory Authority
STO	Semi-automated Train Operation
TA	Transport Authority
TOS	On-sight Train Operation
UTO	Unattended Train Operation

**4 Methodology**

Methodology used for deriving generic safety requirements given in this standard is based on the principles of life cycle phases described in IEC 62278. Figure 1 below shows the V representation of system life cycle and highlights the activities of the methodology.



**Figure 1 – Life cycle phases covered by this standard (see Figure 10 of IEC 62278)**

The methodology consists of the following sequence of activities (shown by the shaded areas in Figure 1):

- defining a generic AUGT system and its application conditions;
- performing a hazard analysis at the top system level;
- deriving safety requirements.

These activities are briefly described below.

#### **4.1 System definition and application conditions**

Clause 5 defines a generic AUGT system, subsystems, their boundaries and application conditions. The basic functions of train operation considered are those covered under DTO and UTO only and shown as shaded in Table 1. System definition clarifies application conditions as a basis for the generic hazard analysis and enables comparability with specific applications.

#### **4.2 Hazard analysis at top system level**

A hazard analysis at top system level has been conducted for the generic system defined in Clause 5.

In the sense of this standard the hazard analysis comprises:

- determination of hazardous situations;
- identification of possible causes for identified hazardous situations;
- allocation of possible safeguards.

Hazardous situations considered are those that arise in an AUGT system when there is:

- no train driver in the front train cabin (i.e. DTO);
- no operational staff on board trains (i.e. UTO).

#### **4.3 Safety requirements**

As result of the hazard analysis at top system level, possible safeguards, which are able to compensate for the absence of a train driver in the front cabin, or any operational staff on board the train, have been identified and are listed in Clause 7. For each safeguard listed in Tables 2 to 9, Clause 8 gives the corresponding safety requirements. Safeguards and requirements also take into account the consensus of operational experience gained from a number of automated systems currently in operation.

This standard does not state the choice of safeguards nor the acceptable level of residual risk which may vary depending on the local safety culture. The tasks for setting safety policy or safety targets or for defining safety acceptance or risk tolerability criteria are the responsibility of the relevant SRA that has jurisdiction over the application. Safety requirements derived may result in different levels of residual risk and therefore the solution chosen depends on the risk acceptance by the relevant SRA.

### **5 System description**

An Automated Urban Guided Transport (AUGT) is a system which

- transports passengers between stations,
- uses automated self-propelled trains,
- runs on an exclusive guideway,
- allows train operation independent from other traffic,
- provides conditions of safe train movement.



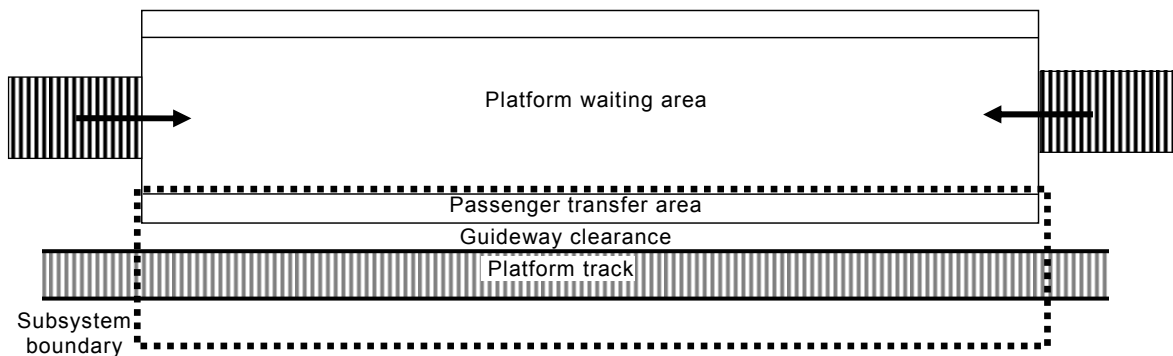
The subsystems (stations, trains and guideway between stations) and their boundaries, shown as dotted lines in the figures below, are described in the subclauses below.

## 5.1 Station

Locality which allows passengers access to the system by transfer from the public environment to the trains (i.e. boarding and alighting activity).

The subsystem station is divided into a number of areas as shown in Figure 2 and defined below:

- the platform waiting area, considered for the purpose of this standard as safe area where persons are not endangered by moving trains. The platform waiting area is by definition outside the scope of this standard;
- the passenger transfer area (platform edge zone) used for passenger transfer between a platform waiting area and a train, but where passengers would be endangered by moving trains or falls;
- the platform track which is used by moving trains to ensure transport.



IEC 1030/09

**Figure 2 – Boundary of the station subsystem**

## 5.2 Train

The subsystem that operates within the guideway and, under regular conditions, moves along the guideway and stops in the stations for passenger transfer.

The train can be a

- single vehicle,
- composition of single vehicles, forming a unit, which cannot be decoupled in regular operation,
- composition of single vehicles or of units which can be decoupled in regular operation.

The subsystem train is divided into:

- the passenger cabin, which is defined as a safe area if a safe train movement is ensured and adequate safeguards are provided against external events impacting on the train, e.g. obstacle on the guideway; or impacting on passengers, e.g. fire;
- the staff (drivers) cabin if provided;
- passenger/transfer doors;
- other train doors or additional emergency exits, if provided.

The train itself with its drive, bogies and passenger cabin is defined as safe if the general requirements for mechanical and electrical train construction are fulfilled and safe guiding of wheels is provided. This is outside the scope of this standard.

Train subassemblies comprising a propulsion/braking system, bogies and guidance equipment, signalling system, mechanical and electrical aspects of the passenger compartment, communications systems, and other such elements of the train subsystem addressed by other complimentary IEC safety standards are outside the scope of this standard. However, functional design requirements for train subassemblies may be dictated or influenced by the safety requirements contained in this standard.

The basic function "Ensure safe train movement" (see Table 1) is typical of all grades of automation from NTO to UTO, regardless of the presence of operational staff on board trains (see IEC 62290-1) and is therefore outside the scope of this standard.

### 5.3 Guideway between stations

The subsystem guideway between stations (Figures 3 to 5) is divided as follows:

- infrastructure elements (e.g. bridge, tunnel, viaduct, track), which are only regarded as safe if the requirements for safe buildings (static system), safe guiding of wheels, etc., are complied with. By definition, this is outside the scope of this standard;
- guideway clearance;
- safety space of the guideway including emergency exits, if provided for specific rescue reasons.

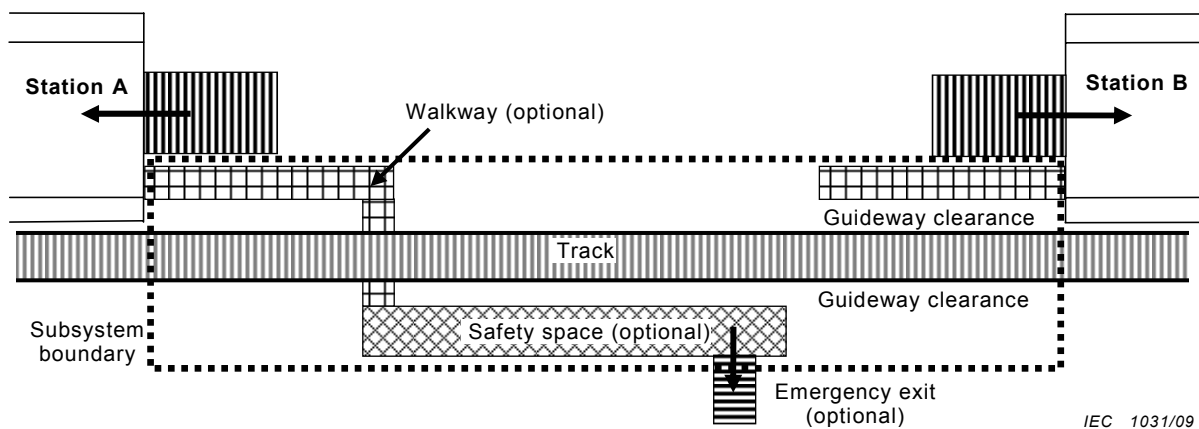
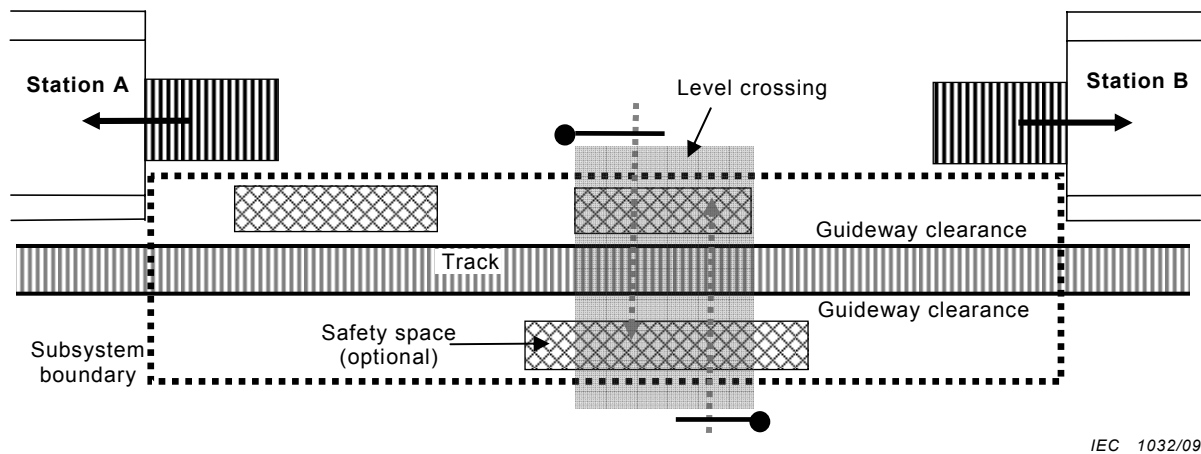


Figure 3 – Boundary of the “guideway between stations” subsystem

Level crossings are considered in this standard as part of the guideway between stations.

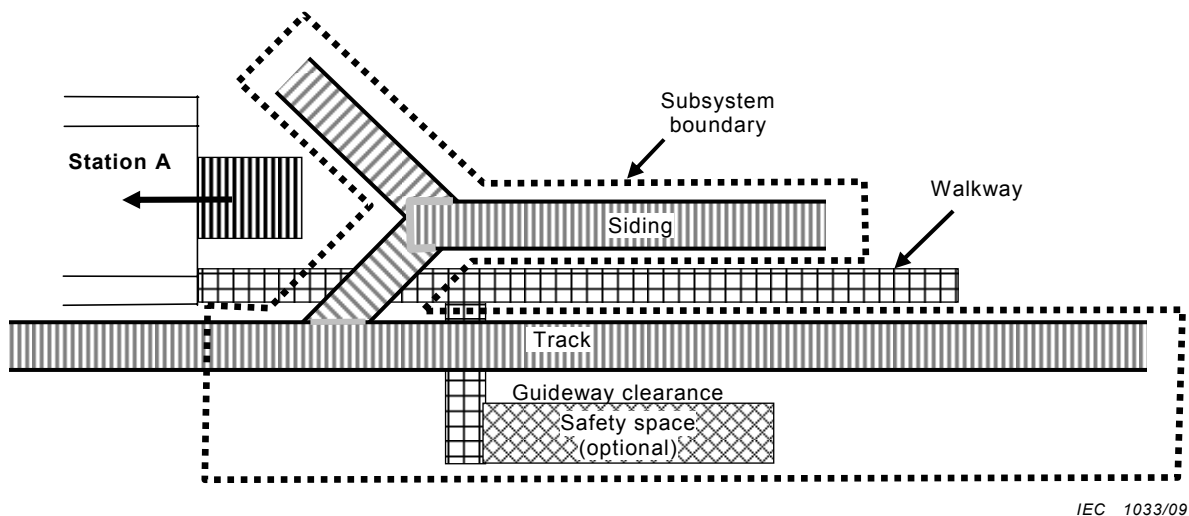
Level crossings are within the scope of this standard (Figure 4).



**Figure 4 – Boundary of the “guideway between stations” subsystem with level crossing**

Sidings (see Figure 5) are sections of the guideway which are specifically used

- for storing trains, when they are not in use for passenger service, or
- for receiving trains taken out of operation and putting trains in operation,
- for performing turn-back rides during operations.



**Figure 5 – Boundary of the “guideway between stations” subsystem with sidings**

#### 5.4 System boundaries

The system also includes the following:

- service vehicles,
- automated sections of the depot,
- interface between automated and non-automated sections,
- the OCC,
- traction power elements along the guideway.

The following items in particular are excluded:

- stations (except passenger transfer areas),

- lifts, escalators, etc.,
- tunnels, bridges, structures,
- areas where trains cannot be operated automatically (e.g. workshop),
- the power distribution system, except for elements along the guideway.

## 6 Entities to be protected

For hazard identification carried out as part of risk analysis of a specific application, exposure to a hazard of the following persons and property shall be considered.

### 6.1 Persons

Persons within the system are classified as passengers, public and staff, including external emergency services.

#### 6.1.1 Passengers

Persons using the system to travel from any one station to any other one and entitled (e.g. by paying the fare) or authorized (e.g. by the relevant TA) to use the system. People who are using the system at any particular time (users) are assumed to be doing so of their own volition.

Passengers may have different levels of awareness, mobility and capacity to react to a hazardous situation. Users may:

- carry belongings of various bulk and shapes (e.g. bicycles and luggage);
- be accompanied by or carry children (including for instance in prams, etc.);
- be children;
- be persons with reduced mobility (elderly people, physically handicapped people);
- have limited perception (not understanding the local language, under the influence of alcohol or drugs);
- have a mental handicap;
- be auditorily and/or visually impaired;
- be accompanied by or carry a pet.

The different levels of passenger awareness and accompanying children/luggage/property to be taken into consideration for risk analysis are the responsibility of the TA by agreement with the SRA.

#### 6.1.2 Staff

Persons who are involved in the operation process of the system as employees of the TA or employees of other involved entities.

There are different types of staff, for example:

- operational staff;
- maintenance staff;
- rescue staff;
- external staff (e.g. maintenance and cleaning staff).

### 6.1.3 External emergency services

This refers to other external agencies that may be involved in the provision of emergency services including but not limited to police, fire department and emergency medical support.

### 6.1.4 Public

Persons who are within the boundary of the AUGT system but neither staff nor passengers.

## 6.2 Property

This includes the whole system infrastructure, trains, system equipment that is part of the AUGT system, neighbouring properties and environment outside the system boundary and property carried by passengers. The definition of property to be taken into consideration by the risk analysis shall be agreed between the TA and the SRA.

## 7 Identified hazardous situations and possible safeguards

Basic functions of train operation for the different grades of automation are shown in Table 1. All those functions, even when outside the scope of this standard, are expected to be fulfilled as basic requirements to ensure safe operation.

This clause tabulates for each basic function within the scope of this standard, as shown by the shaded areas in Table 1, the hazardous situations and the possible safeguards against these hazardous situations and provides a cross reference with the relevant safety requirement description in Clause 8.

It lists the possible safeguards which are able to compensate for the absence of a driver or any operational staff in trains, based on the methodology applied through a generic hazard analysis at a top system level (see 4.2) and the experience from existing specific AUGT applications.

Safeguards and safety requirements proposed in this standard are supplementary to the safety requirements for a conventional system.

Hazardous situations and safeguards identified in the tables below that are not specific to DTO and UTO operation are considered to be outside the scope of this standard. Therefore, they are marked as “Outside scope” in the reference column of the tables and are not described in Clause 8. However, some safeguards that may also be used in conventional systems need to be considered because in the absence of a driver and staff they contribute to safety and availability in UTO/DTO systems. Therefore, they are described in Clause 8 and cross-referenced in Tables 2 to 9.

The choice of a listed safeguard or combination of safeguards, or the choice not to use any safeguard to resolve or mitigate a specific hazard in a specific application depends on the risk tolerability which is to be assessed under the responsibility of the TA and SRA. However, to ensure that all risks arising in a specific application have been taken into account, a risk analysis for the specific application shall be undertaken.

Without a pre-defined priority or preference, safeguards against hazardous situations can be categorized as follows:

- safeguards relying on performance of operational procedures derived from defined operational rules;
- safeguards based on warnings for passengers or other persons (e.g. visual, aural or tactile means of warning such as “mind the gap” announcements);
- safeguards by detection of hazardous situations and reaction to reduce the probability of the resulting accidents or to mitigate the consequences of the resulting accidents;

- safeguards by the application of equipment and facilities designed to avoid hazardous situations (for example platform screen).

However, it must be noted that irrespective of the grade of automation there are top system-level hazards present that must also be mitigated by

- the application of design rules and guidelines for trains and infrastructure, and
- the basic function “Ensure safe train movement”.

The two bullets above are also applicable for a conventional system and are not specific to DTO and UTO. Therefore, they are outside the scope of this standard and are marked as “Outside scope” in the reference column of Tables 2 to 9.

## 7.1 Supervising guideway

### 7.1.1 Prevent collisions with obstacles

Because in DTO and UTO mode, operational staff is absent from the front cabin of the train, provisions shall be made to reduce the risk of collision with obstacles in the guideway clearance. Table 2 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff in the front cabin of the train.

**Table 2 – Prevent collisions with obstacles**

Hazardous situation	Possible safeguards	Reference
Obstacle from outside the system protrudes into the guideway clearance inside tunnel e.g. drill	External rules	Outside scope
Obstacle from outside the system has fallen into the guideway clearance above ground on the track (e.g. tree, crane, car, vandalism included)	Rules for checking guideway clearance	8.3.4
	Physical barriers on bridges	8.7.4
	Physical barriers along the track	8.7.3
	Wayside obstacle detection device	8.7.7
	On board obstacle detection device	8.5.5
Obstacle from inside the system after maintenance left over in guideway clearance (e.g. tools or materials)	Rules for checking guideway clearance	8.3.4
	On board obstacle detection device	8.5.5
	Rules for hand over of the guideway following maintenance	8.1.3.6
Obstacle from inside the system falling during operations in the guideway clearance (e.g. parts of a train, or the structure or wayside equipment)	Rules for checking guideway clearance	8.3.4
	On board obstacle detection device	8.5.5
	Design rules for trains	Outside scope
	Design rules for structures	Outside scope
	Design rules for wayside equipment	Outside scope
Obstacle intrudes onto closed level crossing	Level crossing supervision	8.7.12.2
	Level crossing barrier	8.7.12.1
Obstacle is present on level crossing, when closing is requested	Level crossing supervision	8.7.12.2
Obstacle (e.g. car) coming from level crossing intrudes into the guideway clearance between stations	Prevention and detection of intrusion into the guideway from the level crossing	8.7.12.3

### 7.1.2 Prevent collisions with persons

Because in DTO and UTO mode, operational staff is absent from the front cabin of the train, provisions have to be made to reduce the risk of collisions with persons on track. Table 3 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff in the front cabin of the train.

**Table 3 – Prevent collisions with persons**

Hazardous situation	Possible safeguards	Reference
Person at platform edge and part of approaching train protrudes into platform area	Train complies with guideway clearance	Outside scope
Person at the platform edge with part of their body protruding into the guideway clearance when train is approaching	Warning means related to platform edge	8.4.1.2
	Action of operational staff	8.2.2
	Emergency stop switch on platform	8.4.1.5
	Platform fences	8.4.1.3
	Partial-height platform screen	8.4.2.2
Person at platform edge and passing train causes pressure pulse	Full-height platform screen	8.4.2.1
	Warning means related to platform edge	8.4.1.2
	Reduced speed in stations	Outside scope
	Partial-height platform screen	8.4.2.2
Person having fallen onto platform track – whether accidentally or on purpose by stepping down from platform edge (trespassing) when train is approaching. Suicide is not considered	Full-height platform screen	8.4.2.1
	Emergency stop switch on platform	8.4.1.5
	Action of operational staff	8.2.2
	Traction power cut-off for platform track	8.4.1.6
	Partial-height platform screen	8.4.2.2
	Refuge between rails or under the platform	8.4.1.4
Person entering platform track from outside the system when train is approaching	Open platform with detection system	8.4.3
	Guideway segregated by legal statute	8.7.1.2
	Warning means along the guideway	8.7.2
	Open platforms with detection systems	8.4.3
	Physical barriers along the track	8.7.3
	Traction power cut-off for platform track	8.4.1.6
	Emergency stop switch on platform	8.4.1.5
Action of operational staff	8.2.2	
Person entering guideway clearance between stations from platform track	Intrusion detection device between platform track and guideway between stations	8.7.5
Public, staff or rescued passengers entering guideway clearance between stations from outside	Physical barriers along the track	8.7.3
	Guideway intrusion detection device	8.7.6
	Guideway physically segregated	8.7.1.1

Hazardous situation	Possible safeguards	Reference
	Guideway segregated by legal statute	8.7.1.2
Passenger or staff entering guideway clearance between stations from train	Rules for rescue of passengers	8.3.1
	Keep doors closed between two stations	Outside scope
	Door closed supervision	8.5.1
Person enters guideway clearance from level crossing	Prevention and detection of intrusion into the guideway from the level crossing	8.7.12.3
Staff in guideway for maintenance purposes	Work zones	8.7.13
Staff in safety space of guideway between stations (coming from platform end, from outside the system or from a train – organized evacuation) and parts of approaching train protrude into safety space	Train complies with guideway clearance	Outside scope
Staff in safety space of guideway between stations (coming from platform end, from outside the system or from a train – organized evacuation) protrudes in the guideway clearance and train is approaching	Training and education for staff	Outside scope
Staff in safety space of guideway between stations (coming from platform end, from outside the system or from a train – organized evacuation) and passing train causes pressure pulse	Training and education for staff	Outside scope
Unauthorized person (passenger, public coming from platform end) in safety space of guideway between stations	Rules forbid entry to the safety space, when there is no emergency	Outside scope
	Platform end door with controlled access	8.7.8
	Intrusion detection device between platform track and guideway between stations	8.7.5
	Warning means along the guideway	8.7.2
Person enters safety space from outside the system	Guideway intrusion detection device	8.7.6
	Physical barriers along the track	8.7.3
	Guideway physically segregated	8.7.1.1
	Guideway segregated by legal statute	8.7.1.2
Unauthorized person enters safety space from a train (self-evacuation) and comes in contact with exposed live conductor (e.g. power rail)	Warning means in the train for evacuation	8.5.17
	Traction power cut-off	8.1.3.5
	Keep doors closed between two stations	Outside scope
	Door closed supervision	8.5.1
Person enters level crossing reserved for train movement	Level crossing supervision	8.7.12.2
	Level crossing barrier	8.7.12.1
Person is already present on level crossing when reservation for train movement is initiated	Level crossing supervision	8.7.12.2
Staff in transfer area and unexpected automatic movement of train	Rules for train operation in depot	8.3.6
	Safeguards for transfer areas and depots	8.8



## 7.2 Supervising passenger transfer

### 7.2.1 Control passenger doors

Because in UTO mode there is no operational staff in attendance on the train or the station, for supervising passenger transfers, provisions shall be made to reduce the risk of injuries to passengers from closing and opening passenger transfer doors. Table 4 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff supervising passenger transfer. It should be noted that identified safeguards are sometimes also used in NTO and STO mode.

**Table 4 – Prevent injuries to persons associated with opening and closing passenger transfer doors**

Hazardous situation	Possible safeguards	Reference
Passenger beside train door and doors open or are released for opening during train movement between stations	Keep doors closed between two stations	Outside scope
Train stationary and passenger beside train door opposite the platform or outside the platform area and doors open or are released for opening	Door release for passenger transfer	8.5.2
Passenger can enter the space between platform screen and train because train doors are released for opening or are open but the platform screen doors are not, or vice versa	Door release for passenger transfer	8.5.2
	Alignment of train doors with platform doors	8.4.2.1 a)
	Alignment of train doors with platform doors	8.4.2.2
	Design measures to minimize the distance between train and platform screen	8.6.8.1
Passenger has hand (or other part of body) in the door pocket and hand trapped during opening or closing procedure	Design to minimize the possibility of trapping by an opening door (may include stickers or optical and/or acoustic warning measures)	Outside scope
During passenger transfer, door unexpectedly closes with high closing force	Design to limit closing pressure (force) of door leaves	8.6.3.2
	Optical and acoustic door signals prior to closing	8.6.3.1

### 7.2.2 Prevent injuries to persons between cars or between platform and train

Because in UTO mode there is no operational staff in attendance on the train or the station, for supervising passenger transfer, provisions shall be made to reduce the risk of injuries to passengers resulting from falling into the gap between platform edge and car body or into the coupling area between cars of a train. Table 5 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff supervising passenger transfer. It should be noted that identified safeguards are sometimes also used in NTO and STO mode.

**Table 5 – Prevent injuries to persons between cars or between platform and train**

Hazardous situation	Possible safeguards	Reference
During passenger transfer, passenger falls or is trapped in the gap between platform edge and car body and is endangered by exposed live conductor (e.g. rail) or by the train starting to move	Marking of train door areas on the platform	8.6.4
	Public address system (platform) (e.g. announcement “mind the gap”)	8.4.1.9
	Public address system (train)	8.5.8
	Emergency stop switch on platform	8.4.1.5
	Emergency stop demand on board	8.5.10
	Emergency call device on platform	8.4.1.8
	Emergency call device on board	8.5.11
	Warning means on platform related to gap	8.6.6.2
	Surveillance by operational staff	8.6.5
	Gap-filling device on board or on platform	8.6.6.4
	Gap supervision device on board or on platform	8.6.6.5
	Minimize gap between platform edge and car body	8.6.6.1
	Warning means in the train related to gap	8.6.6.3
Safeguards to protect passengers from electrocution after falling into the gap	8.6.9	
During passenger transfer, passenger (e.g. visually handicapped person) falls in the coupling area between two cars of the train and is endangered by exposed live conductor (e.g. rail) or by the train starting to move	Emergency stop switch on platform	8.4.1.5
	Emergency stop demand on board	8.5.10
	Emergency call device on platform	8.4.1.8
	Emergency call device on board	8.5.11
	Warning means on platform related to gap	8.6.6.2
	Surveillance by staff	8.6.5
	On board closing of coupling area of train	8.6.7.1
	Partial barriers on the platform at the stopping position of the coupling areas of train cars	8.6.7.2
	Monitoring device for coupling area	8.6.7.3
Safeguards to protect passengers from electrocution after falling into the gap	8.6.9	

### 7.2.3 Ensure safe starting conditions

Because in UTO mode there is no operational staff present on the train or the station for supervising passenger transfer and for ensuring safe starting conditions, provisions shall be made to reduce the risk of injuries to passengers resulting from a train starting unexpectedly with one or more train doors open or while any part of a passenger or his possessions is trapped in the train doors or, when relevant, in platform doors. Table 6 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff supervising passenger transfer. It should be noted that identified safeguards are usually also used in NTO and STO.

**Table 6 – Prevent passenger injury during train starting**

Hazardous situation	Possible safeguards	Reference
During passenger transfer, passenger close to open train doors and train unexpectedly starts moving	Train immobilisation during passenger transfer	8.6.1
	Door closed supervision	8.5.1
	Reaction to unexpected train movement	8.5.16
During passenger transfer, passenger close to open train doors, train unexpectedly starts moving and continues to move with doors open and passenger falls	Emergency stop switch on platform	8.4.1.5
	Emergency stop demand on board	8.5.10
Passenger on platform: passenger or his belongings (belt, dog leash, etc.) trapped between leaves of closed doors after passenger transfer and train starts moving	Door closed supervision	8.5.1
	Detection of obstacles during the closing of the doors	8.6.3.3
	Emergency stop switch on platform	8.4.1.5
	Emergency stop demand on board	8.5.10
	Detection of trapped objects after the doors have been closed	8.6.3.4
	Full-height platform screen	8.4.2.1
	Partial-height platform screen	8.4.2.2
	Manual release of trapped objects	8.6.3.5
Passenger trapped between train and platform screen and train starts moving	Emergency stop demand on board	8.5.10
	Emergency stop switch on platform	8.4.1.5
	Ensure that platform screen doors cannot be closed when a passenger is between train and platform screen	8.4.2.1 8.4.2.2
	Detection of obstacles during the closing of the doors	8.6.3.3
	Design measures to minimize the distance between train and platform screen	8.6.8.1
	Device on board or on platform to supervise the lateral space between train and platform screen	8.6.8.2

### 7.3 Operating a train

#### 7.3.1 Put in or take out of operation

Because in UTO mode there is no operational staff present on the train or the station to prepare trains for being put in operation or taken out of operation, provisions have to be made to reduce the risk of harm to passengers, who may need help and would remain in the train intended to be taken out of operation. Table 7 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff supervising a train taken out of operation or put in operation.

**Table 7 – Prevent harm to passengers in relation to taking the train out of operation or putting the train in operation**

Hazardous situation	Possible safeguards	Reference
Passenger on board a train taken out of operation (scheduled or unscheduled) and passenger trapped in unsupervised train or leaves the train under unsafe conditions	Action of operational staff (visual check by staff)	8.2.2
	Rules for taking a train out of operation	8.3.7.2
	On board video surveillance	8.5.7
	On board announcement for taking a train out of operation	8.5.9
	Emergency call device on board	8.5.11
Passenger asleep or unwell is unaware of safeguards on board a train taken out of operation and is trapped in unsupervised train	Rules for taking a train out of operation	8.3.7.2
	Action of operational staff (visual check by staff)	8.2.2
Train put in operation with failure	Train status supervision and testing	8.5.13

### 7.3.2 Supervise the status of the train

Because in UTO there is no operational staff on the train or the station to supervise the train in order to detect failures, provisions have to be made to reduce the risk of injuries to passengers resulting from unidentified train failures leading, directly or indirectly, to an accident. Table 8 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff in cases of train failures. It should be noted that identified safeguards are sometimes also used in NTO and STO mode.

**Table 8 – Prevent injury to persons resulting from train failures**

Hazardous situation	Possible safeguards	Reference
Passenger in a stranded train between stations and train cannot move in automatic mode	Manual operation	8.5.14
Person on board moving train, unauthorized decoupling and person remains in uncontrolled part of the train	Supervise train integrity	Out of scope
Loss of train train composition (outside coupling of units), person is exposed to open train ends or is in uncontrolled parts of the train	Ensure train composition integrity	Out of scope
	Supervise train integrity	Out of scope
Inadequate or incorrect reaction to failures which may affect safe operation	Train status supervision and testing	8.5.13
	Train design leading to safe state	Out of scope
Train starts in wrong driving mode (e.g. fully automated mode instead of staff supervised mode)	Locking of driving mode switch	8.5.14.1
	Interlocking between automatic and manual modes of operation	8.5.14.2
	Ensure safe driving modes	Out of scope
Train starts in wrong driving direction and person or obstacle in front of the train	Ensure safe driving direction	Out of scope
Overspeed during coupling of train	Safe speed during automatic coupling	8.5.15

#### 7.4 Ensuring detection and management of emergency situations

Because in UTO mode there is no operational staff present on the train or on the station to recognize emergency situations arising on board trains or on stations, provisions shall be made to reduce the risk of injuries to passengers resulting from unidentified emergency situations. Table 9 lists safeguards against identified hazardous situations that are able to compensate for the absence of operational staff in cases of emergency. It should be noted that identified safeguards are sometimes also used in NTO and STO mode.

**Table 9 – Prevent injury to persons related to emergency situations**

Hazardous situation	Possible safeguards	Reference
Person on board train and fire starts inside train (due to failure of component, imprudence or vandalism)	Fire protection (measures to mitigate ignition)	8.1.2
	Fire extinguishers	8.1.2
	Rules for passenger behaviour	8.1.4
	Monitoring by the OCC staff	8.2.1
	Rules for fire emergency	8.3.2
Person on board train and fire in progress and smoke and toxic fumes propagate inside train	Fire extinguishers	8.1.2
	Fire protection (measures to mitigate propagation of fire, smoke and toxic fumes)	8.1.2
	Monitoring by the OCC staff	8.2.1
	Rules for fire emergency	8.3.2
	Emergency call device on board	8.5.11
Fire in progress in train stranded on guideway between two stations	Monitoring by the OCC staff	8.2.1
	Rules for fire emergency	8.3.2
	Door release for emergency opening	8.5.3
	Emergency call device on board	8.5.11
	Fire and smoke detection (train)	8.5.12
Fire in progress inside train and passenger not informed about best course of action	Rules for passenger behaviour (in train)	8.1.4
	Monitoring by the OCC staff	8.2.1
	Public address system (train)	8.5.8
Train approaches a station with fire in progress	Fire protection (for station)	8.1.2
	Monitoring by the OCC staff	8.2.1
	Fire and smoke detection (station)	8.4.1.10
Train in a section where a fire is in progress between stations	Fire protection (for guideway between stations)	8.1.2
	Monitoring by the OCC staff	8.2.1
	Fire and smoke detection (guideway between stations)	8.7.10
Person in station and fire starts inside station or guideway	Fire protection (measure to mitigate ignition and propagation for station and guideway between stations)	8.1.2
	Monitoring by the OCC staff	8.2.1
	Rules for fire emergency	8.3.2

Hazardous situation	Possible safeguards	Reference
	Emergency call device on platform	8.4.1.8
	Fire and smoke detection (station)	8.4.1.10
	Emergency call device on board	8.5.11
	Fire and smoke detection (train)	8.5.12
	Fire and smoke detection (guideway between stations)	8.7.10
	Ventilation system to influence the flow of smoke	Outside scope
	Emergency exits from station	Outside scope
Person on board train and train derails	Design rules (safe guidance on guideway)	8.1.3.1
	Monitoring by the OCC staff	8.2.1
Derailment is not detected and train will not be stopped causing injuries to person due to collision with oncoming train or infrastructure, etc., following derailment	Monitoring by the OCC staff	8.2.1
	Rules for the rescue of passengers	8.3.1
	Derailment detection device	8.5.6
	Emergency call device on board	8.5.11
Person in train is seriously ill, injured or threatened by aggressive behaviour and needs assistance	Monitoring by the OCC staff	8.2.1
	Emergency call device on board	8.5.11
Unauthorized person takes control of train in manual mode leading to unstable or unsafe conditions	Monitoring by the OCC staff	8.2.1
	Rules for foreseeable vandalism	8.3.3
	Recognize video surveillance	8.5.7
	Locking of driving mode switch	8.5.14.1
Earthquake occurs possibly leading to train derailment or collision with infrastructure	Monitoring by the OCC staff	8.2.1
	Emergency call device on board	8.5.11
	Earthquake detection device	Outside scope
Guideway flooded with the possibility that trains and stations get flooded	Monitoring by the OCC staff	8.2.1
	Emergency call device on board	8.5.11
	Water flooding protection	8.7.11
Strong wind occurs possibly leading to train derailment or collision with infrastructure	Monitoring by the OCC staff	8.2.1
	Wind observation	Outside scope
Heavy snowfall with the possibility that train gets stuck in snow covered guideway	Monitoring by the OCC staff	8.2.1
	Emergency call device on board	8.5.11
	Observation of weather conditions by staff	Outside scope
Slippery guideway caused by ice or rain (especially drizzle) extending the stopping distance with the possibility of collision with another train	Monitoring by the OCC staff	8.2.1
	Ensure safe separation of train though heated guideway or specific train protection profile for bad weather conditions	Outside scope

Hazardous situation	Possible safeguards	Reference
Passenger is in stranded train and train can be rescued	Monitoring by the OCC staff	8.2.1
	Rules for stranded train removal	8.3.8
Passenger is in stranded train and needs to be evacuated from the train	Traction power cut-off	8.1.3.5
	Monitoring by the OCC staff	8.2.1
	Communication systems	8.2.3
	Rules for rescue of passengers	8.3.1
	Stop oncoming traffic	8.5.3
	Door release for emergency opening	8.5.3
	Emergency exits (from train)	8.5.4
	Public address system (train)	8.5.8
	Emergency call device on board	8.5.11
	Warning means in the train for evacuation	8.5.17
	Provide adequate means for stepping down to the track (e.g. steps, ladders, straps)	Outside scope
	Emergency evacuation walkway	Outside scope
Guideway lighting	Outside scope	
Passenger is in stranded train and self evacuates from the train	Traction power cut-off	8.1.3.5
	Rules for passenger behaviour (in train)	8.1.4
	Monitoring by the OCC staff	8.2.1
	Communication systems	8.2.3
	Rules for rescue of passengers	8.3.1
	Door closed supervision	8.5.1
	Door release for emergency opening	8.5.3
	Stop oncoming traffic	8.5.3
	Emergency exits (from train)	8.5.4
	Public address system (train)	8.5.8
	Emergency call device on board	8.5.11
	Warning means in the train for evacuation	8.5.17
	Provide adequate means for stepping down to the track (e.g. steps, ladders, straps)	Outside scope
	Emergency evacuation walkway	Outside scope
Guideway lighting	Outside scope	
Person between two stations cannot escape from guideway following an evacuation from train	Monitoring by the OCC staff	8.2.1
	Platform end doors	8.4.1.1
	Full-height platform screen	8.4.2.1 item m)
	Emergency exit from physically segregated guideway	8.7.9

## 8 Safety requirements

This clause specifies the generic safety requirements for identified safeguards as listed in Clause 7 and derived from the results of the hazard analysis. The description of the identified safeguards takes into account the experience of existing specific AUGT applications and their corresponding regulatory frameworks (see bibliography).

This clause is structured according to the different parts of the AUGT system where safeguards are intended to be implemented. It should be noted that each safeguard may cover different hazardous situations.

It must be recognized that aspects of a particular topographic, environmental, social or legal consideration for a specific application may generate their own additional safety requirements.

Safeguards or combinations of safeguards chosen for designing and implementing a specific AUGT system depend on the tolerability for the risk. Therefore, to ensure that all risks arising in a specific application have been taken into account, a risk analysis for the specific application shall be undertaken which takes into consideration any specific hazardous situations that may result from the combination of DTO and UTO grades of automation with site-specific conditions and failure modes. Judgement regarding which of the described requirements for a chosen safeguard are relevant to the specific AUGT system also depends on the specific risk analysis. Risk analysis may even conclude that a specific hazard is tolerable without the need for any safeguard. The basic premise is that an AUGT operation should provide at least the same level of safety as an equivalent conventional system. However, accepting the tolerability level of risk or defining the risk tolerability criteria is the responsibility of the SRA that has jurisdiction over the specific AUGT system application.

Passengers can usually be considered as having the ability to contribute positively to all factors of availability and safety of the public transport system. Usually, it can be assumed that passengers will respect warning signs and warning means. It can also be expected that the behaviour of passengers will conform to the written terms of the transport contract and to usual patterns of behaviour. However, specific risk analysis should take into account the actual behaviour of passengers in the context of the local culture, including malicious or careless behaviour.

The safeguards listed in this standard cover the risks which arise through foreseeable negligence of the passengers. Safeguards cannot cover hazardous situations resulting from intentional misuse of the transport system. Taking into account the availability of operations and the different safety cultures that arise from different jurisdictions, the expected behaviour of persons is an important parameter when choosing safeguards during the specific risk analysis. The normal use of safeguards listed in this standard, a positive behaviour and the will not to endanger oneself is expected of passengers.

### 8.1 General requirements

The requirements related to the basic functions “ensuring safe movement of trains” and “driving” in Table 1 have to be fulfilled by adequate safeguards. These requirements are outside the scope of this standard. Therefore, safety requirements given in this standard are supplementary to the safety requirements for a conventional system and the requirements for the basic functions “ensuring safe movement of trains” and “driving”.

#### 8.1.1 Public works regulations to protect the guideway

As is the case with any urban guided transport systems, regulatory covenants shall be instigated. These covenants shall protect the guideway when public works is performed in close proximity of the guideway.

Furthermore the TA shall ensure that procedures and inspection activities to monitor the covenants do exist and are carried out on a regular basis.



### **8.1.2 Fire protection**

For sections of the guideway where persons can be endangered by fire or fire-generated smoke and toxic fumes (e.g. in a tunnel), measures shall be implemented such as smoke extraction equipment (ventilation system), fire alarm equipment, fire reporting equipment, escape and guidance equipment (installation of escape passages and exits and indication of their position), fire extinguishing equipment and the establishment of a complete fire/smoke prevention and control system.

While also applicable to NTO and STO modes, trains and infrastructure shall be designed in accordance with the relevant fire protection guidelines for rail vehicles and infrastructure, e.g. preventing combustion, spread of fire and smoke, production of toxic fumes and providing fire extinguishers or other suitable fire suppression devices or systems (see also 8.3.2).

### **8.1.3 Systems and equipment**

Generally, any system reaction time shall not exceed the equivalent reaction time of NTO and STO systems. Moreover, any message and reaction from an automatically acting safeguard caused by a safety-related function described in 8.1.3.5 shall remain active until the reason for the hazardous situation no longer exists.

#### **8.1.3.1 Design rules**

While also applicable to NTO and STO modes, design, manufacturing and installation rules and criteria for ensuring safety of trains and infrastructure and for safe guidance of trains on their guideway, whatever the grade of automation, shall be fulfilled in accordance with the relevant standards and guidelines.

As also required for NTO and STO modes, and in accordance with relevant standards and guidelines, measures shall be designed and implemented to protect passengers from any unsafe touch voltage between trains and the platform or any equipment on platforms.

#### **8.1.3.2 Availability**

As the operation of UTO modes are conducted without staff on board the train, recovery from failure takes longer and can potentially worsen hazard consequences. Therefore, availability for such systems shall always be considered as having a potential impact on safety.

#### **8.1.3.3 Auxiliary power supply**

As required in NTO and STO modes, in addition to the normal source of power supply, there may have to be an emergency supply fed from an independent source for devices on board trains, on the wayside or the OCC essential for maintaining safety. In the event of the main supply failure, the emergency supply shall be able to maintain power to these devices for a sufficient time for the train to reach a location where passengers can be evacuated if necessary. The emergency supply shall be provided with automatic changeover facilities. Devices which are likely to prevent a train from running into a station, in the event of the power supply failure, shall also be connected to the emergency supply.

#### **8.1.3.4 Reset of safe state**

Following confirmation by operational staff or by the system itself that the hazardous situation no longer exists, the message or reaction can be reset locally or remotely by an authorized staff. It can be reset automatically only if it has been demonstrated by a risk analysis that there is no risk associated with automatic resetting.

#### **8.1.3.5 Traction power cut-off**

While also applicable to NTO and STO systems, provisions shall be considered for cutting off traction power for the locations where a hazardous situation exists from electrocution.

The cut-off may be automatic or by action by the OCC or local staff as necessary. For specific cases, see 8.4.1.6 and 8.5.3.

#### **8.1.3.6 Maintenance**

The maintenance process for AUGT is essential for fulfilling the RAMS requirements at the specified levels defined for the specific application (see 6.11.1 of IEC 62278).

#### **8.1.4 Rules for passenger behaviour**

As required in NTO and STO modes, the TA shall establish and publish rules for the behaviour expected of passengers for their safety when using the system. Such rules may include the following:

- it is prohibited to enter the passenger transfer area when no train is at the platform;
- it is prohibited to cross the platform edge area when the door closing announcement is being made;
- the emergency call system is strictly dedicated for emergency calls. It should not be used, under any circumstances, for requesting information;
- passengers are prohibited from leaving the train stopped outside platforms unless instructed to do so by operational staff;
- smoking and transport of flammable material is prohibited within the system (to reduce the risk of fire).

Such rules shall be communicated to passengers through appropriate visual or aural means in the stations and trains.

### **8.2 Monitoring the AUGT system**

Safeguards, or combinations of safeguards, shall be selected from those given in the following subclauses through the process of risk analysis for each specific application.

#### **8.2.1 Monitoring by the OCC staff**

During normal operation, the OCC staff shall continuously monitor the system to detect abnormal operating conditions and respond to hazardous situations as quickly as possible. In particular, the location and operational status of trains shall be reported to the OCC to enable the OCC staff to take prompt and appropriate action. In particular, the OCC staff shall be able to prevent trains from entering the area affected by the emergency.

Where video surveillance is provided (see 8.4.1.7 and 8.5.7) video-recording systems may be used to improve post-incident analysis.

##### **8.2.1.1 General**

Failures, disturbances and alarms of automatically acting equipment which might influence the safety of operations (affecting persons or causing damage to properties) shall be alarmed at the OCC.

Since the OCC centrally receives and has to deal with a large number of alarms and messages, these alarms and messages shall be prioritized according to their criticality. Special consideration shall be given to the amount of information to be displayed in emergency situations to take into account the human factor.

Provisions shall be made to ensure communication between passengers in trains and on platforms with operational staff in the OCC.

OCC controls and equipment shall enable operational staff to suspend operations and resume normal operations.

The measures described above shall enable the rescue of persons from stranded trains or in case of emergency in accordance with the rules for rescue of passengers (see 8.3.1 and 8.3.2).

Video images displayed in the OCC shall be organized in a way that enables OCC staff to identify clearly the image location (see also 8.4.1.7).

### **8.2.1.2 Functions and responsibilities**

The possible functions monitored by the OCC are shown in informative Annex A.

The functions for monitoring the system and their requirements for the OCC match the choice of the safeguards identified through the risk analysis for the specific AUGT application.

If the OCC staff is required, in accordance with specified procedures, to reset a safety device, provisions shall be made to ensure that OCC staff can judge that the emergency situation no longer exists.

### **8.2.1.3 Reaction in case of unavailability of the OCC**

When any of the functions described in 8.2.1.1, except the requirement related to the organization of the video displays, is not available, including through back-up facilities, the system shall avoid leaving trains stranded between stations. Conditions for continuation of operations shall be defined by the specific risk analysis.

### **8.2.2 Action of operational staff**

Operational staff can support normal operations by surveillance of specific parts of operations (e.g. permanent surveillance of platforms) or visual checks on demand (e.g. visual check for remaining passengers in trains prior to taking a train out of operation, visual check of operational facilities). Such staff activities can also serve as an alternative to technical safeguards, depending on the specific risk analysis.

In UTO systems, additional roving operational staff shall support operations in cases of technical failures or operational disturbances as well as in emergency situations.

Members of roving staff shall be able, as a minimum, to

- examine by visual check technical and operational conditions prior to resetting detection devices to ensure that dangerous conditions are no longer existing,
- supervise temporary safety tasks (e.g. temporary surveillance of platforms) in cases of deactivated safeguards due to technical failures,
- perform the evacuation of passengers from stranded trains by driving the train in manual mode to the next station or by guiding passengers to reach the next station on foot,
- support rescue of passengers in cases of emergency situations.

Actions of operational staff shall be specified by operational rules as described in 8.3.

### **8.2.3 Communication systems**

As required in NTO and STO modes, provisions shall also be made for communication between

- passengers in stations and in trains with OCC staff in cases of emergency (emergency call device on platform – 8.4.1.8, emergency call device on board – 8.5.11),

- OCC staff and passengers in stations and in trains for announcements to provide information in cases of abnormal operational or instructions in case of emergency situations (public address system on platforms – 8.4.1.9, public address system in trains – 8.5.8),
- staff in the OCC and operational and maintenance staff in local facilities or roving.

As the operation of DTO and UTO systems is remote and centralized, such communication means are essential for ensuring safety, availability and reliability of operations by enabling a rapid, coordinated and effective response from the staff involved.

All audio communication and visual information equipment shall operate independently of the traction power supply. All audio and visual communications equipment shall be powered by an uninterruptible power supply for a time period determined by analysis based on the risk analysis of the specific AUGT application.

In case of emergency, communication with external emergency services staff related to operational rules shall be ensured.

### 8.3 Operational rules

Safeguards, or combinations of safeguards, shall be selected from those given in the following subclauses through the process of risk analysis for each specific application.

As needed for all grades of automation, duties and procedures for operational staff shall be described in this clause. Operational staff shall be regularly trained to perform these operational rules.

The following operational rules are particularly relevant in the context of UTO/DTO systems.

#### 8.3.1 Rules for rescue of passengers

It is essential to rescue passengers from stranded trains or in cases of emergency. This requires a rescue plan which defines in particular

- a) measures to establish the location of the emergency,
- b) measures required, depending on the operating conditions prevailing at the location and at that time,
- c) the organization within the transport company responsible for initiating and coordinating the measures.

The rescue plan shall be immediately activated once an emergency has been recognized. Rescue of passengers shall start without undue delay, depending on the emergency and prevailing circumstances, in accordance with local regulations.

#### 8.3.2 Rules for fire emergency

Whilst also applicable to NTO and STO systems, an overall fire emergency plan shall be established in order to describe the strategies and rules for fire emergency. In particular, the rules shall indicate

- the organization and responsibilities of the operational staff,
- how operational staff (6.1.2) and external emergency services (6.1.3) shall communicate and cooperate,
- how to rescue passengers (8.3.1) in case of fire and/or smoke,
- the use of devices for containment and/or suppression of fire, smoke and toxic fumes and for rescue equipment,

- measures/procedures which are required depending on the specific operating conditions, the local environment, and the requirements of the SRA,
- plan for conducting regular exercises.

### **8.3.3 Rules for foreseeable vandalism**

Strategy for dealing with foreseeable vandalism situations shall be established based on the prevailing social and political environment.

### **8.3.4 Rules for checking guideway clearance**

Operational rules shall be established which ensure by periodical checks, that the guideway clearance is free from persons and obstacles.

The guideway clearance shall be checked as follows:

- periodicity to be defined by the TA in conjunction with the SRA (e.g. once a day) and/or after interruptions of operation (e.g. night breaks);
- after events which might result in a disturbance of guideway clearance (e.g. weather conditions or works in the guideway or adjacent areas).

The check can be performed by inspection by operational staff at the front cabin of a moving train at an appropriately reduced speed. Conditions shall ensure that staff are able to detect obstacles in the guideway clearance.

Staff shall be able to stop the train when required.

Passengers may be transported during the inspection ride.

The rules to be established shall describe:

- the periods, the permitted speed, the events for triggering an inspection, the staff responsible for taking the decision to carry out an inspection;
- the duties of operational staff during the inspection and the area to be inspected, which shall include guideway clearance in order to recognize those circumstances which might later influence the clearance;
- the procedure to follow by staff upon detection of an obstacle.

### **8.3.5 Rules for start-up and shut down of operations**

#### **8.3.5.1 Scheduled operations**

Operational rules shall be provided describing

- checks to be performed by OCC staff to ensure that there are no outstanding issues related to safety before allowing scheduled operations to start,
- announcements and checks that are necessary prior to taking trains out of operation to ensure that no passenger remains inside an unsupervised train and may be exposed to hazardous situations (e.g. passenger exits the train and risks electrocution, passenger exposed to low temperatures).

#### **8.3.5.2 Operation restart following recovery from system failure**

Operational rules shall be provided describing

- the restart, if necessary, of the technical system or part of it,
- the checks to be performed by OCC staff to ensure that there are no outstanding issues related to safety before allowing scheduled operations to start.

These checks shall include the location and status of all the trains.

### **8.3.6 Rules for train operations in the depot**

When part of the depot is automated, a depot operation plan shall be established to describe depot operation and access control in order to maintain safety and security of staff and property within the depot.

Rules for train operation in the depot shall address the segregation of staff from moving trains in the transfer area, identification of areas where staff or trains may be present and how the access will be controlled.

All train movements between automatic areas and manually driven areas in the depot are always under the responsibility of staff.

### **8.3.7 Rules for trains to be put in or taken out of operation**

#### **8.3.7.1 Rules for putting a train in operation after recovery from system failure**

Operational rules shall be provided to

- restart, if necessary, the train equipment,
- initialize, if necessary, the train location before it is put in operation.

Use of the restart facility shall be limited to situations where it is explicitly required. In particular, the restart facility shall not be used by staff as a “workaround” for functions not yet operational or implemented.

#### **8.3.7.2 Rules for taking a train out of operation**

Operational rules shall be provided describing the announcements and checks that are necessary prior to taking the train out of operation to ensure that no passenger comes under unsafe conditions within the system.

#### **8.3.7.3 Rules for transition of train operational mode**

When a train is taken out of operation, the process of mode transition shall not depend on rules but shall be handled by the system automatically.

Operational rules shall be provided describing the conditions and procedure under which a transition from automatic mode to manual mode is allowed.

### **8.3.8 Rules for stranded train removal**

In the case of a stranded train, moving the train can be achieved through a manually or automatically driven rescue train. Operational rules shall be provided to describe the appropriate measures for safe rescue of the stranded train.

## **8.4 Safeguards on platforms**

Safeguards, or combinations of safeguards, shall be selected from those given in the following subclauses through the process of risk analysis for each specific application.

One of the basic functions relating to platform safety is to prevent a person from being struck by a train. In a non-DTO/UTO system, the basic functions shall be fulfilled by the train driver within the limits of his ability to react.

Therefore, for DTO/UTO systems special means shall be provided in stations to ensure that persons are not endangered by moving trains. According to the required level of safety, this objective is considered fulfilled when there are either:

- a) enclosed platforms having platform edge screens with integral platform doors, as described in 8.4.2, or
- b) open platforms without platform screen but with detection systems which respond automatically when a person is detected in a hazardous situation as described in 8.4.3, or
- c) open platforms without platform screen or detection system but with some or all of the common safeguards (see 8.4.1 for common safeguards).

Regardless of the general decision for one of those approaches, the common safeguards, in particular communication equipment on the station platform as described in 8.4.1.8, shall be considered in any case. The safeguards specific for the approach of enclosed platforms or for the approach of open platforms with detection systems shall be treated as being additional to the common safeguards.

Measures to ensure safety of persons entering the guideway between stations from the end of the platform are described in 8.4.1.1. Measures to ensure safety of persons entering the guideway between stations from the platform track are described in 8.7.5.

#### **8.4.1 Common safeguards for enclosed and open platforms**

##### **8.4.1.1 Platform end doors**

Platform end doors shall allow:

- access by operational and maintenance staff to the guideway between stations, to sidings and to platform tracks,
- escape of passengers to platforms following the evacuation of a train, in an emergency as well as in the case of a stranded train.

Any unauthorized opening of a platform end door shall be detected and indicated at the OCC. Depending on the risk analysis, trains present in the adjacent platform tracks shall be prevented from starting and/or trains approaching the area shall be stopped.

To prevent misuse by passengers, the platform end doors shall be locked. Passengers shall be able to open the doors from the trackside in order to allow escape from the guideway in case of evacuation from a train.

Access of staff from the platform through platform end doors shall be authorized by the OCC. Request for access shall be initiated by staff through the communication system or through a specific system directly associated with the door. Prior to authorizing access, the OCC staff shall initiate all relevant measures according to operational rules (e.g. prevention of automatic operations in the area) and maintain these measures until informed that the staff concerned have reached a safe location.

If additional points to access the guideway are provided, the same functionality shall be provided and the same procedure shall apply.

##### **8.4.1.2 Warning means related to platform edge**

According to circumstances, at least one of the following measures can be implemented:

- a) a warning, such as a tactile and/or contrasting coloured strip along the platform or other suitable means, shall be provided to designate the area on the platform in which persons shall not stand while trains are moving;
- b) an active warning shall be triggered by a system which detects a person infringing the guideway clearance from the platform;

c) the approach of a train shall be signalled by acoustic and/or optical means.

Warning means adequate for the needs of sight- and hearing-impaired people shall also be provided in accordance with local regulations.

#### **8.4.1.3 Platform fences**

A physical barrier shall be installed along the platform edge (barring train door locations when the train is stationary), to prevent persons from falling onto the platform track. The physical barrier may be in the form of a full or partial-height fence, screen or wall (as in enclosed platforms, see 8.4.2.1 and 8.4.2.2).

#### **8.4.1.4 Refuge between rails or under the platform**

As is usually required for NTO and STO systems, a recess shall be provided with sufficient free space to enable a person fallen onto the track, when a train is entering the station or is already berthed, to escape into the said refuge and avoid being hit by the train. This recess may be between the rails and/or under the platforms.

#### **8.4.1.5 Emergency stop switch on platform**

As is also applicable to NTO and STO systems, emergency stop switches shall be provided on the platform. These shall be accessible to passengers to activate, if they notice a hazardous situation on the platform, in the platform track, during passenger transfer or if safe starting conditions are not provided.

When activated, this emergency switch shall

- prevent trains outside the predefined danger area from entering it,
- stop trains already inside the predefined danger area,
- prevent trains inside the predefined danger area from departing.

Emergency stop switches shall be clearly visible and recognizable as such. The identification and location of switches shall be uniform throughout the system.

#### **8.4.1.6 Traction power cut-off for platform track**

A traction power cut-off device shall be provided for track areas where there is a risk of a person inadvertently touching trackside system elements energized with traction power. The device shall cut off the traction power when activated:

- automatically by the system when an intrusion is detected (8.4.3),
- manually by passengers or staff activating a handle on the station platform,
- from the OCC.

If the need for a manually activated device on the platform is identified, this function shall be combined in an appropriate manner with the switch described in 8.4.1.5 in order to avoid misunderstandings to the user. The identification and location of any manually activated device shall be uniform throughout the system.

#### **8.4.1.7 Video surveillance**

As required in NTO and STO modes, camera placement on the platform shall enable video surveillance by dedicated operational staff, typically at the OCC; they shall be able to observe the entire passenger transfer area and, in the case of open platforms (8.4.3) to also observe the platform track.



To facilitate surveillance by operational staff, it is recommended to have an automatic activation of cameras showing from which locations an alarm or a passenger request has been activated

#### **8.4.1.8 Emergency call device on platform**

Equipment for voice communication between passengers on the platform and the OCC shall be suitable for two-way audio communications.

The emergency call device shall be clearly visible and its function identified.

Each emergency call device shall automatically call the OCC when activated. A display at the OCC shall identify the communicating emergency call device and indicate whether there is any additional activated device. This system may be linked with the video surveillance system.

These emergency audio communications shall have priority over all other audio communications.

The person activating the emergency call device shall receive an acoustic signal that the device is calling. The signal shall remain audible despite the emergency situation.

#### **8.4.1.9 Public address system (platform)**

A public address system shall be provided on each platform for aural announcements from the OCC or additionally from local facilities in the station.

A station public address system shall enable live or pre-recorded announcements to inform passengers about hazardous situations. Live messages shall override pre-recorded messages.

The same system may also be used for operational announcement to the passengers.

The system shall provide full coverage of each platform.

#### **8.4.1.10 Fire and smoke detection (station)**

Fire or smoke detection alarms shall be reported automatically to the OCC so that the staff can take appropriate action according to the rules of operations (see 8.3.2) (e.g. let the trains inside the station area where a fire or smoke has been detected continue to the next station, prevent trains about to enter this area from entering, prevent trains stopped at a previous station from leaving it, etc.). Any restrictions to train operations shall be maintained until the fire alarm is re-set or inhibited by staff, according to specific rules.

It shall be decided on the basis of specific risk analysis whether, in the case of fire, the system shall automatically carry out an action.

#### **8.4.2 Enclosed platforms**

A platform is considered enclosed when screens, with integrally installed doors (platform doors), are provided along the platform edge, forming a continuous barrier wall that provides an enclosed safe area on the platform.

An enclosed platform avoids the risk of a passenger or an object entering the guideway (platform track) from the platform, and enables safe passenger transfer between the platform and a train only when the train is stationary in the station and both the train doors and platform doors are aligned and open.

#### 8.4.2.1 Full-height platform screen

Full-height platform screens shall form a barrier wall the height of which is equal to or greater than that of the train doors. The platform doors shall have a clear opening height equal to or greater than that of the train doors. Passengers shall not be endangered by the movement of the platform screen doors.

Requirements for full-height platform screens and full-height platform doors are as follows:

- a) The platform doors shall be coordinated with the train doors to open/close automatically for passenger transfer when the train stops in a position where the train doors are properly aligned with the platform doors. Otherwise, the doors shall remain closed and locked. For systems with variable length trains, only those platform doors aligned with a corresponding train door shall open.
- b) The platform doors shall be wider than train doors to provide unobstructed access to the clear opening of the train doors, allowing for the tolerance in train stopping position which depends on the stopping accuracy of the trains.
- c) The platform doors shall remain closed and locked until the train has reached the prescribed stopping position. It has to be decided by specific risk analysis if the platform doors can be unlocked some distance before the stopping position in order to reduce the response time of the system to realise short headways. The platform doors shall then open only if an adequate minimum width-of-passage is provided for passengers.
- d) Supervision that platform doors are closed and locked shall be performed continuously (e.g. using the principle of maintaining a continuous closed circuit current). If a train is approaching the station while the closed and locked status of a platform door is lost, the stopping of the train shall be immediately initiated.
- e) The platform door controls shall be designed in such a way that it is possible to stop the doors from operating either via remote control or from a local control panel near the door location, provided it has been verified by staff that the doors are closed and locked. However, whether the removal from operation is performed remotely or locally at the doors, provision shall be made so that passengers can easily recognize that the doors have been taken out of operation.
- f) Platform doors corresponding with train doors that have been removed from operation shall remain closed and locked. It shall be decided by specific risk analysis how many doors can be removed from operation while continuing automatic operations.
- g) The lateral space between the train and the platform screens shall be small enough that a person cannot be trapped between the vehicle and the platform screens. The maximum tolerable lateral space between the train and the platform doors, measured at the relevant height above platform level, shall be specified in accordance with relevant standards or by the TA and the SRA.
- h) L-shaped design of the platform doors: When the space between train and platform screen cannot be minimized, platform screen doors with protection blades (e.g. L-shaped) shall be provided to prevent entrapment of passengers between train and platform screen.
- i) Alternatively, if the space is such that a person could enter it and be physically trapped between vehicle and platform screen, the presence of the person between the vehicle and the platform screen shall be detected and the train prevented from departing. Measures shall be implemented to ensure that trapped passengers can safely exit or be removed from between a stopped train and the platform screen.
- j) Platform doors shall be provided with protective devices to prevent injury to passengers if they are get caught between the door leaves as they are closing (see also 8.6.3).
- k) If a train fails to align properly with the platform doors when it stops in the station such that the automatic opening of the doors is not permitted by the control system and an emergency evacuation from the train is required, there shall be provisions to allow the passengers to evacuate from the train and to reach the platform.
- l) To enable the requirement of item k) above, a train evacuation procedure shall be performed (see 8.5.4), and passengers shall be able to open manually platform doors, emergency exit doors installed in the platform screen or platform end doors.

- m) Platform screens, platform doors and their door leaves shall be designed, constructed and installed in accordance with the relevant standards and guidelines.

#### **8.4.2.2 Partial-height platform screen**

Partial-height platform screens shall form a barrier wall the height of which is no less than the local building requirements for fences or pedestrian safeguards.

Requirements described in 8.4.2.1 for full-height platform screen shall apply generally also for partial-height platform screen especially for item f).

In addition, platforms with partial-height platform screens may also have emergency stop and traction power cut-off equipment, as described in 8.4.1.5 and 8.4.1.6, if considered necessary as a result of risk analysis for the specific AUGT application.

#### **8.4.3 Open platforms with detection systems**

Provisions shall be made to immediately detect persons in the track area that can be reached from the platform.

When the entry of a passenger into the guideway from the platform is detected, the system shall stop trains present on the platform track and prevent other trains from entering this area.

If the guideway area can be reached from the platform and there is a possibility of inadvertently touching elements that provide traction power, then provision shall also be made to switch off the traction power in that zone.

If a person is detected, an alarm shall be sent automatically to the OCC.

The detection zone is the track area that can be reached from the platform as defined by the specific hazard analysis.

As a minimum, persons are considered to be endangered if they enter the detection zone, at least at the running surface height.

If the detection principle is a sensitive surface reacting to weight, it is reasonable to assume that a person who has fallen onto the track is not lying exclusively on the running rails.

The monitoring function of the platform track detection is considered to be fulfilled if a test body is detected. The test body shall be defined for each specific application by the TA and SRA.

The platform track detection system can be reset by safety-related OCC command when the OCC staff has verified (e.g. by observation of the platform track, see also 8.1.3.4) that a dangerous situation no longer exists.

It might be sensible to combine this platform track detection system with an intrusion detection system as described in 8.7.5. This should be considered in the risk analysis for the specific AUGT application. As both functions are very similar, it is possible to integrate both functions into one common system.

### **8.5 Safeguards in trains**

Safeguards, or combinations of safeguards, shall be selected from those given in the following subclauses through the process of risk analysis for each specific application.

This subclause addresses safety requirements for safeguards installed on trains. They deal first with operation of train doors, preventing negligent opening, ensuring safe starting

conditions after passenger transfer, as well as evacuation in cases of emergency. It should be noted that these requirements are not specific to DTO/UTO systems. Additionally, certain safeguards have to be taken into account as a consequence of the train itself and the guideway in front of the train not being continuously supervised by operations staff.

The basic principle to be applied for passenger safety in trains is to ensure that the train reaches the next station, unless there are conflicting safety-related conditions to be considered.

### 8.5.1 Door closed supervision

As required for NTO and STO systems, passenger transfer doors shall be maintained in the closed position. Doors are considered as being held in closed position if they cannot be opened by passengers.

This can be achieved by one of the following means:

- adequate forces pushing the doors leaves together and maintaining them in a closed position,
- a locking mechanism for closed doors.

Unexpected loss of door closed supervision status shall be reported automatically to the OCC. Provisions shall also be made that, in case of such a message, the OCC staff can assess the situation and initiate measures to ensure safety (e.g. stopping oncoming traffic, switching off traction power, etc.).

If open doors and a recognized zero speed are detected, the train shall be prevented from starting.

Specific risk analysis shall decide whether, in the case of unexpected loss of door closed supervision status while the train is moving, the train should be halted or continue its journey to the next station.

### 8.5.2 Door release for passenger transfer

Passenger transfer doors shall be released for opening under normal conditions in designated areas if

- a pre-selection for opening has been effected on the part of the train,
- a zero speed status is detected,
- the full train length is within the platform area.

Additionally, in enclosed platforms:

- passenger transfer doors and platform doors are aligned and synchronized for common opening;
- train doors corresponding with platform doors that have been deactivated shall remain closed and locked. It shall be decided by specific risk analysis how many doors can be deactivated while continuing automatic operations.

Doors which are released for opening under normal conditions may be opened

- automatically,
- automatically if a passenger request has been previously stored,
- by passenger request.

### 8.5.3 Door release for emergency opening

As required in NTO and STO modes where evacuation via a walkway or a safety space of the guideway is possible, in UTO/DTO systems passengers shall be able to open the doors in case of an emergency. Therefore, passenger transfer doors shall be unlocked following an evacuation request if the train is stopped. Passengers shall be able to open the doors after they have been unlocked.

It has to be decided by specific risk analysis if, in case the on board evacuation request is activated while the train is moving, the train shall brake to a stop or shall continue its ride to the next station or designated evacuation area. After an unscheduled stop between two stations, if the train doors are not open and no longer unlocked for emergency opening, the train shall be allowed to continue to the next station. In the case of an activated on board evacuation request, the train shall be prevented from proceeding towards the next station or designated evacuation area until the evacuation request is reset by a safety-related command from OCC or by manual reset of operational staff.

Initiating door release for emergency opening by on board evacuation request shall be reported to the OCC before being activated. Provisions shall be made to enable OCC staff, in case of such a message, to assess the situation and initiate the necessary measures to ensure safety (e.g. stopping oncoming traffic, switching off traction power).

If there is an evacuation request in combination with an open door when the train is stopped between stations, the train shall remain stopped.

If an evacuation request leads to a train stopping at least partially outside of the platform track and the train doors are opened, it shall be ensured that traction power in the designated area is cut off if there is a danger of electrocution (see 8.1.3.5).

### 8.5.4 Emergency exits

If other emergency exits are provided for passenger rescue purposes, then they shall be supervised and released for emergency opening in the same way as described for the passenger transfer doors.

### 8.5.5 On board obstacle detection device

An on board obstacle detection device can reduce detrimental consequences to passengers and property from collisions with obstacles on the track.

The obstacle detection device shall detect obstacles in front of the train at the latest when the obstacle is in contact with the device. Specification of obstacles to be detected shall be defined for each particular application by the TA and SRA. If an obstacle is detected, the train shall apply the emergency brake.

Detection of an obstacle shall be reported to the OCC as an emergency message.

Normal operation shall only be resumed after it has been verified that all hazardous conditions have been resolved.

### 8.5.6 Derailment detection device

A derailment detection device can reduce the escalation of accident consequences to passengers and property, even in the event of partial train derailment.

The derailment detection device shall monitor, at a minimum, the leading running axle, and when activated, it shall apply the emergency brake. Specification of derailment to be detected and therefore the required design of the derailment detection device shall be in accordance with specific train and guideway design.

The detection of derailment shall be automatically reported to the OCC as an emergency message. Provision shall be made to enable staff in the OCC to assess the situation, and initiate relevant measures defined by rules and procedures in order to ensure a safe operation (e.g. stopping oncoming traffic, switching off traction power).

#### **8.5.7 On board video surveillance**

As required in NTO and STO modes, video surveillance shall enable the assessment of the situation inside passenger cabins in case of alarms or requests coming from the train. If video surveillance is used for monitoring from OCC that all passengers have left the train at terminus stations it shall be ensured that all areas of the passenger cabins are clearly visible and that trains are only allowed to continue their ride if permitted by a specific command from the OCC resulting from the assessment procedure.

#### **8.5.8 Public address system (train)**

As required in NTO and STO modes, trains shall be equipped with a public address system, which shall be connected, at least for UTO systems, directly to the OCC.

The public address system is considered as a supporting system that helps in coping with certain situations (e.g. evacuation procedures). The public address system serves to announce operational and traffic-related information such as

- instructions to passengers as to how to behave in an emergency,
- train dispatching announcements, when dispatched directly by the OCC,
- information on train delays, connecting trains etc. by the OCC,
- automatic announcements, e.g. “next station”,
- other announcements.

Urgent announcements given by the OCC shall automatically interrupt initiated announcements having lower priority.

All audio and video communications equipment shall operate independently of traction power and shall fully function under the ambient conditions to which it may be exposed. All audio and visual communications equipment required by this standard shall be connected to an emergency power supply capable of being maintained for at least the time period required for evacuation.

#### **8.5.9 On board announcement for taking a train out of operation**

As required in NTO and STO modes, an announcement shall be made on board trains to inform passengers that the train has been taken out of operation, e.g. at terminus stations. The announcement shall be aural and visual. For existing rolling stock, the requirement of a visual announcement is only applicable if compatible with the rolling stock.

In addition, depending on the level of safety required by the TA, different control measures can be put in place to check that no passenger remains on board the train, e.g. visual checks carried out by staff (see 8.4.1.9 for corresponding announcements on platform).

#### **8.5.10 Emergency stop demand on board**

As required in NTO and STO modes, trains shall be equipped with an emergency stop demand switch (emergency brake handle) for passenger use.

Activation of the emergency stop demand shall be reported to the OCC, at least for UTO systems.

Operating the switch shall initiate an emergency procedure to stop the train which shall not however allow the train to come to a halt outside a station, neither in tunnels nor in areas without a safety space. Once the train has stopped in a station, it shall not continue its journey without being authorized by an OCC command.

If, for other reasons, the train does stop between stations and the doors remain closed, then the train shall continue to the next station. If any door is opened while the train is stationary then the train shall not be allowed to restart, because a self-evacuation is assumed.

The TA and SRA may specify alternative areas where to stop the train such as at a location of safe refuge outside the station where passengers can be effectively evacuated from the train.

#### **8.5.11 Emergency call device on board**

As required in NTO and STO modes, trains shall be equipped with an emergency call device. At least for UTO systems, this device shall enable communication between passengers and the OCC. Emergency messages shall be of high priority. Equipment shall be provided which enables staff in the OCC to assess the situation and take prompt and appropriate action (e.g. stop operation immediately and initiate relevant operational procedures).

The location for emergency call devices within the train shall be chosen in accordance with other emergency-related switches (emergency stop demand switch, etc.). Emergency call devices shall be clearly visible and their function identified. The identification and location of switches shall be uniform throughout the system.

All audio and video communications equipment shall operate independently of traction power and shall fully function under the ambient conditions to which it may be exposed. All audio and visual communications equipment required by this standard shall be connected to an emergency power supply capable of being maintained for at least the time needed for evacuation.

#### **8.5.12 Fire and smoke detection (train)**

A fire or smoke detection alarm shall be reported automatically to the OCC. Trains emitting a fire or smoke detection system alarm shall continue to the next station and shall be stopped there, i.e. continuation of the journey shall be inhibited. If the train is in a station when the fire or smoke is detected, it shall be prevented from leaving the station.

#### **8.5.13 Train status supervision and testing**

The specific safety analysis shall identify all safety relevant systems which need testing to maintain their safety target. Test conditions and testing frequency shall also be defined.

Failure of train equipment, which may result in an unsafe condition for the train to continue its journey, shall be detected. Depending on the type of failure detected, the train shall either be stopped immediately or allowed to continue to the next station where further continuation of its journey shall be inhibited. If the failure is detected before the train has been put into operation, then the train shall be prevented from starting.

The train shall also be held in the station in cases of detected failures which may result in the train being subsequently stranded if allowed to continue its journey.

Classification of the train failures which may allow the train to continue functioning shall be established according to the impact of such failures on operations. Operational rules related to these failures shall also be established.

Failures and classification of failures shall be reported to the OCC (8.2.1).

#### 8.5.14 Manual operation

Manual operation on board the train shall be provided for each train conductor in order to drive a train unable to run in automatic operation mode. For manual operation of the train, the following safeguards shall apply.

##### 8.5.14.1 Locking of driving mode switch

A train is switched from automatic mode to manual mode either in the main line when it fails to function and needs to be driven manually, or in a transfer area between automatic and non-automatic areas.

As required in NTO and STO modes, trains shall be designed in a way that manual operation by unauthorized persons is prevented (e.g. by locking the covers and operators' controls).

When the train is in automatic mode, if the unlocking of the covers and operator's controls is detected for no obvious operational reasons, an alarm shall be sent to the OCC. Relevant procedures shall be applied in this case, e.g. the train can be stopped at the next station.

The switching of a train from automatic to manual mode and vice versa shall comply with operating procedures.

##### 8.5.14.2 Interlocking between automatic and manual modes of operation

Automatic operation of the train shall be prevented as long as the automatic mode is not selected.

Safe separation between trains in automatic mode and trains in manual mode shall be ensured under all circumstances. In systems which are not designed for mixed operation, automatic operation shall be suspended at least in a specific area of the line before a train movement in manual mode is allowed.

#### 8.5.15 Safe speed during automatic coupling

If automated coupling of trains with passengers on board is provided for recovery of stranded trains or reconfiguration of trains, the system which ensures safe train separation shall, for this specific movement

- overrule the conditions for safe train separation,
- command a speed to be specified.

The coupling speed shall be specified in accordance with relevant standards or by the TA and SRA so that remaining passengers are not endangered by an excessive coupling jerk.

NOTE However, the coupling speed should be such that a connection of trains is ensured.

#### 8.5.16 Reaction to unexpected train movement

As required in NTO and STO modes, an unexpected train movement at any time shall lead to an immediate application of the emergency brakes function.

#### 8.5.17 Warning means in the train for evacuation

A warning shall be provided to passengers, using appropriate means, to prevent them from leaving the train between stations (see also 8.1.4).

### 8.6 Safeguards for passenger transfer area

Safeguards, or combinations of safeguards, shall be selected from those given in the following subclauses through the process of risk analysis for each specific application.



This subclause addresses safety requirements associated with safeguards dedicated to the passenger transfer area, which might be realised on board trains or on platforms. These requirements deal with safeguards fulfilling the basic requirement of preventing injuries to persons (fall, entrapment, dragging, etc.) between coupled cars of the train or between platform and train or during passenger transfer between the station platform and the train. These requirements are not specific to DTO/UTO systems and may also be required for NTO and STO.

Passenger transfer begins

- for a station with an open platform, when the train has reached its expected position at the platform and the train doors are unlocked ready to be opened,
- for a station with an enclosed platform, when the train has reached its expected position and train doors and platform screen doors are unlocked ready for opening.

Passenger transfer ends when all required conditions for train departure are satisfied.

### **8.6.1 Train immobilization during passenger transfer**

As required in NTO and STO modes, the train shall remain immobilized during passenger transfer. As long as all train doors, and (for an enclosed platform) all platform doors are not detected as closed and locked (see 8.6.3.3), train departure shall remain inhibited.

### **8.6.2 Safeguards related to the opening of the doors**

See 8.4 and 8.5.

### **8.6.3 Safeguards related to the closing of the doors**

Measures to prevent significant risk of injury to passengers during the closing of train doors are described in the following subclauses.

Train departure shall only be authorized when all the train doors, and (when the platform is enclosed) all platform doors are closed and locked.

#### **8.6.3.1 Optical and acoustic door signals prior to closing**

As required in NTO and STO modes, termination of passenger transfer shall be announced by optical and acoustic door closing signals prior to start of doors closing. This measure aims at improving operational availability as it avoids interference between the door closing procedure and continuing passenger transfer.

This requirement applies to train doors and, if provided, to platform doors.

The door-closing sequence is engaged when the dwell time is over.

The public address system (see 8.4.1.9 and 8.5.8) may be used to broadcast a door closing announcement aurally.

#### **8.6.3.2 Design to limit the closing pressure (force) of door leaves**

As required in NTO and STO modes, passenger transfer doors shall be provided with safeguards to prevent passengers being forcibly wedged or trapped. This requirement shall be fulfilled in accordance with the relevant standards and guidelines.

#### **8.6.3.3 Detection of obstacles during the closing of the doors**

As required in NTO and STO modes, door control shall detect obstacles between closing door leaves which disturb the door closing process and which prevent the doors from reaching the

closed and locked status. Thresholds for detection, depending on the shape and bulk of the obstacle, shall be specified in accordance with relevant standards or by the TA and SRA. A train shall only be able to start if all train doors and (if provided) platform screen doors are supervised in a closed and locked status.

When an obstacle is detected, different types of door closing sequences may be used to allow the obstacle to exit from between the door leaves. The TA shall decide on the sequence to be applied when an obstacle is detected. Possible sequences include:

- re-opening the door whose closing cycle is interrupted and start a new door closing attempt a few seconds later,
- stopping any closing effort for a few seconds without re-opening the door to free the obstacle, and then tentatively resume the door closing.

As required in NTO and STO modes, trains shall only be able to start after all passenger transfer doors are properly closed and locked. The specification and design of detection equipment shall be in accordance with relevant standards and guidelines.

When the closed and locked status cannot be obtained in a predefined time an alarm shall be given to OCC staff.

#### **8.6.3.4 Detection of trapped objects after the doors have been closed**

To mitigate the risk of passengers being dragged by a train on open platforms without operational staff supervising the passenger transfer, it is recommended to provide additional equipment able to detect a thin object between door leaves. The thinness of the object to be detected shall be decided by the TA and SRA after a specific risk analysis. Whenever the device detects such an object it shall inhibit the information that the door be closed and locked. If the object cannot be detected when doors are closed and locked, it shall be detected at least during train departure. In the latter case, an emergency brake for the departing train shall be applied and an emergency message shall be provided to the OCC. To ensure acceptable operational availability, it is recommended to deactivate this additional equipment after a predefined time, distance or speed after the train departure.

#### **8.6.3.5 Manual release of trapped objects**

A train can start its departure process even when a thin object has been trapped between the door leaves during the closing of the doors. A thin object is one which cannot be detected during the door closing sequence. In order to free any such belonging, a limited re-opening of the door shall be possible for the passenger. This re-opening shall permit limited movement of the door leaves, sufficient to free small belongings but still sufficiently narrow to avoid further hazard to passengers (further entrapment, hand or belonging put through the opening or other mis-use). The door leaves re-close, thanks to sufficient pressure. The door re-opening and push back action does not alter the closed and locked status of the door. This feature is available at any time on any closed train door. The movement limitation and push back force shall be defined by the TA and/or SRA.

A suitably designed door edge can also allow the passenger to drag the object out easily without re-opening of the door.

#### **8.6.4 Marking of train door areas on the platform**

For open platforms, train door areas on platforms shall be marked in order to guide passengers to the expected position of train doors, thus reducing the risk of falls into the gap between two coupled cars or into the gap between the platform edge and the carriage. This marking shall be effected explicitly for the needs of the visually impaired as expressed for example in 8.4.1.2.

### **8.6.5 Surveillance by operational staff**

Passenger transfer can be subjected to surveillance by operational staff. The extent of surveillance and the conditions under which it is used needs to be clarified on the basis of the specific risk analysis.

Staff may be located

- on board trains,
- on platforms,
- at a remote site (e.g. station or OCC).

### **8.6.6 Safeguards related to gap between train and platform**

#### **8.6.6.1 Reduction of gap between platform edge and car body**

As required in NTO and STO modes, consideration shall be given to the design and arrangement of system elements such that, under normal operating conditions, the horizontal gap between platform edge and car body is small enough to avoid any accident resulting from a fall into the gap or a passenger being at least partly trapped in the gap. The threshold value under which the gap is defined as safe for operation shall be defined by the TA and the SRA.

Consideration shall also be given to the difference in height between the train and the platform insofar as it increases the risk of a passenger falling and being trapped in the horizontal gap.

To allow comfortable passenger transfer, especially for mobility-impaired persons, and to avoid tripping in the door area, the use of steps needed between platform and train shall be avoided as much as possible.

#### **8.6.6.2 Warning means on platform related to gap**

By using specific measures to attract the attention of passengers to the gap between platform edge and car body during passenger transfer, the risk associated with the gap can be reduced.

At a minimum, the platform edge shall present a highly visible contrast.

In all, or in specific stations as the case may be, signs having an unequivocal and uniformed design and located near the platform edge, e.g. painting on the platform floor or highly visible signs, shall be provided as permanent warning feature.

Strong lighting from below may also be considered if it increases the visibility of the gap. Lighting can be provided either by the platform or from train equipment. It may be switched on only during passenger transfer. In addition to lighting, the gap may be indicated by a specific sound signal as to when passenger transfer is allowed (e.g. to take into account visually impaired passengers).

To take into account crowded situations where signs are no longer visible and the needs of persons with limited sight, aural announcements such as “mind the gap” synchronized with the door-opening sequence can reduce the risk associated with the gap. The announcement shall be made in all stations where there is high risk. The different aural announcements related to passenger transfer shall be synchronized to avoid inaudibility or possible confusion within proximity of the passenger transfer area.

### 8.6.6.3 Warning means in the train related to gap

By using specific measures to attract the attention of passengers to the gap between platform edge and car body during passenger transfer, the risk associated with the gap can be reduced.

Highly visible signs having an unequivocal and uniformed design and located inside the trains in the area of the passenger transfer doors, e.g. marking of the edge of the floor, shall be provided as a permanent warning feature.

Oral announcements, e.g. “Mind the gap”, shall be used to warn passengers when arriving at all stations having a high risk, e.g. curved stations.

To avoid inaudibility due to bad synchronization, the announcement shall only be made by platform or train devices, e.g. loudspeakers outside the train announcing the door closing sequence.

### 8.6.6.4 Gap-filling device on board or on platform

Gap-filling devices installed in front of each door area are recommended if there is no possibility of reducing the gaps. A foot plate constitutes a gap-filling device if it prevents passengers from falling into the gap between platform edge and car body. Each gap-filling device shall be in place at least when the train is correctly stopped at the station before the activation of the door opening sequence, and removed at the end of the door closing sequence. The gap-filling device can be a part of the train or a part of the platform. A train door shall not open if the gap-filling device is not extended.

Malfunction or failure of the gap-filling device, including opening outside passenger transfer periods, shall not lead to a hazardous situation.

### 8.6.6.5 Gap supervision device on board or on platform

Detection devices to detect a passenger falling through or being trapped in the gap between platform edge and car body are recommended if there is no possibility of reducing the gap sufficiently.

In case of detection an emergency message shall be reported to OCC staff.

In case of detection, the train departure shall be inhibited and train doors shall not close at the end of dwell time. The system reaction shall be maintained until it is cancelled by operational command under the responsibility of operational staff.

The detection device may be installed as wayside equipment related to the platform edge or as an on board device related to the train door. The detection device shall cover the gap in the area of train doors and shall be activated when

- the train has come to a complete stop (wayside equipment), or
- the assigned train door is opened (on board equipment).

The relevant threshold value for detecting a passenger at least partially trapped shall be specified in accordance with relevant standards or by the TA and SRA.

### 8.6.6.6 Refuge between rails or under the platform

See 8.4.1.4.

### **8.6.7 Safeguards related to coupling area between cars**

#### **8.6.7.1 On board closing of coupling area of train**

As required in NTO and STO modes, the space of the coupling area between cars shall be reduced by design or closed by barriers to limit as much as possible the risk of a passenger falling into this space.

#### **8.6.7.2 Partial barriers on the platform at the stopping position of the coupling areas of train cars**

See 8.4.1.3.

#### **8.6.7.3 Monitoring device for coupling area**

In order to detect the fall of a person into the coupling area between any two cars of a train, a detection device shall be used. The device may be installed as wayside equipment for the area where the coupling area is situated during station stops or as an on board device. The device shall be activated at the latest when the train has come to a standstill (or zero speed is detected). In case of detection, the train shall be prohibited from starting and an emergency message shall be provided to the OCC.

### **8.6.8 Safeguards related to space between train and platform screen**

#### **8.6.8.1 Design measures to minimise the distance between train and platform screen**

See 8.4.2.1, item g).

#### **8.6.8.2 Device on board or on platform to supervise the lateral space between train and platform screen**

A detection device shall be used as required in 8.4.2.1, item i) and 8.4.2.2.

### **8.6.9 Safeguards to protect passengers from electrocution after falling into the gap**

The risk for a passenger being electrocuted by touching an exposed live conductor on the train shall be mitigated by the following measures

- minimize the gap,
- gap-filling device,
- protection of any exposed live conductor (e.g. current collector shoe) on the train.

### **8.7 Safeguards for guideway**

Safeguards, or combinations of safeguards, shall be selected from those given in the following subclauses through the process of risk analysis for each specific application.

In the first instance, measures shall be implemented to prevent the hazardous situation from occurring, as follows:

The guideway shall be protected from intrusion from outside the guideway by means of

- installation of physical barriers along the guideway (e.g. fences or walls);
- platform screen (see 8.4.2) or other means to avoid intrusion of persons and/or objects onto the guideway from the platform;
- platform end doors and other doors leading to the guideway locked and protected by alarms and warning signs;

- statutory, legal or contractual regulations shall be implemented to prevent the neighbours of the guideway from violating the guideway clearance.

Rules and procedures for regular checking of the guideway clearance shall exist as described under 8.3.4.

### **8.7.1 Segregated guideway**

A guideway intended for exclusive use may be segregated either physically or by legal statute as described by the following subclauses.

#### **8.7.1.1 Guideway physically segregated**

The guideway between stations shall be provided with physical barriers (sidewalls, superstructures, or other measures) to protect against the public entering the guideway. When these structures are provided with doors for emergency egress or maintenance, the doors shall be locked and monitored.

#### **8.7.1.2 Guideway segregated by legal statute**

Segregation of the guideway by legal statute shall be considered sufficient except when the SRA deems the residual risks unacceptable.

### **8.7.2 Warning means along the guideway**

As required in NTO and STO modes, warning means (e.g. information, signs and marking) shall be provided at the end of the platform to attract the attention of passengers as to the specific danger of entering the track from the end of the platform and proceeding along the guideway.

### **8.7.3 Physical barriers along the track**

As required in NTO and STO modes, physical barriers (e.g. fences and sidewalls) shall be provided along the guideway between stations to prevent intrusion into the guideway.

Specific barrier requirements shall be detailed for each application in accordance with relevant standards or by the TA and SRA.

### **8.7.4 Physical barriers beside bridges**

At bridges passing over the guideway, physical barriers (e.g. grid, nets and fences) shall be provided besides the bridge to prevent objects from falling onto the track.

Specific barrier requirements of the barrier shall be detailed for each application in accordance with relevant standards or by the TA and SRA.

### **8.7.5 Intrusion detection device between platform track and guideway between stations**

The intrusion detection system detects passengers entering the guideway between stations from the platform track.

Entry of passengers into the guideway between stations is least likely to happen when the platform is an enclosed platform. In this case, therefore, no intrusion detection device is needed.

Where deemed appropriate by risk analysis for the specific AUGT application, intrusion detection devices shall be provided to trigger system reaction to unauthorized access.

Facilities and equipment for open platforms with a detection device may also perform the intrusion detection task. In this case the following applies:

- In the most simple application case: if the detection area of the platform track protection has activated an alarm, the endangering of persons in the adjacent guideway between stations must also be assumed.
- The automatic suspension of operations in the adjacent guideway between stations can be avoided if there are additional means in the platform track protection by which it can be confirmed that the adjacent track area has not been entered, e.g. if a dedicated emergency walkway exists along the guideway, the danger area may be unoccupied.

An alarm message shall be sent to the OCC.

See 8.5.1 and 8.5.3 for the measures against the entry of the passengers into the guideway from the train.

#### **8.7.6 Guideway intrusion detection device**

Where the guideway between stations is not completely physically segregated, a guideway intrusion detection device can be provided. When entry of public into the guideway is detected, all trains in the section, or approaching the section, where the public has entered the guideway shall be stopped (see also 8.7.1).

For the guideway beyond the platform and between stations, provisions shall be made to stop train operations if persons entering the guideway in the “between stations” area are detected. Trains running within the affected guideway area but in the direction away from the location of detection shall be allowed to continue running. Trains about to enter the affected guideway area should be prevented from doing so. An alarm message shall be sent to the OCC.

#### **8.7.7 Wayside obstacle detection device**

Where deemed necessary by risk analysis, permanent supervision of the guideway clearance against the risk of intruding obstacles shall be provided. In particular, this is necessary when third parties are in danger of disturbing the guideway clearance, for example when civil works are in progress in or close to the AUGT. It might be necessary to have permanent supervision, i.e. by staff, video surveillance systems or independent detection systems.

#### **8.7.8 Platform end door with controlled access**

See 8.4.1.1.

#### **8.7.9 Emergency exit from physically segregated guideway**

In case of passenger evacuation between stations, passengers shall, where possible, be directed to exits via the platforms (see also 8.4.1.1).

The need for specific emergency exits allowing passengers and staff to exit a physically segregated guideway in case of passenger evacuation between stations shall be determined for each specific application by the TA and SRA.

Specific signs pointing to the nearest emergency exit shall be provided in such a way that at least one sign is visible from any location in the guideway.

#### **8.7.10 Fire and smoke detection (guideway between stations)**

Fire or smoke detection alarms shall be reported automatically to the OCC. The area defined as affected by fire and smoke shall be the complete section of guideway between stations. Trains inside the area where fire or smoke has been detected shall continue to the next

station. Trains about to enter this area shall be prevented from doing so. Trains halted at a previous station shall be prevented from leaving the station.

#### **8.7.11 Water flooding protection**

As required in NTO and STO modes, in underground tunnel sections and other guideway sections where the track surface is lower than the surrounding area and subject to water inflow during flooding, floodgates shall be provided in the guideway and in station access areas in order to prevent water inflow and/or detect flooding. In case of detection, an alarm shall be sent to the OCC and OCC staff shall apply the relevant procedure, including possibly evacuating passengers.

The system shall ensure that the closing of floodgates/doors shall be coordinated with the inhibition of the movement of trains so that floodgates only close after trains have vacated the zone.

#### **8.7.12 Level crossing**

If the implementation of level crossings is necessary, and accepted after specific risk analysis, then the following applies.

As required in NTO and STO modes, train movement via level crossings shall be authorized only if covered by a command forbidding concurrent use by road traffic.

If the level crossing is reported as not being in a position to provide such a command, trains shall be prohibited from leaving all previous stations.

##### **8.7.12.1 Level crossing barrier**

Movable barriers (gates) shall be installed at level crossings to physically segregate the system from road traffic. They shall be closed to road traffic prior to the level crossing being reserved for train movement. The barriers shall be designed to prevent, as far as possible, persons and vehicles negligently entering the level crossing when the barriers are closed.

If there is insufficient safety space between the guideway clearance and the barriers, provisions shall be made for persons to leave the level crossing under emergency conditions.

If it is seen that the barriers are not properly closed, train movement shall be inhibited.

##### **8.7.12.2 Level crossing supervision**

For reasons of detecting

- persons which might be endangered by train movement,
- vehicles or obstacles which might endanger train movement,

while they are locked in by closed barriers, provisions shall be made to supervise the whole area of level crossing inside the barriers, including the safety space beside the guideway clearance.

Authorization of train movement shall remain inhibited if the area is not reported as free by the level crossing supervision device after barriers have been closed. In this case a warning message shall be provided to OCC and video surveillance of this level crossing shall be activated.

Authorization of train movement shall be withdrawn, if an intrusion is detected after barriers are closed. In this case an emergency message shall be sent to the OCC and video surveillance of the level crossing shall be activated.



Abnormal situations may require specific rules to continue operations under OCC responsibility.

#### **8.7.12.3 Prevention and detection of intrusion onto the guideway from the level crossing**

If an intrusion is likely, the following applies:

- Access from level crossing to safety space beside clearance of guideway shall be impeded as much as possible by physical means, allowing exit under emergency situations similar to functionality of platform end doors.
- Direct access from level crossing to guideway within the area of guideway clearance shall be impeded as much as possible by constructional measures in the area adjacent to the level crossing.
- Additional provisions shall be made to detect intrusion of persons and vehicles via the clearance of guideway with similar functionality as designated for intrusion detection between platform track and tracks between stations. This detection function shall be permanently active, even when the level crossing is reserved for train movement and the barriers are closed.

#### **8.7.13 Work zones**

The movement of trains in DTO and UTO modes shall not be allowed in zones where maintenance staff are present. Work zones shall be established and released by OCC staff. Movement of trains in DTO and UTO mode shall only be authorized in such zones by OCC staff if maintenance staff has given prior agreement.

### **8.8 Safeguards for transfer areas and depots**

Safeguards, or combinations of safeguards, shall be selected from those given below through the process of risk analysis for each specific application.

If automatic train operation is provided inside a depot, three areas shall be considered:

- automated areas;
- transfer areas between automated and non-automated areas;
- non-automated areas (as required in NTO and STO modes).

For automated areas, safeguards for the AUGT system shall apply. For transfer areas, a train in automatic mode shall never move into non-automated areas.

Transfer areas are considered as a specific area of the AUGT system. The transition of a train between automated and non-automated areas shall be made inside a transfer area.

To prevent a possible collision of an automated train with a manually driven train, the AUGT system shall receive an input signal to allow an automated train to enter the transfer area or to prohibit the movement of trains in automatic mode in this area.

Staff entry into the transfer area shall be covered by operational rules defined by the TA. Additionally, warning means or physical barriers can be used to protect staff.

Handing over of a train from manual to automatic mode shall be covered by operational rules.

## 9 Information for use

The supplier of the system, supported by the TA, shall provide the user with the necessary information to ensure safe and orderly operation of the system. This information shall be available at the latest by the end of phase 9 of the life cycle described in IEC 62278.

User information shall include at least:

- instructions for use by operational staff including a description of all command elements and displays of all the HMI Interfaces provided along the wayside and on board trains;
- a description of the safety-related application conditions in accordance with relevant safety standards for railway applications (e.g. IEC 62425);
- a hazard log in accordance with relevant safety standards for railway applications;
- technical descriptions in sufficient detail for maintenance and reference purposes when carrying out changes to the system at a later time. The extent of maintenance and changes that can be applied to the system without affecting the safety of the system shall be agreed upon between the supplier and the TA in charge of maintenance.

Information for use shall also address the needs of basic functions as shown in Table 1, including those that are not in the scope of this standard.

In case of upgrading a system from conventional operation to DTO or UTO mode, user information shall also include the specific needs for the migration process (see also Clause 10).

Information for use shall enable the TA to establish all operational rules as well as rules for maintenance which fall under its responsibility, provided that responsibility was given over to the TA before start of phase 11 of the life cycle. Safety-related application conditions shall include intervals for preventive maintenance as well as repairing advices in case of failure conditions. Starting with phase 11, Hazard Log shall be continued by the TA with respect to all safety relevant occurrences and measures derived as a result.

In order to ensure a link between human and technical responsibility to achieve overall safety of operation, all operational and maintenance rules to be established by the TA shall be included in the verification and validation process which leads to system acceptance in phase 10.

Given the special nature of AUGT systems, consideration shall be given to the content of the documentation related to:

- organization of operations and maintenance to enable an effective and prompt reaction with short intervention time by staff, for normal, degraded and emergency situations, deployment of staff (including roving staff), support of OCC operators by technical specialists in charge of various subsystems (e.g. train control system, rolling stock, etc.), appropriate number of staff that have authority to drive a train when necessary, etc.;
- staff training, especially for degraded operations and emergency situations, and multi-skilled staff;
- maintenance: multi-skilled staff, and emphasis on regular inspections of rolling stock, infrastructure, audio- and video-monitoring equipment, and equipment detecting or preventing intrusion on the guideway.

## 10 Specific safety requirements for upgrading existing lines to DTO or UTO

Generally, all safety requirements given in this standard are also applicable for specific applications dealing with upgrading existing lines to DTO or UTO.

The existing facilities and equipment, which will subsequently be used in DTO and UTO, with both their existing functionality and their constraints, have to be considered in the specific hazard and risk analysis. This may lead to a need for additional safeguards and specific requirement specifications.

The transition process from existing operation to DTO or UTO shall be described, taking account of the contribution of existing equipment to safe operation and the impact of additional equipment and the changed activities of operational staff at each step of the process. The following transition strategies shall then be addressed, depending on the needs of the specific application:

- closing the existing line completely and reopening for passenger service after completion and system acceptance (with completely new equipment or existing equipment);
- continuing passenger service during installation works, with tests and trial runs performed outside passenger service hours (e.g. at night or on weekends) or outside passenger service areas;
- continuing passenger service during installation works, with tests and trial runs interspersed with passenger service trains.

Terms and conditions for the transition process shall be agreed upon between the supplier, the TA and the SRA. It shall be ensured that tests and trial runs of trains operated in automatic mode without final system acceptance will not endanger ongoing passenger service. Therefore a risk analysis covering the specific situations during the transition process shall be performed and the derived safeguards implemented during the transition process (e.g. operational staff on board trains responsible for emergency breaking, additional trip stops). Operational staff and additional safeguards can be reduced step by step according to the progress of the system acceptance process.

## 11 Verification of safety

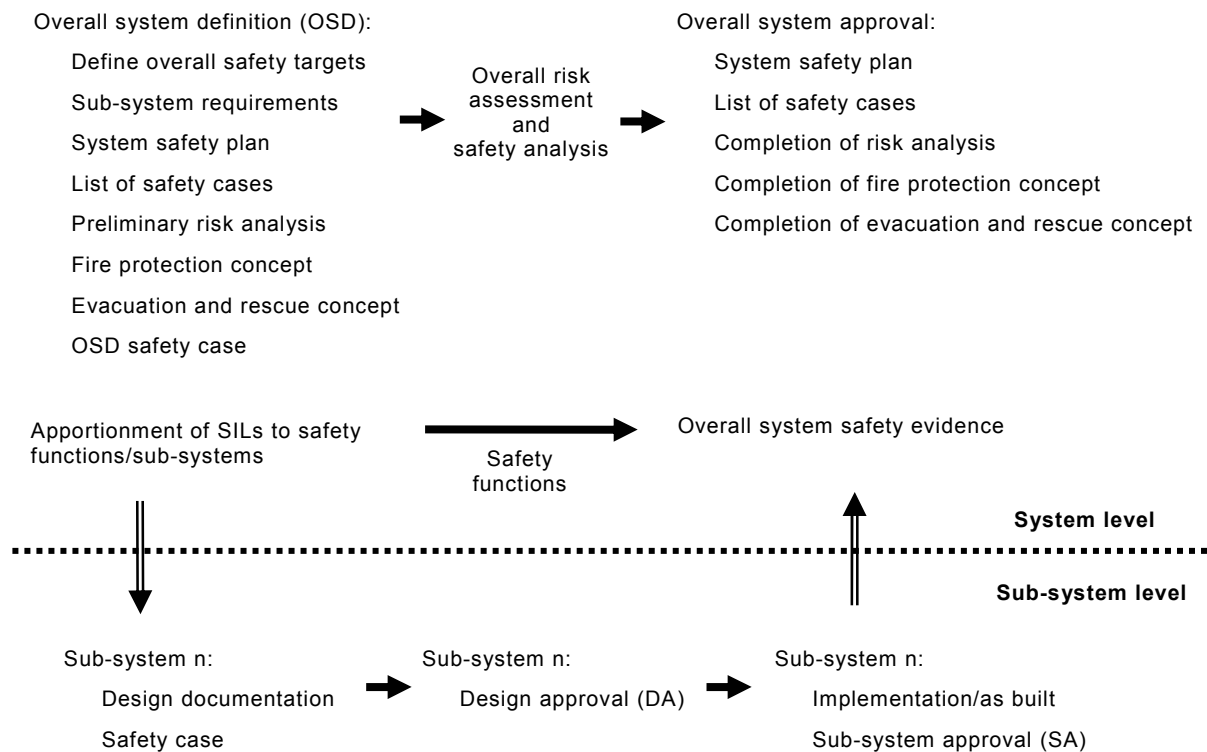
This standard deals with safety requirements needed to compensate for the absence of a driver or attendant staff as stated in Clause 1. These requirements are listed in Clause 8.

This clause describes the safety verification process that shall be performed for each specific application to prove that safety targets have been met. If required by the SRA, the TA may use independent assessor(s) for the verification of safety.

The verification process is complementary to the individual technical or procedural safety requirements. Therefore, the verification process for a UTO or a DTO system is the same as for an STO or NTO system.

Consequently, the description of the verification process cannot be restricted to the phases of the life cycle covered by the standard (see Figure 1) but should cover the whole life cycle.

The methodology shall be based on the principles of risk analysis as described in IEC 62278 (reliability, availability, maintainability and safety (RAMS) standard). The basis for a process model can be derived from the V-diagram in IEC 62278 and applied in practical terms to the specific application in question. Such a process model is depicted in Figure 6.



IEC 1034/09

**Figure 6 – Verification of safety**

**11.1 Documentation and responsibilities**

The body responsible for the application provides an overall system definition (OSD) at the beginning of the project. The OSD includes the definition of the overall safety targets, and at least the following:

- system safety plan;
- list of safety cases;
- preliminary risk analysis;
- subsystem requirements specification;
- fire protection concept document;
- operational rules, including rules for rescue of passenger.

The acceptable residual risks resulting from the risk analysis shall be endorsed by the TA in agreement with the SRA.

It may be convenient to extract the fire protection concept in a single document for endorsement by the fire authority. The same applies for the evacuation and rescue concepts document for endorsement by the external security authority, e.g. police and rescue authorities.

**11.2 Verification process**

After all OSD activities are completed and endorsed, the detailed design and implementation of each defined subsystem can be completed and approved by the SRA (see design approval (DA) milestone in Figure 6).

All processes shall be considered including civil works construction, system engineering and operational rules.

Operational rules shall also be subjected to a validation procedure ensuring the overall safety of operations.

When a subsystem has been implemented and the safety documentation has been approved by the SRA, the subsystem approval (SA) milestone is achieved. When all the SA milestones have been achieved, the system level OSD shall be reviewed and updated with the actual information obtained from the implementation of the subsystems. Accordingly, the following documents shall be completed and updated:

- system safety plan;
- list of safety cases;
- risk analysis;
- hazard log.

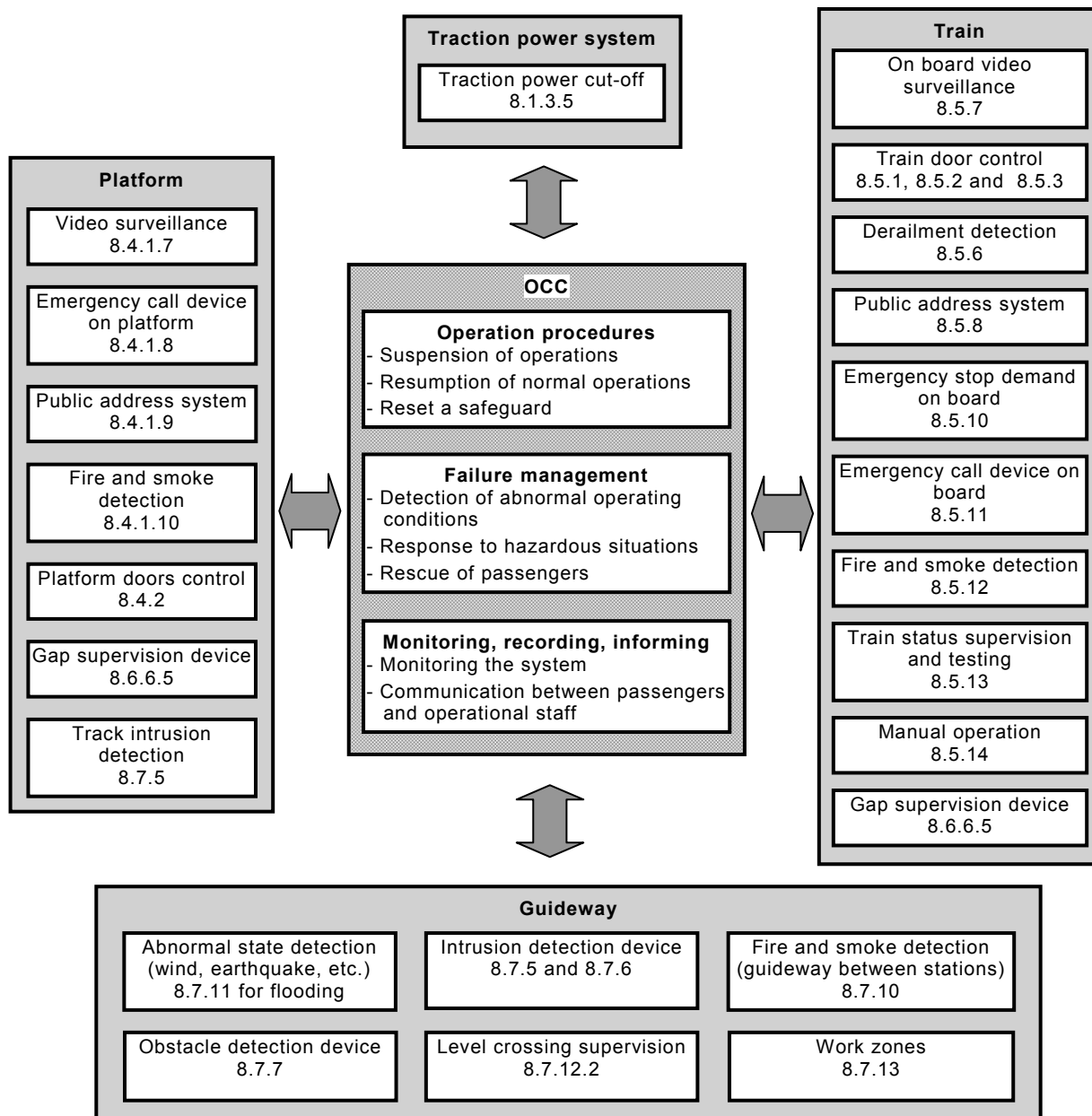
It shall also be ensured that all hazards are covered and residual risks are acceptable. Similarly, the fire protection concept as well as the evacuation and rescue concepts shall be updated, taking into account results from fire and rescue exercises.

Finally, the risk analysis shall be reviewed in order to ensure that the overall safety target, as specified in the OSD, is met.

When all the above has been achieved, the TA can seek from the SRA the overall system approval, accompanied if required by a statement (assessment report) from the independent safety assessor.

## Annex A (informative)

### Role of the OCC



IEC 1035/09

NOTE The choice of functions by the OCC depends on requirements by the TA and/or SRA.

**Figure A.1 – Role of the OCC in the safety of the system**

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