

Locomotive Drivers Advisory Group

European
Cab
Ergonomics
February 2018

Guidance Document
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General Information

Approval and authorisation of this document

This document has been written on behalf of the European Transport Federation Locomotive Drivers Advisory Group. Any alterations to this document must be ratified at a meeting of the same.

Issue record

Issue	Date	Comments
One	April 2017	First Issue
Two	February 2018	Integrated the feedback from the LDAG meeting of the 24 th of April 2017 and subsequent research developments.

Foreword

Purpose

The purpose of this document is to provide guidance to Manufacturers and European Transport Federation (ETF) affiliates for future cab design. It is **not** the intention of this guidance document to cover every aspect of the cab environment however it is intended to focus on the requirements as laid out in the scope of the project.

Introduction

The construction and design of the train drivers cab is one of the factors highly influencing the performance of the train driver in matters related to safety. As the cab is the daily workplace of the Train Driver, the facilities offered are of great importance to the general well-being of our members.

Locomotives and multiple units are used in highly different kinds of operations, from local passenger trains to long distance freight trains. This means that apart from the general requirements, options for onboard facilities should be developed, also taking into account gender equality aspects. These options should be prepared technically on prototype designs and should not substantially increase the cost of a locomotive.

As the market for rolling stock is getting increasingly international and cross border operations are becoming more usual, we have also seen the design of several European standard locomotives. Today the specifications for construction and design of the drivers' cab are described in various TSIs and in UIC code 651. These specifications are partly outdated and incomplete. In order to facilitate interoperability and improve safety and working conditions new guidelines/recommendations should be developed based on scientific research and involving the social partners at a high level.

This document should be regularly reviewed and updated to take into account new developments in technology or research.

Scope of the project

The cab project is on the work program for the social dialogue committee and was proposed by the European Transport Federation (ETF). The Commission for European Railways (CER) asked if the ETF could define more exactly what changes wished to make to the present specifications.

The project was therefore initiated to develop guidelines/recommendations for the construction and design of a train drivers cab including options for on-board facilities for ETF affiliates and manufacturers. From this guidance it is the aim to develop and produce Technical Specification Interoperability (TSI) changes proposal document to the CER.

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Section 1: General requirements

Representative involvement

1. It should be recognised that successful cab design can only be achieved through cooperation, consultation and agreement with trade union representatives. It should also be recognised that there will be a cost saving benefit to this approach as any subsequent remedial work would be expensive to implement retrospectively.
2. Representatives must be provided with all information relating to the proposed cab design and also be provided with the results of any assessment or evaluation as the project progresses.

Ergonomic Principles¹

1. Design preference shall be given to the operation by a lone driver.
2. The interior layout of the cab should be designed through the application of a user centered approach, taking into consideration the physical attributes of the target user population to ensure the safe and efficient operation of the train.
3. 'State of the art' anthropometric data should be used when designing a driving cab.

Collision protection²

1. There must be protection provided to the Driver and any other person reasonably expected to be in the driving cab from collision and external impacts.
2. The inside of driving cab must have no sharp edges or protrusions. If this cannot be avoided, then all instances of this must be covered with a shock-absorbing material.
3. Portable equipment and other components inside the cab must be secured in such a way that they do not come loose after impact or during the normal operation of the train.
4. The driving cab shall be precluded from forming any part of the impact (crumple) zone. Where possible this should be in rear of the driving cab at all times.

¹ Amend Article. Article needs to reference its own data. At the moment the TSI refers to UIC 651 in its appendix. The Article also notes that this is subject to an EN standard that is in the drafting process - this should be investigated.

² New Article. Further research by EU projects were due to be carried out. Suggested changes should take into account this research if available.

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Evaluations and Measurements

1. Evaluations and measurements may only be carried out by qualified persons or services.
2. They must have the necessary specialist knowledge and professional experience and must ensure the conscientious and representative performance of the assessments and measurements according to the “state of the art” at the time.
3. Experts or services must have the necessary and appropriate facilities, depending on the nature of the task.
4. Employee representatives must be consulted and involved in evaluating and measuring exposure to any element or condition referenced within this document.
5. The driving cab must be regularly tested during its lifetime to ensure that the exposure limit value for any element or condition referenced within this document is kept as low as possible.
6. If individual countries have set stricter values / limits then these should be used as maximum values.

Revision of Cab standards

1. The Cab environment and equipment of current traction should be reviewed against this guidance and the relevant TSI's according to the state of the art.
2. Remedial action should be taken where current rolling stock is deemed to not meet these standards or TSI's as soon as practicable.
3. A full Cab assessment should be carried out at regular intervals to ensure compliance with current standards, guidance and “state of the art” available at the time.
4. The minimum period for the Cab assessment should be at the “half life” stage of the traction concerned as determined by the manufacturer.

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Section 2: Cab features

Welfare³

1. On-board toilet facilities must be provided on rolling stock that has its main use in the freight sector or on passenger trains where there is no access to internal facilities.
2. Toilets shall be unisex and provide disposal facilities for sanitary products and should be equipped with a “full door” for privacy and an internal locking mechanism.
3. A drink holder must be provided within reach of the driving position but away from equipment that may become damaged in the event of spillage.
4. Every cab must contain a receptacle for containing refuse. It must be of a suitable size and have a lid to contain odours.
5. Depending on the role, size and design characteristics of locomotives consideration should be given to additional welfare facilities (e.g. fridges and cooking equipment) especially where drivers are expected to work long distances in remote areas where there is minimal or no infrastructure.

Storage

1. Where mobile or portable electrical equipment is permitted to be used, an appropriate stowage and sockets for re-charging should be provided.⁴
2. Where possible, storage space shall be provided for the Drivers’ bag and any associated personal equipment.
3. At least two coat hooks should be provided within the cab.

Seating

1. The priority for manufacturers should be the ability of the Driver to easily see external signals and signage whilst allowing for comfort and range of movement to operate the controls safely, taking into account the target users anthropometric measurements.
2. The normal driving position shall be with the driver seated and facing forward. A secondary driving position must be facilitated in a way that the driver can drive in the standing position.

³ New Article required to take into account toilet facilities and associated standards.

⁴ New Article required to take into account accommodation of electronic equipment.

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3. Comfortable compressed air suspension seats of an agreed standard should be fitted. Seats should be fully adjustable and the controls must facilitate easy adjustment on the move.⁵
4. It is preferable that the driver's seat be positioned as close to the center of the cab as possible whilst allowing sufficient room for safe egress around and from the second person's seat.
5. The cab seating must not present an obstacle to reaching an exit in an emergency.
6. An extra seat facing forward must also be provided for a second person (pilot-man, guard, or other person) for the carrying out of their duties.
7. When considering the seat cushion design to mitigate the effects of vibrations, it is recommended that a simulation, based on a recognised numerical model is used to simplify and reduce the time this procedure takes.
8. It is recommended that the seat cushion is a two layer, shaped geometry cushion or similar that evenly distributes contact forces.
9. The seat must have a back rest with lumbar support

⁵ Amend Article to take into account the need for intuitive controls to allow the driver to adjust the seat on the move.

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Section 3: Cab entry and exit points

General

1. All cab access doors (either external or internal) should be robust enough to be able to resist malicious attempts to gain access to the driving cab illegally and must be fitted with a locking mechanism for access from outside the cab.

External Doors

1. The driver's cab must be externally accessible (without risk to safety) from both sides of the vehicle from at least 200 mm below the rail.
2. External access to the driving cab can be provided from an adjacent compartment if necessary.
3. Doors on the sides of drivers' cabs must only open inwards or be of the plug door or sliding variety.
4. The external doors must have the ability to be opened and secured/remain in the open position to enable safe entry into the cab when the vehicle is standing on an uneven surface.⁶
5. The external doors that provide access to the driving Cab directly or via an interior vestibule must have a minimum clearance 1675 x 500 mm when accessed by the access steps.
6. If the cab is to be accessed at floor level, there must be a minimum clearance of 1750 x 500 mm (without footboards).
7. Access to the driver's cab shall be possible without any energy supply available on board. External Cab doors should be designed so as not open unintentionally.

Internal Doors

1. The internal exit should measure at least 1800 mm in height, at least 500 mm in width, with a minimum free door space of at least 1700 x 430 mm.
2. In through corridor stock the sidewall should be able to pivot away from the driver in order to lessen the feel of claustrophobia and open the cab environment up,

⁶ Amend Article to take into account the need for a mechanism to ensure that the door remains open whilst entering the cab when the train is on an uneven track.

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this allows proper observation of cab equipment without having to use an awkward body posture.⁷

3. If there is any risk of obstruction (baggage, passengers), the door must be of the swing-type (opening outwards and inwards) or of the sliding type.⁸
4. Internal doors that provide access to engine or maintenance compartments shall also (in addition to the requirements of this section) provide protection against fire, smoke and noise.⁹

Access steps

1. Where the external design permits, the steps to access the cab must be in the same vertical plane and equidistant from one another.
2. The distance between the access steps must not exceed 450 mm. The bottom step must be as low as permitted by the gauge.
3. Where possible the steps must be of equal width. The minimum width should be 300 mm, and the minimum depth shall be 150 mm. The steps must also be slip proof.
4. Appropriate lighting should be provided to illuminate the access steps.¹⁰

Hand rails

1. A hand rail must be provided in all cases on each side of the doors and footboards leading to drivers' cabs.
2. The distance from the top end of the hand rail to the driver's cab floor level must be of a suitable length taking into account the anthropometric measurements of the target user population.
3. The hand rails must be rounded and permanently fixed to the side of the locomotive in a way that ensures stability and strength when in use and where possible, recessed into the bodywork to prevent the creation of additional noise.

⁷ Amend Article to take into account the need (in through corridor stock) of a facility the sidewall should be able to pivot away from the driver to allow proper observation of cab equipment without having to use an awkward body posture.

⁸ Amend Article to take into account the need for a swing-type door (opening outwards and inwards) or of the sliding type door if there is any risk of obstruction (baggage, passengers).

⁹ Amend Article to take into account the need for the door providing access to an engine compartment provide protection against fire, smoke and noise.

¹⁰ Amend Article to take into account the need for the access steps to be illuminated.

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4. There must be a minimum clearance of 40 mm between the hand rails and the vehicle side, and this clearance can be increased to 60 mm at the bottom, if the vehicle gauge permits.

Door handles

1. At least one handle of every external cab door must be accessible from ground level.
2. The rotational axis of the handles must be at a minimum distance of 80 mm from the lower edge of the door and 50 mm from the side edge. This distance of 80 mm shall also apply for fixed handles.
3. The clearance between the handle and surface of the door must be at least 50 mm.
4. The door handles must be at least 120 mm long and rounded in shape.

Flooring

1. All walkable floor surfaces must be slip resistant.¹¹
2. Any changes in the level of the walkable area within the cab shall be sloping. The use of steps within the cab environment must be avoided.
3. Drivers should be permitted to navigate freely around the cab without obstruction.

Walkways

1. Rolling stock with external walkways shall be equipped with handrails and foot bars (kicking strips) for driver safety when accessing the cab.

¹¹ Amend Article to take into account the need the flooring to be non-slip

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Section 4: Emergencies

Emergency access

1. The emergency services must be able to gain access to the driving cab on both sides of the vehicle for the purpose of evacuating Train Crew. This can be achieved by using external doors, side windows or emergency hatches.
2. In all cases, the means of emergency exit shall provide a minimum clearance (free area) of 2000 cm² with a minimum inner dimension of 400 mm to allow the release of trapped persons.
3. Emergency hatches can be located on the roofs of vehicles for the purpose of access, if it is safe and practicable to do so.

Emergency Cab Egress

1. Drivers' cabs at the ends of vehicles must have at least one internal door or a gangway allowing easy access for staff for use in an emergency.
2. This internal door must open outwards from the driver's cab and be very simple to open from the drivers' side and be fitted with a mechanism that can be used quickly in an emergency.¹²
3. It must be possible for all occupants to exit from the driver's cab safely and without difficulty into a guaranteed clear space of at least 2000 mm in length.
4. Escape routes must be clearly labelled and identifiable in day and night making use of luminescent labels where required.¹³

Emergency equipment

1. Equipment that a Driver may be required to use trackside, in an emergency must be stowed in a portable container. The container itself must be durable, light and easy to handle and be located in an area with easy access preferably close to the cab door.¹⁴

¹² Amend Article to recognise that the internal door must open outwards from the driver's cab and be very simple to open.

¹³ Amend Article to recognise that escape routes must be clearly labelled and identifiable.

¹⁴ Amend Article to accommodate this novel idea.

Section 5: The Cab desk

General

1. The driver's desk and its operating equipment and controls shall be arranged to enable, when in the most commonly used driving position, the driver to keep a normal posture, without hampering freedom of movement, taking into account the anthropometric measurements of the target user population.
2. Through the identification of the task requirements by task analysis, the target user (driver) requirements shall be established. Having established the tasks to be performed, the design of the cab shall be based on the following design principles:
 - Importance principle – those items of equipment, displays and controls which are most essential to safe and efficient operation should be in the most accessible positions.
 - Frequency of use principle – those items of equipment, displays and controls, which are used most frequently, should be in the most accessible positions.
 - Function principle – items of equipment, controls and displays with closely related functions should be located close to each other.
 - Sequence of use principle – items of equipment, controls and displays, which are used in sequence, should be located close to each other and their layout should relate logically to the sequence of operation.
3. The power brake controller should be suitably positioned and easy to use and use a “notched system” for operation so as to prevent accidental release of the brake and/or emergency brake.
4. A provision should also be provided for a flat writing surface for completing paperwork.

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Illumination

1. All indicator lights must be designed and positioned so that they can be read in all variations of natural or artificial lighting especially during periods of bright sunlight.
2. Indicators should be positioned on the desk in such a way that windscreen glare is mitigated during periods of darkness. Indicator lighting behind the driver should be kept to a minimum and shrouded to prevent windscreen glare during periods of darkness.
3. When additional lamps are provided (e.g. a lamp for the second person) these must not dazzle the driver.
4. Desk and instrument lights should be provided with a rotary control dimmer so that the lighting levels within the cab can be kept to a minimum to aid vision during times of reduced visibility and darkness.

Switches and controls

1. Operating switches and controls shall be clearly marked, so that they are easily identifiable by the driver.
2. Critical controls should be positioned or designed (e.g. countersunk or covered) to prevent accidental operation.
3. Operating switches and controls shall be positioned in such a way as to enable easy navigation of the cab controls.

Display screen equipment¹⁵

1. The amount of display screen equipment in the cab must be kept to a minimum. Integration of functions with other display screen equipment is preferable.
2. In cab display screen equipment must be regularly maintained and cleaned with the appropriate cleaning solutions to ensure reliable operation and a clear image.
3. Operators of in cab display screen equipment must be able to fully adjust all aspects the display (including brightness and contrast) to make operation of the equipment as comfortable as possible.
4. The display screen equipment must have a “sleep” mode function that can be operated by the Driver to disable the display so as to prevent distraction when

¹⁵ New Article required to take into account all paragraphs of this section.

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the equipment is no longer needed. This function should be automatically disabled when there is a need for information to be displayed by the system.

5. In cab display screen equipment must have a manually selected “Day” and “Night” mode to mitigate the effect of glare at night and enable the operator to use the equipment effectively during bright sunlight.
6. The number and volume of audible warnings or alerts emitted from the display screen equipment must be kept to a minimum.
7. Any touch screen equipment or driver interface must have clear, user-friendly, intuitive and responsive controls.

Section 6: The Cab Environment

Cab air pressure and ventilation¹⁶

1. Driver's cabs must be fully enclosed on all sides. The doors, windows, pipe runs and cable runs, inspection traps and any ventilation flaps must be sealed against liquids, exhaust gases and draughts. A slight over-pressure in the driver's cab is desirable.
2. Driving crews must be protected against sudden and major air-pressure fluctuations that might occur - especially at high speeds - when passing other trains and/or travelling through tunnels (both of these may occur at the same time). This system should also be capable of being adjusted manually by the driver.
3. Pressure variations measured in a tunnel of 90 m² cross-section should comply with the following values:
 - absolute pressure variation $\leq 1\ 000$ Pa,
 - pressure variation over a given period ≤ 400 Pa in 1 second.
 - These values also apply when trains cross in the tunnel.
4. The driver's cab, and particularly the floor and roof, shall be provided with heat insulation.
5. The ventilation system must be designed to ensure that at least 30 m³ of air is changed per hour and per person without causing unpleasant draughts. The driver shall be able to adjust the airflow. Under normal conditions of ventilation, the air velocity must not exceed 0,3 m/sec level with the driver's head.
6. In order to ensure rapid evacuation of accumulated heat, it is recommended that the ventilation system be designed to enable the external airflow to be increased by the driver to at least 300 m³ per hour and per driver's cab.
7. A ventilation system shall maintain an acceptable interior CO₂ level under operational conditions and provide an alert to the driver if these levels are exceeded.

¹⁶ With the exception of paragraph 1 The working Group suggest a new Article. The UIC data is old - there may be a requirement for further research. The working group felt that the topic was important enough to be in a TSI.

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Climate control¹⁷

1. All Drivers' cabs must be equipped with an air-conditioning system.
2. The temperature controls must be variable preferably with numbers indicating the corresponding temperature. If this is not available, then a numbered/sliding scale is acceptable. This helps the drivers acquire their preferred temperature as quickly as possible.
3. The driver must be able to regulate the temperature as required, within the range of 18-23°C. Heating power must be designed to reach at least 19°C in cold weather. With the heating switched on, the installation must be capable of supplying an external airflow of at least 30 m³ per hour and per person.
4. The cab air-conditioning, climate control system and associated equipment (air-vents etc.) must be robust enough to ensure that cab temperatures do not rise above 26°C.

Noise

1. Noise levels in the driver's compartments must be kept as low as possible, by limiting noise at its source through appropriate measures (acoustic insulation, sound absorption) using the 'State of the art' technology available at the time of installation.
2. Any assessment of the noise values in Driving Cabs shall be documented and include the type, extent, duration and frequency spectrum of exposure to noise, including exposure to impulsive sound, as well as to intermittent and repeated vibrations.
3. The continuous noise level in Driving cabs measured over 30 minutes must not exceed 70 dB The desired limit is 60 dB.¹⁸
4. A p(peak) maximum noise level of 85 dB should not be exceeded. This peak should not exceed a maximum period of 3 seconds.¹⁹
5. Measurements shall be effected under the following conditions:
 - The maximum speed and power (diesel engines) must be maintained for at least 90% of the measurement time.

¹⁷ The working group suggest an amendment to the Article to reflect the lower values recommended in this section.

¹⁸ The working group suggest an amendment to the Article to take into account the lower limits set by the guidance.

¹⁹ The working group suggest an amendment to the Article to take into account the lower limits set by the guidance.

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- The measurement time as defined may be subdivided into several short periods in order to comply with the above-mentioned conditions.
 - The signal horn must be used for several times in every measurement process.
 - The measurement shall be made level with the driver's ear (in the seated position), in the center of the horizontal surface stretching from the front window panes to the rear wall of cabs.
6. To ensure accurate and effective testing and to protect the maximum limits, hearing protection must not be used.
 7. Measurements should take into account the affect of noise on warning signals, which must be considered to avoid accident hazards, especially with regard to the cab radio and the signal horn.

Glare

1. Sun blinds must be fitted to windscreens enable crew members to protect themselves from being dazzled by sunlight or artificial lighting. These blinds should preferably be electrically powered with a coordinating, simple to use control for its operation.
2. Sun blinds must cover the full width of the windscreen and provide complete protection (cover) at the top of the blind mechanism.²⁰
3. All cab equipment and indications (once installed ergonomically) should be fully assessed for the impact of glare from sunlight entering the cab and remedial action taken.

Cab Lighting

1. It must be possible, in daylight, for all the details in the drivers' cabs, especially the means of access and escape, to be easily distinguishable.
2. It is recommended that the driver's cab incorporate a general lighting scheme guaranteeing 60 Lux continuously at the level of the driver's desk.
3. A reading light should be provided for the Drivers writing surface that is focused on the area concerned and does not dazzle the Driver during the hours of darkness.
4. After general lighting has been switched off, there must remain sufficient light in the driver's cab for the crew to find their way around the cab.²¹

²⁰ Amend the article to take into account the guidance

²¹ New Article required to take into account the guidance.

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5. Cab lighting should be able to function without the main battery switch being engaged.²²
6. Cab light switches should be located strategically so that the lights can be switched on from key points within the cab such as entry from track level, entry from platform level, entry from within the train and from the driving seat.²³

Vibrations²⁴

1. Manufacturers must design and construct vehicles and cabs which reduce whole-body vibration to the minimum that can be achieved for example; seats that effectively dampen whole-body vibrations, or armrests that reduce vibrations transmitted to the hand-arm area.
2. Vibrations at the driver's cab are to be subjected to an evaluation using the "state of the art" at the time of installation. If, based on such an assessment, an exceedance of the exposure limit values can not be safely excluded, the assessment must be based on a representative measurement.
3. Measurements to determine vibration exposure must take at least one hour. The state of the track superstructure must be taken into account.
4. The maximum values for hand-arm vibrations in a particular viewing period are: $a_{hw,8h} = 2,5 \text{ m/s}^2$. A value of $a_{hw,8h} = 5 \text{ m/s}^2$ must never be exceeded.
5. The maximum values for whole-body vibrations in a particular viewing period are: $a_{w,8h} = 0,5 \text{ m/s}^2$. A value of $a_{hw,8h} = 1,1 \text{ m/s}^2$ must never be exceeded.

Electromagnetic Radiation²⁵

1. Manufacturers should design and construct vehicles and cabs which reduce exposure to Electromagnetic Fields to the minimum that can be achieved.
2. The driving cab must be regularly tested to ensure that the exposure to Electromagnetic Fields (EMF) is kept to a minimum.
3. The actual values are to be determined according to the "state of the art" available at the time and may not exceed the limit values defined by the ICNIRP (2010). If individual countries have set stricter limits then these should be used as maximum values. Exceeding the limits under maximum load are not permitted.

²² New Article required. Provision of a method for protecting battery power whilst this facility.

²³ New Article required to take into account the guidance.

²⁴ New Article required to take into account all paragraphs of this section.

²⁵ New Article required to take into account all paragraphs of this section.

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4. The limits for the electric field strength must not exceed 5 kV / m for systems up to 50 Hz. Furthermore, the limits given in table 1 must be observed
5. In the case of high-voltage direct current systems, the magnetic flux density must be limited to 500 μ T.

Frequency range	E-field strength E (kV m ⁻¹)	Magnetic field strength H (A m ⁻¹)	Magnetic flux density B (T)
1 Hz–8 Hz	5	$3.2 \times 10^4/f^2$	$4 \times 10^{-2}/f^2$
8 Hz–25 Hz	5	$4 \times 10^3/f$	$5 \times 10^{-3}/f$
25 Hz–50 Hz	5	1.6×10^2	2×10^{-4}
50 Hz–400 Hz	$2.5 \times 10^2/f$	1.6×10^2	2×10^{-4}
400 Hz–3 kHz	$2.5 \times 10^2/f$	$6.4 \times 10^4/f$	$8 \times 10^{-2}/f$
3 kHz–10 MHz	8.3×10^{-2}	21	2.7×10^{-5}

Table 1 – Maximum limits

Section 7: Cab Equipment

Safety devices

1. The driver's safety device (DSD) should be on an adjustable footrest to accommodate the different body sizes of drivers and be set at a pressure which provides resistance but not at one which requires too much effort from the driver.²⁶
2. Consideration should be given to the provision of a DSD 'holdover' button being located on the desk or within the design of the Combined Power Brake Controller (CPBC) in order to give the driver more options to achieve the most comfortable driving position.²⁷

Communication devices

1. The amount of telephone handsets should be kept to a minimum. Where there is a requirement for multiple communication options to be provided to the Driver the preference is for these options to be separated by technical solution rather than additional handsets. Where multiple handsets are required these should be clearly distinguishable and be within easy reach of the driver.
2. So as to avoid distraction, where provided the guard should have the ability to answer Passenger Alarm Units or Call for Aid devices.
3. All communication devices (including In-cab radio equipment) should be positioned to take into account the driving position so as to minimize the amount of movement required by the driver to use the equipment and view any corresponding displays.
4. All communication devices (internal and external) should be able to operate without power.

Driver – Machine Interface (DMI)

1. As well as the contents of this section, the relevant recommendations contained in *The Display Screen Equipment* sub-section of Section 5 *The Cab Desk* must also be taken into account.
2. The preference for the type of DMI equipment fitted to driving cabs is the soft key variation for freight locomotives and the touch screen variety for passenger services.

²⁶ New Article required to take into account the need for an adjustable DSD that does not require excessive pressure by the driver.

²⁷ New Article required to take into account the need for an alternative position.

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3. When the DMI is incorporated in to new builds of traction vehicles, it is expected that the state of the art technology will be used available at the time.
4. When retrofitting DMI equipment into driving cabs a full human factors assessment must be carried out in accordance with the provisions contained the sub-section *Evaluations and Measurements* of section 1 *General Requirements*.
5. If the human factors assessment proves that that there is an increased risk in the safe operation of the train due to the proposed fitment of the DMI then a full cab remodeling process should take place or retro-fitment abandoned for that particular traction type.

Electronic timetables

1. If fitted the relevant recommendations contained in *The Display Screen Equipment* sub-section of Section 5 *The Cab Desk* must also be taken into account.
2. The provision of an additional screen solely for the provision of an electronic timetable should be avoided.
3. The electronic timetable should preferably be integrated into the Train Management system or other similar device as a navigable page.

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Section 8: On train Camera / monitor systems²⁸

General

1. The On train camera / monitor system must be capable of displaying real time images to the driver.
2. The system shall automatically display images from external cameras on the side of the train on which the doors have been activated / armed.

External Body-side Cameras²⁹

1. External body-side cameras must be capable of showing the areas of risk along the whole length of the train without any blind spots. These areas include (and are not limited to) the entire entry and exit areas of any passenger doors and the gap between the train and the platform edge, including the gap between adjacent vehicles.
2. External body-side cameras must be capable of detecting a person (or any part thereof) that may become trapped in passenger doors including any item of clothing.
3. External body-side cameras must be able to provide the driver with a viewing area capable of showing events or movement whilst not immediately posing a risk to safety may do so in the immediate future e.g. a person running for a train.
4. External body-side cameras must be able to reproduce high quality and high resolution images down to a level of at least 1.5 lux.
5. External body-side cameras that monitor the entry and exit of passengers should consist of the state of the art technology available at the time of installation.
6. External body-side camera equipment must be regularly reviewed and replaced when necessary to take into account any industry changes or developments in technology.
7. External body-side cameras must be regularly maintained and cleaned so as to be free from dirt and the degrading effects of rain, snow and foreign objects.
8. External cameras must be equipped with an efficient heating system capable of keeping the equipment free from snow and ice.

²⁸ New Article required to take into account all paragraphs of this section

²⁹ New Article required to take into account all paragraphs of this section

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In-cab monitors³⁰

1. As well as the contents of this section, the relevant recommendations contained in *The Display Screen Equipment* sub-section of Section 5 *The Cab Desk* must also be taken into account.
2. In-cab monitors shall be capable of reproducing a colour image that is accurate, free from distortion and able to cope with varying light levels.
3. There must be a method in place whereby a driver can easily determine that the images being viewed are live and not frozen due to a technical fault or other reason.
4. There must be a function available to the driver that enables activation of the monitors without the doors being activated / armed to ensure it is safe to depart when stopping out of course whilst no in passenger service.
5. The monitors should extinguish as soon as the power controller is engaged and the train is moving.
6. The maximum number of images able to be displayed at any one time shall be 12 (6 per screen).
7. In-cab monitors must be regularly reviewed and replaced when necessary to take into account any industry changes or developments in technology.

³⁰ New Article required to take into account all paragraphs of this section

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Section 9 - Windscreens and windows

Windscreens

1. Windscreens must not inhibit the Drivers view in any way and should fully support the driving task.
2. Windscreens must be able to resist an external impact taking into account the velocities achieved when the train is travelling at its maximum speed.
3. A windscreen demister must be provided with an automatic cut out to prevent accidental damage.
4. The driver's cab shall be designed to allow the driver to easily see external signals and signage on both sides of a straight track, and on curves with a radius of 300 m.
5. The location, type and quality of windscreen cleaning and clearance devices shall ensure that the driver is able to maintain a clear external view in most weather and operating conditions, and shall not inhibit the drivers external view.

Side Windows

1. Side windows are a valuable asset to the driving cab which allows the driver to have a fuller view of the immediate area at the front of the train can assist in the safe operation of the train including collision avoidance and train dispatch.
2. Driving cabs must be fitted with side windows that must be large enough to allow the driver to have as much vision to the side of the train as possible without reducing structural integrity.
3. Side windows must be tinted to reduce the effect of heat transfer and glare during extreme sunlight.

Appendix 1: Glossary

CER	Community for European Railways
CPBC	Combined Power Brake Controller
DMI	Driver Machine Interface
DSD	Drivers Safety Device
EMF	Electromagnetic Fields
ETF	European Transport Federation
ICNIRP	International Commission on non-ionizing radiation protection
LDAG	Locomotive Drivers Advisory Group
RSSB	Rail Safety and Standards Board

Appendix 2: Sources

- I. UIC Code 651 Layout of driver's cabs in locomotives, railcars, multiple unit trains and driving trailers | 4th edition, July 2002
- II. ASLEF cab ergonomics handbook.
- III. RSSB T698 Human Modelling of Train Cabs and Train Driver Anthropometrics | 03 September 2007
- IV. ICNIRP - International Commission on non-ionising radiation protection (2010).
- V. TSI LOC&PAS 2014
- VI. TSI CR LOC&PAS 2014
- VII. TSI Noise 2014
- VIII. HSE The Control of Vibration at Work Regulations 2005
- IX. RSSB RIS-2703-RST-issue 1 – Driver Only Operated On-Train Camera / Monitor Systems
- X. Modelling the Human Body/Seat System in a Vibration Environment (Jacob Rosen and Mircea Arcan)

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Appendix 3: Further research

The following was identified as areas of further research by the LDAG working group on Cab ergonomics:

Electromagnetic radiation

- I. The group recommends that research be carried out on the exposure to EMF radiation (specific to the Driving role) generated by all traction types.
- II. The group recommends that research be carried out on the mitigation available to Drivers who are exposed to the maximum values as determined by the guidance and/or research. For example; possible engineering solutions or maximum driving limits.

Vibrations

- I. The group recommends that research be carried out on the exposure to vibrations specific to the driving task on all tractions including the direction and severity of movement whilst seated.
- II. The group recommends research into mitigation of the effects of vibrations with the view to finding a generic standard of Driving seat that provides the most protection from the effects of vibrations.

Noise

- I. Research into the effects of noise on Drivers including the effect on health and on distraction from driving duties.
- II. The group recommends that research be carried out on the mitigation available to Drivers who are exposed to the maximum values as determined by the guidance and/or research. For example; possible engineering solutions or maximum driving limits.