6 TRAINS

6.1. RUNNING GEAR

Principle 6.1 Running gear

The running gear should guide the train safely along the track within the operational parameters specified.

6.1.1. General Requirements for Running Gear

6.1.1.1. Provisions should be made to minimise the risks to people from powered systems (traction, brakes, pneumatics and hydraulics etc.).

6.1.1.2. The transfer of noise and vibration to the track and train body should be minimised.

6.1.1.3. The effects of any bonding on an electric railway should be considered so as not to cause damage or degradation to any parts of the running gear.

6.1.2. Wheel Rail Interface

6.1.2.1. The running gear should be capable of operating safely at all permitted combinations of track condition, vehicle speed and loading and the suspension system should prevent:

(a) excessive forces from wheels and axles leading to track damage;

(b) unloading of wheels or axles leading to derailment risk.

6.1.2.2. The running gear, under all permitted states of loading, should be compatible with the track and track geometry under normal condition and maintenance tolerances. The risk of the track being outside normal tolerances should also be considered.

6.1.2.3. The bogie characteristics should result in axles remaining perpendicular to the longitudinal axis of the track to facilitate wear practices and the suspension may have elements to permit, encourage 'steering' of axles round sharp curves.

6.1.2.4. Wheel rim profiles should be compatible with the track design and the train's suspension parameters so as to minimise flange contact and potential damage to rails.

6.1.2.5. The effects of traction, curving and braking forces should be considered.

6.1.2.6. The effects of permitted forces imparted to the track; train body and components of the running gear should be considered.

6.1.2.7. Sufficient damping needs to be provided to minimise vertical and horizontal accelerations and to ensure the decay of any continuing oscillations.

6.1.2.8. Key elements of the running gear should be designed for infinite fatigue life when constructed to the standards specified and operated within the parameters specified.

6.1.2.9. Bogies and running gear components should be secure so as to remain attached and in place during serious but foreseeable perturbations from normal running (e.g. running into or over obstacles, derailment etc.).

6.1.2.10. If excessive heating of axle bearings cannot readily be detected by eye or trackside equipment, then on-board detection should be provided.

6.1.2.11. Consideration should be given to on-board condition monitoring of other suspension components e.g. wheel rim wear, flats, vehicle ride height etc. so far as reasonably practicable.

6.1.2.12. The suspension should maintain the vehicles ride height within the tolerances specified to ensure the correct and safe operation of buffing and coupling systems, and correct clearances between structures and other trains.

6.1.3. Failure Conditions

6.1.3.1. Failure of key components, such as axle bearings and other equipment or systems which could cause significant danger, should be detectable in motion and result in communicating a clear warning to the train crew. Failure of a single component should not lead to a dangerous

condition.

6.1.3.2. The risk and effects of component failure should be considered, the following are examples:

(a) The failure of wheel-sets and bearings;

(b) The failure of attachments of equipment to the running gear;

(c) The failure of suspension components.

6.1.4. Maintenance

6.1.4.1. Running gear should be easy to maintain at those maintenance facilities where it is intended to maintain running gear.

6.1.4.2. Identification of wheels, tyres and axles (including axle bearings) should be permanent and conveniently visible.

6.1.4.3. Tyres, wheels and axles should have batch identity markings to enable traceability. These markings should not act as stress raisers.

6.2. STRUCTURAL INTEGRITY

Principle 6.2 Structural integrity

The structural integrity of trains should be maintained in normal operation and provide protection to any occupants in an accident or emergency

6.2.1. General Requirements for Structural Integrity

6.2.1.1. The structural compatibility of all trains using the route should be considered unless there are arrangements to reduce further the risk of collision.

6.2.1.2. The structural performance of vehicles intended for the carriage of the public should ensure their safety in all but the most extreme cases of failure. The risk and consequences of such events should be minimised or mitigated.

6.2.1.3. Passenger vehicles should be capable of carrying the maximum possible crush load without giving rise to additional risk from the effect of such loading on components and systems.

6.2.1.4. Freight vehicles should contain their maximum loads safely and where they share tracks with passenger trains, they should not present undue additional risks to passenger safety.

6.2.1.5. Controls should be put in place to ensure maximum loads on passenger and goods trains are not exceeded.

6.2.1.6. The vehicle structure should withstand the full range of railway loading experienced during normal operation and throughout its lifetime. The structure and couplings should be capable of operating with the tractive and braking effort that the train is designed to deliver, and foreseeable in-service stresses, without permanent deformation or cracking. Dynamic testing may be required to demonstrate the behaviour of the structure in a traction environment where novel features are incorporated. Risks to safety consequent upon failure of any vehicle component should be limited by appropriate means.

6.2.1.7. Sharp edges on the exterior of rail vehicles that could cause injury to passengers or crew should be removed.

6.2.1.8. Spillage of materials or exposure to weather should not lead to the corrosion of any structural parts which could result in the failure of the structure. Suitable drains, paint finishes or other means should be used to remove or provide protection from any unwanted materials.

6.2.2. Protection of Passengers, Train Crew and Goods

6.2.2.1. Passenger and train crew areas should be designed to provide a safe space for occupants and goods under normal operating conditions and protection in the event of an accident. The probable accident scenarios should be identified using risk assessment techniques and measures should be taken to mitigate against such incidents as they might affect the safety of other rail traffic or the safety of people.

6.2.2.2. In the event of an accident, structural component members should not intrude into areas where there are people.

6.2.2.3. Where structural design involves large deformations or crumple zones, then these should be in areas where people are least likely to be present.

6.2.2.4. Leading vehicles that are occupied by passengers during normal operations may require special consideration to be given to their performance in the event of collision (with other trains or obstacles on the track) or derailment. Speed limitation, axle loading, vehicle end performance etc are factors in this.

6.2.2.5. The crashworthiness of vehicle driving cab ends should be designed to give the train driver and other train crew members' protection in event of an accident and impact with foreseeable objects.

6.2.2.6. All vehicles should be constructed to minimise overriding between the vehicles themselves or at buffer stops. Particular attention should be paid to passenger vehicles in this respect.

6.2.2.7. In event of overriding of freight vehicles, telescoping of the cargo space should be minimised.

The design should minimise the likelihood of the container being ruptured. Particular attention to this aspect may be necessary when dangerous goods are carried.

6.2.2.8. Trains for the carriage of goods should retain the goods securely under normal operating conditions.

6.2.3. Equipment Attachment Failure

6.2.3.1. Items of equipment, their ancillary mountings, fittings etc, both inside and outside the train, should be suitably secured. They should be designed to withstand the range of loads that they may experience throughout their life, including, but not limited to; vibration, thermal loading, extreme operational loading, accident loading, foreseeable abuse and vandalism.

6.2.3.2. Consideration should be given to the effects of equipment attachment failure which could adversely affect the safe operation of the train or of passengers within it or of people adjacent to the lineside or on station platforms. The structure should be protected against the foreseeable failure modes of equipment and any likely penetration that might result.

6.2.3.3. The crashworthiness of the vehicle should take into account the performance of the structure with respect to the attachment of fixtures, fittings and heavy items of equipment in survivable incidents so as not to give rise to undue risks to people on board the train.

6.2.3.4. The structure should be protected against foreseeable failure modes of equipment and any likely penetration of the vehicle structure that might result.

6.2.4. Identity Markings

6.2.4.1. Safety critical items should have batch identity markings to enable traceability. These markings should not act as stress raisers.

6.2.4.2. Unique identification may be necessary for other safety critical equipment including microprocessor control cards and large microprocessor units.

6.2.4.3. Identity markings should be permanent and remain visible under all operating conditions where necessary this should be achieved through routine maintenance.

6.2.5. Couplings, Buffing and Drawgear

6.2.5.1. Any buffers between vehicles should resist buffer locking. Buffers and drawgear systems should resist overriding and relative rotation to keep vehicles upright.

6.2.5.2. The buffing gear of trains should be compatible with the buffer stops or other arrestor devices in use on the railway. The possible loads imparted by such equipment in foreseeable collisions should also be taken into account.

6.2.5.3. Vehicle end load performance, buffing strengths and heights of all trains using a route should not to give rise to danger due to the different performance of vehicles.

6.2.5.4. Mechanical couplings should withstand the normal railway loads between the vehicles of a train and retain integrity if misalignment or overload occur, in the event of a derailment.

6.2.5.5. Where couplings are locked/latched in position, there should be a visible indication or other detection that the locking mechanism has worked correctly.

6.2.5.6. The range and compatibility of coupling devices in use on the railway should be considered to keep the different types of couplers in use to a minimum and aid the interaction of rolling stock, this includes compatibility for rescue and recovery purposes.

6.2.6. Lifting Arrangements

6.2.6.1. Arrangements for lifting the vehicle for both normal maintenance and emergency situations should be considered.

6.2.6.2. There should be arrangements to facilitate the lifting of the body.

6.2.6.3. The structure should be able to withstand, without adverse effect, the jacking loads and other loads to which it is subject during maintenance and recovery activities.

6.2.6.4. All normal lifting and jacking points should be clearly marked and any limitations indicated.

6.2.7. Glazing

6.2.7.1. The type of glazing used in passenger and train crew compartments should resist breakage and minimise danger when broken. Where glazing has to be removed to provide a means of escape a suitable way to achieve this should be provided.

6.2.7.2. Exterior glazing, whether in the train crew or passenger areas, should be able to resist impact from projectiles or objects, taking into account the speed of the train.

6.2.7.3. Exterior glazing, whether in the train crew or passenger areas, should be able to resist aerodynamic effects, taking into account the speed and relative speed of the trains, and the proximity of infrastructure.

6.2.7.4. Protection should be provided to the driving cab occupants to prevent glass particles/splinters in the event of an impact to the windscreen.

6.2.8. Doors

6.2.8.1. Exterior doors should retain passengers during all service conditions including crush loading and should minimise the risk to passengers in the event of an accident, including where the vehicle does not remain upright.

6.2.9. Obstacle Deflectors

6.2.9.1. Arrangements to deflect any obstacle on the track, e.g. use of a lifeguard and/or obstacle deflector, may be necessary in addition to operational measures such as enforcing a low operating speed. Lifeguards, obstacle deflectors and snowploughs should withstand the loads expected of them without failing. Those designed to collapse under certain loading, should do so in a controlled, predictable and safe manner.

6.2.9.2. Body panelling should protect people and have a resistance to impact and accidental damage appropriate to the use of the train.

6.3. SPEED REGULATION

Principle 6.3 Speed regulation

The speed regulation system should meet normal operational safety requirements, be compatible with the design of the infrastructure elements and behave in a safe manner in specified abnormal conditions and not endanger people or goods carried.

6.3.1. General Requirements for Speed Regulation

6.3.1.1. Speed regulation covers the equipment which affects the trains ability to reach and maintain the required speed safely including acceleration and deceleration.

6.3.1.2. Reliable speed indication should be provided in all driving positions, the accuracy should be sufficient to allow the train to be operated safely to a mandated speed profile.

6.3.1.3. The braking system should be sufficient to regulate the train's speed over its intended operating routes, including all gradients.

6.3.1.4. The traction system should be sufficient to regulate the speed of the train over its intended operating routes, including all gradients. This should include starting from standstill with maximum load.

6.3.1.5. The acceleration and deceleration rates and the rate of change of those rates should not give rise to danger of people and goods carried on the train and adverse effects on the train's equipment. Traction and braking control systems should provide this as far as possible.

6.3.2. Braking System

6.3.2.1. Braking should be provided on all vehicles and must be continuous and automatic throughout the train as required by the Regulation of Railways Act 1889. Continuous automatic brakes should operate effectively in all operating conditions and when applied should inhibit traction power. If the train becomes divided due to a coupling failure emergency braking must be applied automatically on all parts of the train. Where these conditions cannot be provided for any reason, it should not give rise to danger.

6.3.2.2. There should be an emergency brake that can be reliably applied from the control position. Emergency braking should be effective at all times. The emergency braking system should be designed to optimise the train retardation and should not be degraded by wheel slide protection equipment.

6.3.2.3. Where an electric braking system is used that uses the regenerative principle, it should be compatible with the electric traction system, signalling and communication systems.

6.3.2.4. Regenerative, rheostatic, friction or other braking systems may be used either separately or in combination. Any combined system should have a means of blending braking effort. Electrical braking systems should be arranged so that the application cannot suddenly be lost without compensation.

6.3.2.5. A parking brake should be fitted to all freight vehicles. It should be capable of holding the vehicle indefinitely on any gradient over which it can be operated.

6.3.2.6. There should be sufficient parking brakes fitted to non-freight vehicles so that they are capable of holding the train indefinitely, in which they are fitted, on any gradient over which the train can be operated.

6.3.2.7. It should be possible for the parking brake to be applied by one person without separate specialist equipment.

6.3.2.8. Manually applied parking brakes should be operable from a convenient position on board the vehicle, where this is not possible it may be operated from ground level on each side of the vehicle.

6.3.3. Braking Safety Features

6.3.3.1. The risk of dragging brakes should be minimised and features for releasing the brakes on longer trains in shorter times should be considered, such as brake pipe overcharging and Electro-

Pneumatic Assistance.

6.3.3.2. No foreseeable braking system operation or fault should give rise to shocks that might cause injury to people or cause the failure of couplings.

6.3.3.3. Any compressed air or hydraulic supply to the brake equipment should be suitably protected against the ingress of water or other contaminant into the system whilst maintaining braking system performance.

6.3.3.4. Any precautions against frost should ensure that any contaminant ingress will not render the brake control or operation unsafe.

6.3.3.5. Braking system controls should be robust and tamper proof to prevent damage by unauthorised actions by passengers or train crew.

6.3.3.6. All cocks, valves and levers that have an isolating effect on any part of the brake system should either be readily identifiable, visible and clearly show their position or be equipped with a prominent indicator. Where appropriate, the direction of movement to operate the device should be indicated. Such cocks, valves and levers should be tamper resistant and designed to prevent accidental operation if knocked.

6.3.3.7. Brake friction materials should have low spark emission properties. They should not give rise to toxic or harmful emissions that present a nuisance or danger to people.

6.3.3.8. The braking system should be designed so that any malfunction giving rise to potential danger should default to the brakes being applied and remaining on until specific remedial action is taken. It should not be possible to start the train or release the brakes unless sufficient braking effort is available.

6.3.3.9. If redundancy of braking system components is used to ensure train safety, then it should be possible to detect easily failure in individual components and any failure masked by the redundancy feature.

6.3.4. Train Safety Features

6.3.4.1. Wheel slide/slip protection equipment should be considered as a means of improving wheel/rail adhesion and may be necessary to assist traction and braking. Where provided and in operation this should not degrade the braking performance. Automatically controlled wheel slide equipment should be self checking and disengaged if the system fails or control is not fully established within a safe period.

6.3.4.2. The provision of a means of maximising adhesion under both braking, for the prevention of signal overruns, and traction should be considered, the use of sanding equipment is an acceptable means of achieving this. Single application ‘one shot’ sanding equipment may be considered for modifications only, however, multiple application sanding equipment should only be considered for new trains. The risk to health and safety, and the risk of contamination of equipment by pulverised sand should be considered, and a suitable compound should be used to minimise these risks.

6.3.4.3. The effects of the driver becoming incapacitated should be minimised by the use of a Driver’s Safety Device (DSD) and/or a means of continual monitoring of the train driver’s safety performance (vigilance) should be provided. Such facilities should be resistant to malpractice.

6.3.4.4. The release of the DSD or failure to respond to the vigilance equipment by the train driver should result in an emergency application of the train’s brake.

6.3.4.5. Failure of the device should either initiate an emergency brake application or inhibit release of the service brake and prevent traction power from being applied. A means of operating the train in restricted mode may be necessary.

6.3.5. Train Protection

6.3.5.1. Where Automatic Train Operation (ATO) is fitted this should have an associated independent Automatic Train Protection (ATP) system. There should be sufficient integrity in this combination to ensure safety.

6.3.5.2. ATP equipment where provided, should interface with the braking system. In the event of any

loss of ATP the speed of the train should be controlled so as not to give rise to danger. Refer to 6.9.4, Compatibility with Signalling Equipment and 6.9.5 European Rail Traffic Management System (ERTMS).

6.3.5.3. Where the foregoing systems are not provided there should be an advisory warning system compatible with the signalling system. Refer to Section 4, Signalling.

6.4. POWERED SYSTEMS

Principle 6.4 Powered systems

Electrical and other on-board powered systems should not endanger people or other systems.

6.4.1. General Requirements for Powered Systems

6.4.1.1. The systems covered by this section include on-board electrical, mechanical, pneumatic, hydraulic, steam and heating systems or equipment including electric traction current collection, main and auxiliary power systems and all electrical control systems including software.

6.4.1.2. Safety critical systems should be designed to remain active or fail to a safe mode either by redundancy or before safety critical levels are reached. Suitable alarms or interventions should be provided as necessary.

6.4.1.3. Full control of any power source (electrical, air, hydraulic etc) should be available and degradation should not result in a hazardous situation for people.

6.4.1.4. Flexible connections, air lines, control cables etc should be protected or positioned to avoid mechanical damage during normal and adverse train movements, the action of brake block sparks and other accidental damage during train running.

6.4.1.5. The coupling and uncoupling of any powered system during normal operations should be arranged to minimise danger and should be automated so far as possible.

6.4.1.6. Unauthorised access or use of powered systems should be restricted.

6.4.1.7. Provision should be made to minimise the risks to people from powered systems and suitable warning notices should be provided to prevent/deter contact with powered systems that may harm people.

6.4.1.8. The effects of loss of safety critical systems should be minimised.

6.4.2. Isolation Devices

6.4.2.1. A means of shutting down or isolating sections or items of powered equipment under all foreseeable conditions including maintenance should be provided. They should be clearly marked and lockable out of use, where necessary, to minimise danger by incorrect or unauthorised operation.

6.4.2.2. There should be appropriate indications or alarms that equipment has been isolated.

6.4.2.3. Engines should have prominent, reliable and readily accessible stop devices which operate by a single brief action.

6.4.3. Pressurised Systems

6.4.3.1. Pressurised systems should be provided with efficient limiting devices to control pressures within the safe operating parameters of the system.

6.4.3.2. There should be a safe means of discharging pressure to ensure danger does not arise during foreseeable service conditions including maintenance.

6.4.4. Electrical Systems

6.4.4.1. People should be protected from dangerous voltages in all foreseeable circumstances of normal operation. There should be mitigation against the likely effects of foreseeable failures that might give rise to an electrical hazard. Suitable warning notices should be provided.

6.4.4.2. Electrical isolation switches should be provided to allow the safe disconnection of electrical equipment. They and the area under isolation must be clearly and unambiguously marked. There should be a means of securing the switches in both normal and isolated modes.

6.4.4.3. Where necessary, earthing devices should be provided to protect the area to which they apply. They and the area must be clearly and unambiguously marked. Where necessary to prevent danger, there should be a means of securing the devices in both normal and isolated modes.

6.4.4.4. The risk of passengers receiving an electric shock, burn or any other injury by touching a

surface, or item which may have suffered damage should be minimised.

6.4.4.5. The effects of lost power supply to electrically powered systems should be considered, this should not create an unsafe situation.

6.4.4.6. The current collection equipment should be sited or protected to minimise risk to people.

6.4.4.7. Electrical and electronic circuits should be protected against the possibility of accidental short circuits and earth faults either within the circuits themselves or with other circuits. They should also be suitably protected against faults in other electrical equipment. Where trains can be connected to shore supplies, similar protection should be provided. Refer to the Safety, Health and Welfare at Work (General Applications) Regulations, 1993.

6.4.4.8. Bonding, short circuit and earth fault protection should be provided to minimise risks from electrical failure.

6.4.4.9. All equipment that may become live when a shore supply is connected must be guarded or otherwise protected.

6.4.4.10. Equipment and electrical conductors should be positioned and be protected to avoid accidental contact by people.

6.4.5. Interference

6.4.5.1. Interference with and from other powered systems should be minimised and should not create an unsafe condition.

6.4.5.2. Electromagnetic fields that are known to adversely affect the health and safety of people should be controlled. Suitable warning notices should be provided where necessary.

6.4.5.3. Electromagnetic interference generated by the train equipment and systems should be controlled so as not to adversely affect the safety of railway equipment. Where it is not reasonably practicable to completely eliminate such interference, a minimum protective fault level may be necessary to enable the risk to be contained within suitable parameters. Safety critical systems sensitive to electromagnetic interference should be adequately protected to minimise the effect of such interference.

6.5. ACCESS AND EGRESS

Principle 6.5 Access and Egress

Trains should have a safe means of access and egress which is not available whilst in motion.

6.5.1. General Requirements for Access and Egress

6.5.1.1. Human factors issues should be considered in all areas relating to the operation and use of doors, gangways, etc used in the access and egress of trains.

6.5.1.2. Trains should provide for ease and convenience of boarding, alighting and retention of their intended passengers and goods.

6.5.1.3. The need for access to wagons and other track plant needs to be taken into account.

6.5.1.4. Stepping distances between steps on the train should be compatible with current regulations and best practise, further guidance on stepping distances is given in section 2, Stations.

6.5.1.5. The edges of steps should be clearly marked.

6.5.1.6. Doors, gangways, steps, corridors and vestibules should be designed for freedom of passenger flow and be suitable for the volume and type of use. In addition, they may need to take into account a need to reach the track safely.

6.5.1.7. The size and number of doors, gangways and steps should take into consideration the envisaged service and the evacuation criteria. An indication should be provided to passengers and train crew if the door is locked.

6.5.1.8. Steps, ledges or handholds exterior to the train which could enable people to hold onto the train once the doors are shut should be minimised.

6.5.1.9. Doors and associated areas should be designed so as to minimise the danger of trapping injury, e.g. the doors should be shielded, have obstacle detection. Doors should also be resistant to serious operational

6.5.1.10. Vehicle connections at the end of and between trains should be capable of being closed and secured. If these doors form part of the escape routes, they should have a suitable emergency release. These should also be clearly labelled. Multiple units designed for working in tunnels without a side walkway should facilitate emergency egress through the front and rear ends of the train: such facilities should not encourage people to ride on the outside of the train.

6.5.1.11. Remotely-operated power doors should be audibly alarmed to give warning prior to their operation. This may not be necessary for a door directly under the control of the train crew or when they are released for passenger use.

6.5.1.12. Power-operated doors should not operate with excessive force. It should be possible to release limbs or other objects trapped by the doors without difficulty.

6.5.1.13. There should be a means of the train crew checking visually whether anybody or anything has been trapped in the doors. To achieve this, special viewing equipment may be required. This equipment may be mounted on the station platform, in which case refer to section 2, Stations. Where the equipment is on board the train it should be directly controlled and visible from the train crew door control position.

6.5.1.14. Where doors open in the direction of passage or onto the platform it should be possible to see what is behind the door.

6.5.1.15. A means of indicating to passengers that a door is out of service should be provided, particularly when this results in the loss of an emergency exit.

6.5.1.16. Passengers should be able to exit from the train to the outside safely. Walking and step surfaces should be slip resistant in all service conditions.

6.5.2. Passengers

6.5.2.1. Normally, passengers should only be able to gain access to and from their vehicle using doors which open directly onto a station platform or by using the inter-connections between vehicles.

Where it is not possible for all doors to open directly onto a platform the following should be considered:

(a) The use of announcements and indications to passengers to advise as to which doors may be used;

(b) The use of an automatic Selective Door Control system.

(c) The use of fewer doors for the access and egress of passengers should not restrict the flow of passengers on, off and through the train in normal operation.

6.5.2.2. It should not be possible or necessary for people to lean out of windows or other apertures.

6.5.2.3. Handrails or similar aids should be provided where necessary to assist passengers boarding or alighting the train.

6.5.2.4. External passenger doors should be equipped with centrally-controlled locking. They should normally be power operated. Where these features are not provided, the agreement of the RSC should be obtained at an early stage.

6.5.2.5. When the vehicle is moving, external passenger doors should be secured in the closed position. A system should be provided to prevent the driver from releasing the brakes and starting the train, unless all external passenger doors are fully closed and secured, this should be indicated to the driver. In the event of doors or their control system moving from the 'closed' position while the train is moving or door locks failing on demand, traction power should be removed automatically. Consideration should be given to simultaneous controlled brake application.

6.5.2.6. Passenger door controls and the method of operation should be clear and clearly and unambiguously signed.

6.5.2.7. With the exception of train crew doors, the controls systems for external doors should be arranged to minimise the risk of a wrong-side opening (opening at places where no platform is present).

6.5.2.8. Controls to release the external passenger doors should be operable from authorised staff locations.

6.5.2.9. The door system design should take account of the loads to which it may be subjected in service so as to prevent danger, including crush loading and misuse.

6.5.2.10. Passenger access doors and their environment should be designed such that adverse weather conditions do not cause an unsafe situation, for example; rain and snow making surfaces unsafe or preventing doors from operating correctly.

6.5.3. Train Crew

6.5.3.1. Where there is a need, normal access to the cab for the train crew should be achieved by a route independent of any passenger area.

6.5.3.2. Train crew access to the cab should be achieved by a route which can be locked independently of the passenger area.

6.5.3.3. Access arrangements from the trackside to the cab, including positions and visibility of steps, handrails, doors, locks and handles, should allow train crew to board and alight with minimum risk of injury, and should make due allowance for the work equipment and personal effects carried.

6.5.4. Emergency Arrangements

6.5.4.1. Provision should be made for passengers and train crew to evacuate the train in the event of an emergency.

6.5.4.2. Emergency interior-mounted external door releases should be provided for powered and/or centrally-locked doors, but should deter use under normal operating conditions. These releases should not require the need for tools, electricity or air pressure and be easily accessible. Once released external doors should be easily openable by hand, from inside and outside, once the train is stationary.

6.5.4.3. There should be a means of releasing designated external doors from the outside in an emergency. The design and labelling of the release mechanism should deter non-emergency use.

6.5.4.4. The door arrangements should enable passengers and train crew to evacuate safely. It should be possible for passengers to open designated external doors, once the train is stationary. Door emergency releases should be operable to open the external and internal doors even if there is a failure of any train equipment, power supply etc.

6.5.4.5. Internal doors should not prevent passengers from evacuating along the train, where internal sliding doors are fitted they should be double leaf.

6.5.4.6. A means should be provided to easily remove or break interior and exterior glazing where it forms part of an escape route.

6.5.4.7. Doors should be easy to locate and easily distinguishable in an emergency, emergency lighting and illuminated exit signage should be provided throughout the train including low level lighting. Such lighting should remain operational following an impact. The provisions of IS3217 should be considered when setting up an emergency lighting system.

6.5.4.8. The design of door systems should take into account the possible need to evacuate when the vehicles are not upright, such as after a collision or derailment.

6.5.4.9. Clear, unambiguous signs giving instructions for the use of passenger door emergency releases should be provided. These signs should be visible at all times. Internationally recognised pictograms and/or multi-lingual signs should be used where appropriate.

6.5.4.10. The train crew should have an alternative means of access to the track from the cab in the event of an emergency. A means of emergency egress for the train crew may be through the passenger accommodation and vice versa.

6.5.4.11. Where emergency egress from passenger accommodation through train crew areas is possible, this should be clearly and unambiguously marked. The method of opening doors into and within the train crew areas should be provided and be clearly marked.

6.5.4.12. Escape routes, equipment and procedures should be clearly signed in all circumstances, making use of internationally recognised pictograms. Consideration may be given to indicating automatically the escape routes to passengers.

6.5.4.13. A means should be provided for passengers to alight safely from the train onto the track in an emergency in all service conditions. This should be clearly and unambiguously indicated.

6.5.4.14. Passengers should be able to exit their vehicle using more than one route. There should be no ‘dead end’ traps. End doors, that form part of an escape route, should be usable by passengers to evacuate.

6.5.4.15. The provision of escape hatches in carriages should be considered. These should be clearly and unambiguously indicated.

6.5.5. Disabled Provisions

6.5.5.1. Where appropriate, consideration should be given to door controls being accessible to, and capable of operation by mobility-impaired people.

6.5.5.2. Door controls should be easily identifiable by disabled people, this includes the visually impaired.

6.5.5.3. Passenger doors should be able to accommodate disabled people.

6.5.5.4. The design of the external doors should be such that a disabled passenger can identify the location of the doors.

6.5.5.5. If vehicles are designated for the use of wheelchair passengers then, unless the platform is suitably marked, a pictogram indicating such facilities should face outwards at the access positions.

6.5.5.6. There should be a means for mobility-impaired passengers to exit from the train in the event of an emergency.

6.6. INTERIORS

Principle 6.6 Interiors

Interiors of trains should provide a safe environment for people sitting, standing or moving inside, and should minimise harm in an accident or emergency.

6.6.1. General Requirements for Interiors

6.6.1.1. Guidance within this section is for passenger and train crew safety on board trains taking account of their normal behaviour including sitting, standing and moving about the train. The driving cab is covered in section 6.10, DRIVER INTERFACE.

6.6.1.2. Human factors should be considered in all areas that require human interaction.

6.6.1.3. Sleeping cars, special purpose vehicles and trains that operate in tunnels without a side walkway or other inaccessible locations may require further consideration for passenger and train crew evacuation.

6.6.1.4. Where privacy locks are provided on internal doors for use by passengers, there should be a means to enable an authorised person to gain access. Similarly, there should be a means for passengers to unlock internal doors that have been locked from the outside.

6.6.2. Internal environment

6.6.2.1. Passengers and crew should be able to ride in (seated and standing) and move about the train with reasonable comfort and safety. The characteristics of the ride should not mean people suffer undue stress, discomfort or injury. The accommodation should be commensurate with the types of service envisaged.

6.6.2.2. Where a train or section of the train is designated for use by disabled/mobility impaired persons, suitable provision should be made for their occupation including accommodation for wheelchairs.

6.6.2.3. Spillage of materials, rainwater etc should be drained or other means used to avoid slippery surfaces.

6.6.2.4. The normal operation of doors, windows or any other moveable items should not cause any injury to people.

6.6.2.5. Sufficient handholds or grab rails should be provided to enable people to steady themselves. They should be placed within easy reach and at appropriate intervals for use by passengers when standing. Handholds should be commensurate with the service envisaged.

6.6.2.6. Fixtures and fittings should be distinct to the visually impaired and easy to use by the mobility impaired.

6.6.2.7. The design and location of interior structures, fixtures and fittings including seats and any other furniture should minimise the risk of injury to passengers in the event of slips and falls or an accident in normal operation and in survivable incidents. Seats should restrain occupants in the event of an accident and should be designed to remain secure and to minimise the risk of injury.

6.6.2.8. Sharp or angular projections, hard surfaces which could foreseeably give rise to injury to passengers should be minimised. Interior glazing should resist impact damage and have protected edges.

6.6.2.9. The design of the interior, fixtures and fittings and any failure modes should not result in any tripping hazards.

6.6.2.10. The interior design, doors and other moveable items should not present potential traps to people.

6.6.2.11. Protection may be required to guard traps around moving equipment, e.g. corridor end connections.

6.6.2.12. Moveable items of equipment such as drop-down seats or tables should be suitably secured or retained when not in use.

6.6.3. Walkways

6.6.3.1. Passengers should be able to move throughout a multiple unit when it is operational unless the doors between vehicles are intended for emergency use only. Such doors should be clearly labelled as such and measures taken to deter unauthorised use.

6.6.3.2. Where there is passenger access between vehicles it should be safe throughout the range of operating conditions. It should not afford unauthorised access to any safety-related equipment.

6.6.3.3. Changes in floor levels should be avoided so far as is reasonably practicable. Where this is not possible they should be clearly marked and stepping distances should be appropriate for all passengers and train crew and be compatible with current best practise and regulations.

6.6.4. Equipment failure

6.6.4.1. The failure modes of any equipment should be taken into account to ensure people are sited away from or are shielded from danger.

6.6.4.2. Equipment, mountings, fittings, seats, other furniture etc should be firmly secured. They should withstand the range of loads that may be experienced throughout their life, including foreseeable abuse and vandalism.

6.6.5. Noise

6.6.5.1. Equipment which emits noise should be located, or provided with suitable protection/attenuation, so that people are not subjected to excessive noise. Suitable warning notices should be provided where necessary.

6.6.6. Hazardous materials

6.6.6.1. Materials with known hazardous properties should not be used. Where it is essential to use such materials other precautions including safe from affecting the health provided.

6.6.7. Fumes, smoke and noxious gases

6.6.7.1. On-board equipment and/or systems should not emit gases, fumes or smoke during normal operation so as to have a detrimental effect on people.

6.6.7.2. Where noxious substances are produced, there should be a means of preventing them from endangering people.

6.6.8. Hot surfaces

6.6.8.1. Equipment or surfaces which might become hot during normal or abnormal operation should be protected or positioned so as not to cause harm to people.

6.6.9. Catering equipment

6.6.9.1. Catering equipment should be positioned, restrained or guarded to minimise the risk of injury to passengers and catering staff.

6.6.9.2. Where catering facilities are provided, provision should be made for the preparation and storage of the food envisaged.

6.6.10. Luggage

6.6.10.1. Provision for stowage should be made commensurate with the types of service envisaged. Purpose-built stowage areas should be provided to minimise the obstruction to passenger gangways or egress.

6.6.10.2. Luggage stowage should be strong enough to withstand the loads imparted by the luggage in normal operation and in an accident.

6.6.10.3. Luggage areas should be divided to ensure that the items stowed are safely contained and do not spill over in the event of an accident and warning notices provided to deter their misuse. The design should also take into account the risk of fire.

6.6.10.4. The provision of facilities for the stowage of special items, e.g. bicycles, should be designed for ease of use and provide secure retention and should not cause injury to the user.

6.6.11. Heating and ventilation

6.6.11.1. There should be a means of ensuring an adequate change of air in all passenger compartments.

6.6.11.2. Where passengers have manual means to control the ventilation, these should be simple and safe to use.

6.6.11.3. Passenger compartments and sleeping accommodation should be maintained at a comfortable level. Heating, ventilation and/or air-conditioning may be provided to these areas. These systems should be capable of providing and maintaining a satisfactory environment throughout the range of foreseeable conditions the train may encounter (including delays and failures).

6.6.11.4. Where heating and ventilation systems are automatically controlled, there should be means of overriding the controls in an emergency. Provision for emergency ventilation in the event of a failure should be suitably addressed. Consideration should also be given to operating the system from a battery or other back-up power source following loss of the main power supply. A controlled degradation of the system may be necessary.

6.6.11.5. The siting of air intakes for any ventilation for people should be arranged not to draw air from sources of noxious fumes, odour or smoke.

6.6.11.6. Where air-conditioning is provided, harmful quantities of the refrigerant should not be released inside the compartment in the event of a failure.

6.6.12. Lighting

6.6.12.1. Passenger compartment lighting should remain operational at all times in normal operation.

6.6.12.2. A reduced level of lighting may be permitted in the event of an emergency to conserve the secondary power source and should last long enough to permit the train to be evacuated safely. See section 6.4.4.7.

6.6.12.3. Lighting in connecting passageways and at steps and exits should be even, adequate and at a similar level to elsewhere in the vehicles.

6.6.12.4. Flashing lights and lights that could give rise to a stroboscopic effect should be avoided where this could cause stress to passengers and train crew.

6.6.13. Sanitation

6.6.13.1. Where toilets are provided they should:

(a) have adequate provision on board to retain waste. Passengers should be deterred from using the toilets when retention provisions are full. They should be adequately vented away from people and ventilating systems;

(b) have appropriate and accessible facilities where passengers in wheelchairs are to be carried;

(c) be easy to clean;

(d) have adequate washing and drying facilities for hygiene purposes;

(e) have considered the provision of baby changing facilities with suitable restraints built in.

6.6.14. Vandalism

6.6.14.1. Trains should be designed to minimise the possibility of opportunist vandalism, which could have a detrimental effect on safety. The provision of surveillance cameras should be considered.

6.6.14.2. Exposed controls, equipment, fixtures, fittings, structure etc should resist unauthorised use and be strong enough to withstand attempts to alter, damage, loosen or remove them.

6.6.14.3. Windows should not open sufficiently to enable people to gain unauthorised access (full or partial) or to throw large objects from them.

6.6.15. First aid

6.6.15.1. Consideration should be given to the provision and extent of on-board first-aid equipment. The

location of any first-aid equipment should be clearly indicated.

6.6.16. Additional Train crew accommodation, working conditions and ergonomics

6.6.16.1. In an emergency, the train crew should have alternative means of egress to the track from the cab. Where a window forms part of an emergency escape route, a suitable means should be provided for opening or breaking it and the method of operation clearly marked.

6.6.16.2. On-track plant may require special consideration for safe access to equipment and controls.

6.6.16.3. The lighting at train crew workstations should remain operational even in the event of failure or temporary cessation of the main source of power. During the latter, a safe but reduced level of illumination may be provided.

6.6.16.4. Heating and ventilation or air-conditioning should maintain conditions in the train crew workstations so that the train crew can perform their duties effectively. The system should take account of the full range of climatic and operating conditions that will foreseeably be experienced.

6.6.16.5. Where air-conditioning is provided, harmful quantities of the refrigerant should not be released inside the train crew areas in the event of a failure.

6.6.16.6. The combined effect of all noise over the period the train crew are operating the train should be at a level where there are no detrimental effects to the train crew or their ability to safely operate the train. Noise levels must comply with the statutory limitations.

6.6.16.7. Attention should be paid to safeguarding train crew from surfaces, which may be hot or become hot in the event of a failure.

6.6.16.8. Adequate facilities should exist for the stowage of standard personal equipment and effects so that they do not interfere with safety.

6.6.16.9. Kitchen and food preparation areas should have facilities that allow staff to undertake their duties safely. They should be easily cleaned to prevent the accumulation of rubbish, waste and fluids.

6.6.16.10. Catering equipment should be positioned, restrained or guarded to minimise the risk of injury to train crew.

6.6.16.11. Where audible warning devices are provided, they should be loud enough to be heard by the train crew under all operational conditions.

6.6.16.12. Adequate and, if necessary, separate sanitation and hygiene facilities should be provided for the train crew.

6.6.16.13. Catering facilities should have adequate provision to retain all waste associated with catering services. Such storage should be easy to clear and clean.

6.7. COMMUNICATIONS

Principle 6.7 Communications

There should be effective means of communicating safety messages to, from and within a train.

6.7.1. General

6.7.1.1. The communication system may comprise a variety of equipment that can vary from direct speech to hard wired, radio or other media and may be controlled manually, by programmable logic or other means.

6.7.1.2. The communication system and its controls, including any associated computer software, should have an adequate level of integrity to render it reliable.

6.7.1.3. Communication systems which may be critical to safety should be protected against failure of the main power source. Other functions should degrade in a controlled and predetermined manner.

6.7.1.4. Radio communications, where used for train control and safety issues, should be adequate to ensure contact at all times. The system should be capable of coping with foreseeable emergencies as well as day-to-day needs. A means of interrupting normal radio traffic in an emergency may be necessary.

6.7.1.5. The provision of a test or self test facility for all communications systems should be considered.

6.7.2. Between Train Crew and Passengers

6.7.2.1. Consideration should be given to providing a means of communication to hearing-impaired passengers through a visual messaging system or similar facility.

6.7.2.2. The [illegible] passenger communication should be signalled clearly to the operator and should in[illegible]rvice at all times throughout the journey. It should be possible for the train crew to identify the source of passenger communication.

6.7.2.3. Communication facilities may need to be enhanced to provide for two way voice communications between the passengers and the train crew or, where appropriate the control centre.

6.7.2.4. Passenger compartments, including toilets, must be fitted with an efficient means of communication between the passengers and the train crew in accordance with the Regulation of Railways Act 1868.

6.7.2.5. Communication devices should be clearly labelled and positioned within easy sight and reach of all passengers. Consideration should also be given to the provision of devices for use by visually- and mobility-impaired passengers.

6.7.2.6. Where public address equipment is installed, it should be provided throughout the passenger accommodation to ensure audibility and convenient use by the train crew.

6.7.2.7. The provision for pre-recorded safety announcements through the public address system should be considered.

6.7.2.8. A public address system, or similar, should be provided to enable the train crew (or, where appropriate, the train control centre) to communicate with passengers. The system should be available during an emergency, and where appropriate, to members of the emergency services.

6.7.2.9. Where automated on-board variable message signs can be used to give safety messages, they should be synchronised to events and readily correctable to overcome inaccurate messages, system failures or interruption. Failures should cause an alarm indication to the train crew or control centre as appropriate. These signs should be visible to all passengers in the main passenger compartments under normal conditions and should be visible under all lighting conditions.

6.7.3. Between Members of the Train Crew

6.7.3.1. Where a fixed communication system is provided, it should be a secure system accessible only to authorised users and can include the use of hand portable transmitter/receivers.

6.7.4. Between the Train and the Control Centre

6.7.4.1. Any communication systems between the train crew and the railway infrastructure control centre should be protected so that they remain operational during an emergency.

6.7.4.2. Driver-only-operated trains which are driven manually, on underground railways or in other circumstances which restrict evacuation, should be fitted with a means of alarm which is transmitted automatically to the railway infrastructure control centre in the event of the train driver becoming incapacitated.

6.7.4.3. Where trains are operated automatically or on driver-only-operated underground railways or in other circumstances which restrict evacuation, the control centre should be able to communicate with the passengers directly.

6.7.4.4. The communication system should remain available over the whole of the proposed route. Where it is not available this should be indicated to the driver and alternative methods shall be employed.

6.8. FIRE SAFETY

Principle 6.8 Fire safety

Trains should be designed for minimum risk of fire, but with adequate emergency egress in case of fire for all foreseeable occupants, including the mobility impaired.

6.8.1. General

6.8.1.1. Passengers should be protected from the effects of fire, heat, smoke and toxic fumes to enable them to evacuate safely. The time required to reach a place of safety should be taken into account.

6.8.1.2. Special attention should be given to trains which operate in tunnels or in other inaccessible locations in the event of fire.

6.8.1.3. The use of automatic detection and release systems in non-passenger areas where there is a higher risk of fire, such as diesel engine and power equipment compartments, should be assessed and implemented if practicable.

6.8.1.4. The use of materials which could give rise to harmful effects on people in the event of a fire should be minimised.

(a) Materials, finishes applied or attached to them and the method of construction used should take account of the overall fire performance including smoke and toxic fume emissions.

(b) Materials should be selected to minimise the risk of fire and explosion within the intended use of the trains concerned. Those trains which are required to operate underground or in other circumstances which restrict evacuation should receive appropriate consideration.

6.8.1.5. Fire safety should be considered in all aspects of design so as to minimise the risk of fire occurring and smoke from it from spreading. The current GM or other relevant fire safety standards for trains provides further guidance on this subject.

6.8.1.6. Where trains operate in tunnels or other inaccessible locations, special measures may be required to protect the vital systems of the train for a sufficient period to enable it to travel to a safe location.

6.8.1.7. The effects of fire or electrical arcing either occurring or being sustained in the vicinity of structural components should be considered. Care should also be taken where substances or equipment, which could provide fire load or ignition sources, are present.

6.8.1.8. Leaks, spillage or other unwanted accumulation should be contained or drained and provision made for easy cleaning throughout.

6.8.1.9. In the event of a fire, the braking, control and other relevant systems should remain operational long enough for the train to travel to a safe position to evacuate its passengers.

6.8.1.10. Power systems should be protected against the possibility of a failure that might give rise to fire. This should include electrical faults, loss of lubrication or coolant etc. Where fire suppressants or extinguishants are used, care should be taken that on release, inadvertently or otherwise, they do not give rise to risks to people.

6.8.1.11. The train crew should have a suitable alarm alerting them of the operation of automatic fire detection or suppression equipment where fitted. Faults and defects should be similarly indicated.

6.8.1.12. Air-conditioning and other ventilation systems should be capable of being shut off and isolated in the event of fire, smoke or fume detection to protect people or contain the fire. Consideration should be given to the provision of heat activated vents in the roof-space, to remove smoke in the event of a fire.

6.8.1.13. Hiding places suitable for incendiary and similar devices should be minimised or controlled to deter vandalism or other malicious acts.

6.8.1.14. Controls, equipment and isolation devices available for the use of the emergency services are to be readily accessible and clearly indicated.

6.8.2. Fire Load

6.8.2.1. Factors to be taken into account when considering fire load are:

(a) using materials for internal fixtures, fittings, furniture and decorations which minimise the spread and effects of fire;

(b) siting and securing fuel tanks to minimise the risk of fire and spillage in both normal and accident situations;

(c) selecting, containing and monitoring fuel, lubricants, hydraulic oils and coolants including transformer oils etc to minimise harmful effects, including the effects of fire;

(d) selecting litter bins and ash trays which minimise and contain the effects of fire should a lit cigarette or similar hot item be placed in them;

(e) designing interiors, underskirts and ventilation ducts that are easy to clean and minimise the accumulations of combustible materials; and

(f) luggage stowage arrangements.

6.8.3. Fire Barriers

6.8.3.1. Fire barriers may be required to prevent fire and smoke spreading externally and/or internally along the vehicle or from one vehicle to another. They should resist the effects of fire and heat for long enough to enable people to evacuate safely.

6.8.3.2. Where internal doors are designed to operate as fire doors, they should be self-closing and people should be able to open them easily. Interconnecting door sets between carriages should be designed to resist and retard the spread of fire and smoke.

6.8.4. Ignition Sources

6.8.4.1. All electrical circuits should be fused or otherwise protected to avoid damage from overheating and arcing.

6.8.4.2. Equipment or other items with the potential to provide hot surfaces in normal operation, failure or which could foreseeably fail catastrophically, should be sited, shielded or otherwise protected to minimise the risk of fire.

6.8.4.3. The heat source for cookers, heaters etc should not present an unreasonable risk of fire, explosion etc. There should be no unprotected flames. Steam boilers and steam receivers should be equipped and regularly examined in accordance with good industrial practice, (i.e Factories Act 1955 and Safety in Industry Act 1981).

6.8.5. Fire Detection and Alarms

6.8.5.1. Where appropriate there should be:

(a) a means of fire detection within passenger areas and sleeping accommodation;

(b) audible warnings which are loud enough to alert passengers, including those who are asleep;

(c) alternative warnings for passengers who have impaired hearing;

(d) a means to alert the train crew of the whereabouts of the fire;

(e) consideration given to interactions between fire safety systems and heating and ventilating systems in the event of a fire;

(f) system back up controls, manual releases etc;

(g) indication of faults and defects in the fire detection and alarm system to the train crew.

6.8.6. Fire Extinguishers

6.8.6.1. Fire extinguishers of an appropriate and approved type should be readily available in passenger and train crew compartments, including the driving cab.

6.8.6.2. They should carry clear operating instructions, including pictograms.

6.8.6.3. Automatic release systems should only be fitted in accommodation areas as a last resort and

only then after prior discussion with the RSC.

6.8.6.4. Automatic release systems should be considered for non-accommodation areas and their possible effect on people who may be present or are located nearby should be taken into account.

6.8.7. Fuel Tanks

6.8.7.1. The size and capacity of fuel tanks should be kept to a minimum.

6.8.7.2. Fuel tanks should be positioned away from the front of vehicles and behind the leading bogie, they should also be located away from exposed and vulnerable locations.

6.8.7.3. Fuel tanks should be fitted with internal flexible liners or honeycomb construction baffles.

6.8.7.4. Consideration should be given to the most suitable material available at the time when designing fuel tanks.

6.9. COMPATIBILITY

Principle 6.9 Compatibility

Trains should be compatible with the infrastructure they will operate on, especially regarding clearances, signalling systems and electric traction systems.

6.9.1. General Requirements for Compatibility

6.9.1.1. The design of trains should take into account the need for compatibility, the following four sections detail the areas that should be considered:

6.9.2. Compatibility with the Environment

6.9.2.1. Trains and individual railway vehicles should be compatible with the environment to minimise their impact on those who live, work or have a need to be near to the railway.

6.9.2.2. Trains should be capable of performing their intended function in safety and without endangering the safety of other aspects of the railway (such as the infrastructure, signalling and electric traction system), or other people and property adjacent to the railway.

6.9.2.3. The needs of those who have to work on or near to the tracks should be taken into account to minimise the risks imposed by trains.

6.9.2.4. The needs of people who work on or with trains at maintenance depots, marshalling yards and sidings or as train crew should be taken into account to minimise the risks in their working environment.

6.9.2.5. Equipment and/or systems should not affect populated areas by emitting odours, fumes or smoke which has a detrimental effect, either to health or well-being.

6.9.2.6. Where [illegible] substances are [illegible] be [illegible]ed t[illegible]ould [illegible]mean [illegible]preven[illegible] inh[illegible]tin[illegible]hem[illegible]on entering th[illegible] areas [illegible]he[illegible] people [illegible]e likely to [illegible]e pres[illegible]nt.

6.9.2.7. Exhaust emissions should be controlled so as [illegible] to give rise t[illegible] enviro[illegible]nmentally unacceptable levels of pollution [illegible]or unacceptable [illegible]accu[illegible]tional h[illegible]alth risks.

6.9.2.8. Where harmful substances are concerned, these should be contained or minimised.

6.9.2.9. The release of harmful or hazardous substances should be undertaken in a controlled manner at designated locations.

6.9.2.10. Noise and vibration emissions from trains should be considered with a view to minimising the effect on the environment adjacent to the railway. Infrastructure measures may also be necessary in this respect. The relevant environmental regulations should be complied with.

6.9.2.11. No material should be used on trains in a form which is injurious to health and to which people could be exposed without protection. Effects on the environment should also be considered.

6.9.2.12. Special consideration should be given to any changes in the properties of materials over time and the possible conditions which a material may experience throughout its life or the life of the train. Eventual material disposal should be addressed at the design stage.

6.9.2.13. People should be warned of the possible danger from the effects of any hazardous materials during maintenance or refurbishment processes.

6.9.2.14. Train ends should remain conspicuous at all times. Front and rear ends should be identified separately. This may be achieved by suitable headlamps, tail lamps or other lamps (e.g. flashing lamps) and paint or body finish treatments. The use of integral tail lamps should be considered.

6.9.2.15. Audible warning devices should be available for drivers to signal the approach of their trains. The sound should be appropriate to warn of the approach of the train to those that need to know while not causing undue annoyance to others. It should not cause injury to anyone in close proximity.

6.9.2.16. Signs giving clear and concise warning of the hazards of equipment located behind panels, guards or other points of access should be provided at appropriate places.

6.9.2.17. The provision of warning signs should be such that they are visible at all times when required and do not degrade during their operating life.

6.9.2.18. When considering access requirements, the need to gain access from ground level should be taken into account.

6.9.2.19. Electrically live, or potentially live, surfaces, connections etc must be guarded or positioned to prevent direct access or accidental contact in accordance with the Safety, Health and Welfare at Work (General Applications) Regulations, 1993. Access steps, ladders, platforms and raised surfaces should be protected and signed to warn against the dangers of overhead line equipment.

6.9.2.20. Means of isolating and, where necessary for personal safety, earthing of electrical equipment should be provided.

6.9.2.21. Rotating or other moving parts should be guarded where necessary to ensure the safety of staff who are required to work in the vicinity.

6.9.2.22. Couplings and inter-vehicle connections should be safe and convenient for those staff who have to deal with them. The use of automatic coupling may be appropriate to minimise any risk during coupling operations.

6.9.2.23. Equipment and systems should be accessible for inspection, maintenance and repair without strain to the people involved. Any danger to people caused by crushing, lifting heavy items etc should be avoided.

6.9.2.24. Special tooling, equipment, operating procedures etc required for maintaining and/or repairing the trains should be available before new trains are put in service.

6.9.2.25. The arrangements for the disposal of toilet waste should not be detrimental to the health and safety of [illegible].

6.9.2.26. All lifting points for vehicle bodies and bogies etc should be clearly marked to facilitate maintenance and recovery operations and to minimise danger to staff.

6.9.3. Compatibility with the infrastructure

6.9.3.1. For the safety clearances with the infrastructure see section 1, Permanent way, earthworks and structures.

6.9.3.2. The train should be compatible with the size allowed by the infrastructure including allowances for safety clearances under static or dynamic conditions.

6.9.3.3. Any failure of the vehicle suspension should not result in a gauge infringement or otherwise cause danger. The suspension system should be designed to avoid vertical or horizontal forces likely to cause disengagement from the guidance system under any operating conditions. The vehicle suspension should be compatible with the track geometry and vehicle speed.

6.9.3.4. The train guidance system should guide the train safely taking into account the track geometry in normal and degraded conditions and the crossover arrangements.

6.9.3.5. Equipment, which if detached or loose, would have the potential to derail the train or damage trackside safety-related equipment, should be securely attached. Redundancy in attachment or secondary security may be appropriate. It should not be possible for external parts to become detached or swing free owing to the failure of a single component.

6.9.3.6. The dimensions and properties of the wheel set should be suitable for the operating duties required by the infrastructure, e.g. track circuits, treadle operation etc.

6.9.3.7. The wheel forces and interactions generated by the trains should be compatible with the infrastructure. Static loads and unsprung masses should be compatible with the infrastructure.

6.9.3.8. Trains should be compatible with lineside detectors, e.g. hot axle box detection, automatic power control, signalling and other transponder equipment over the route. Where this is not appropriate, self-contained on-board systems may be used.

6.9.3.9. Consideration should be given to the use of Global Positioning System (GPS) for providing supplementary information on the position of the train to the controller and train driver.

6.9.3.10. There should be external identification on each vehicle defining the operating weights.

6.9.3.11. Consideration should be given to platform interfaces, see section 6.5.1.4.

6.9.4. Compatibility with Signalling Equipment

6.9.4.1. Trains and individual vehicles should be compatible with the signalling and the train detection system. All signalling inter-compatibility between trains and trackside that have safety implications should be defined and agreed between the train operator and the infrastructure controller.

6.9.4.2. The train braking performance should be compatible with the braking distances required by the signalling system. The conditions for degraded mode operation of trains that might influence its braking performance should be clearly defined and where necessary agreed between the train operator and the infrastructure controller.

6.9.4.3. Allowance should be made for deterioration in performance between scheduled maintenance intervals.

6.9.4.4. The acceleration and deceleration rates of any train should be compatible with the signalling system. Foreseeable failures should be assessed and any additional systems, equipment or features necessary for safe degraded operation should be provided.

6.9.4.5. The vehicle dimensions should be compatible with any track circuit or other signalling sectioning. For example:

(a) the dimension from the signal detection point (typically the wheels) to either end of the train (i.e. the nose or tail overhang) should not be large enough to create hazards by providing an inadequate clearance. Calculating the dimension should allow for the possibility that a single axle or a short wheel-base bogie may not be detected owing to the stagger of insulated rail joints on [illegible] track circuits;

(b) the distance between signal detection points on the train should not exceed the minimum track signalling section length, i.e. the wheelbase of vehicles should not span two signalling sections;

(c) the combination of speed and wheel base for any vehicle capable of independent movement should not enable the vehicle to traverse a short track section in less time than the train detection mechanism requires to detect its presence.

6.9.4.6. Where a train is required to operate on more than one signalling system, transition between system should be automated/semi-automated.

6.9.4.7. Train detection

(a) Wheel and flange dimensions should be compatible with train detection devices such as treadles and axle counters.

(b) Brake friction materials should not contaminate the wheels or rails so as to affect train detection adversely. Where sand is used, its effect in this respect should be taken into account.

(c) Built-up or composite wheel sets should provide for redundancy of connection bonds where these are required for track circuit operation and or traction return current.

(d) The use of train based wheel flange lubrication should be considered where the train could operate through sufficiently tight curves. The risk caused by excess lubrication should be considered.

6.9.4.8. On-board equipment should be fully compatible with the infrastructure systems and equipment. On-board systems should be self-checking and provide a warning if a fault is detected. They should be designed to ‘fail-safe’ criteria and not present false signalling information to the train driver. They should not prevent the driver taking control in the event of a fault, subject to any appropriate restrictions.

6.9.4.9. Electromagnetic interference generated by the train equipment and systems should be controlled so as not to adversely affect the safety of railway signalling equipment. Where it is not reasonably practicable to completely eliminate such interference, a means of detecting fault

levels may be necessary to enable the risk to be contained within suitable parameters.

6.9.4.10. On-board emergency signalling equipment items, e.g. track circuit operating device, detonators, fog signals, lamps, flags etc should be securely stowed to prevent unauthorised use but be readily accessible when required.

6.9.5. European Rail Traffic Management System (ERTMS)

6.9.5.1. The guidance in this section applies to ERTMS and includes for transmission of information between the trackside and signalling system and the train, and the interfacing of the train-borne equipment with the train driver and the train braking system.

Note : ERTMS is under development at the time of writing this guidance and therefore the information provided should be read in conjunction with current ERTMS requirements (i.e. at the time of applying the guidance).

6.9.5.2. Signaller control interface, the signalling interlocking and trackside elements are outside the scope of the ERTMS other than balises.

6.9.5.3. All levels of ERTMS provide ATP functionality by continuous supervision of the train speed on board the train.

Level 1

6.9.5.4. Use of this method provides an ATP system which interfaces to the electronic signalling interlocking and transmits to the train by the use of balises mounted between the rails. The train uses the position data along with the aspect of the signal ahead that it receives to output to the driver the correct linespeed. This requires safety integrity information to be held on board the train.

6.9.5.5. Level 1 is an overlay to lineside signalling and can be used for mixed traffic and mixed working of lineside and in cab signalling. The detection of train position and the proving of train integrity is by conventional means (e.g. Track circuits).

6.9.5.6. Level 1 performance may be improved by introducing in-fill loops or balises to improve the performance of the train service by communicating the signalling status at an earlier opportunity than lineside signalling can achieve.

Level 2

6.9.5.7. While still utilising the equipment in place for Level 1, Level 2 improves performance by the used of Radio (GSM-R) to transmit information to the train for display in cab whilst still utilising the fixed block working and the train detection system of the signalling interlocking.

6.9.5.8. Level 2 is an overlay to lineside signalling when it is used for mixed traffic and mixed working of lineside and in cab signalling. The detection of train position and the proving of train integrity is by conventional means (e.g. Track circuits). Movement authority can be provided for ERTMS fitted trains via Radio.

6.9.5.9. The use of radio transmission of control at Level 2 allows for the removal of lineside signals where all traffic is ERTMS fitted.

Level 3

6.9.5.10. The trainborne systems provides train integrity, and detection of position. Transmission is primarily by the GSM-R radio system.

6.9.5.11. Movement authority is conveyed to the driver via a cab display and there is no requirement for lineside signals.

6.9.5.12. The use of balises and on board integrity for train positioning at level 3 allows for the removal of train detection systems such as track circuits and axle counters.

6.9.6. Compatibility with Electric Traction Equipment

6.9.6.1. All trains using an electrified route, including non-electric traction vehicles, should be compatible

with the electric traction supply system so as to prevent danger.

6.9.6.2. Power cables should be adequately supported and positioned so that their insulation is protected from excessive wear and tear, and retains its integrity for its design life. Electrical terminations should be designed to operate in a traction environment and should resist vibration.

6.9.6.3. No on-board electrical system or equipment should present a hazard to people in event of water ingress or the train entering a flood.

6.9.6.4. The train should be protected from arcs or earth faults generated between an electrical power source and the train collector systems to prevent damage. The protection must guard against arcs propagating to the passenger-carrying structure or other part of the train and causing harm to people. Refer to the Safety, Health and Welfare at Work (General Applications) Regulations, 1993.

6.9.6.5. Suitable earth path bonding commensurate with the electric traction supply and its foreseeable failure modes must be provided including adequate redundancy. Refer to the Safety, Health and Welfare at Work (General Applications) Regulations, 1993.

6.9.6.6. When train traction current collector systems are retracted or not in use, such equipment should be held securely to prevent contact with the overhead traction current supply.

6.9.6.7. Where the train traction current collector systems can be retracted, either automatically or remotely, consideration should be given to the detection and indication of their position.

6.9.6.8. Where electric trains are able to operate on more than one electric traction supply system there should be an effective means to control the risk of incorrect connection to a supply that would give rise to danger. Where transition between supply systems is necessary this should be automated/semi-automated.

6.9.6.9. The electrical clearances between vehicles and electrical conductors and the railway infrastructure should not be less than those set out in section 3, Electric traction systems. Allowance should be made for the dynamic movement of the train and the conductors.

6.9.6.10. Details of the clearances between the train collector system and any part of the infrastructure are set out in section 3, Electric traction systems.

6.9.6.11. The train traction current collector systems and other live equipment must not be readily accessible to people on station platforms or from over bridges. Refer to the Safety, Health and Welfare at Work (General Applications) Regulations, 1993.

6.9.6.12. Electrical equipment on trains should not cause electrical interference which is known to be harmful to people, other railway systems and systems adjacent to the railway.

6.9.6.13. Regenerative braking should be compatible with the infrastructure and in particular the electric traction system and signalling.

6.10. DRIVER INTERFACE

Principle 6.10 Driver Interface

The driver's cab and environment should be sufficient to allow the safe operation of the train over its intended routes and type of service.

6.10.1. General

6.10.1.1. The train driver's seating should be fully adjustable to allow a driver to adopt a satisfactory position in relation to the controls and view of the signals (whether lineside or on board) at all times and for all conditions.

6.10.1.2. Human factors should be considered in all areas that require human interaction for normal and degraded modes of operation.

6.10.1.3. Sufficient space should be available in the cab to ensure that the train crew can operate the train safely when there is a need for other personnel to be present.

6.10.1.4. Adequate facilities should exist for the stowage of standard equipment and personal effects so that they do not interfere with safety.

6.10.1.5. Visibility from the cab should provide a suitable view of any lineside signals, or markers, speed restriction signs etc. and railway infrastructure both day and night. Such visibility should take into account the range of operating and adverse weather conditions that the train is expected to experience and may require the use of appropriately mounted headlamps.

6.10.1.6. The train driver should be protected to minimise (sun) glare.

6.10.1.7. The combined effect of all noise over the period the train crew are operating the train should be at a level where there are no detrimental effects to the train crew or their ability to safely operate the train. Noise levels must comply with the statutory limitations.

6.10.1.8. The lighting in train crew workstations should maintain operational effectiveness in the event of failure, including impact, temporary cessation of the main source of power. During the latter, a safe but reduced level of illumination may be provided.

6.10.1.9. Flashing lights and lights that could give rise to a stroboscopic effect should be avoided where this could cause stress to train crew.

6.10.1.10. The railway infrastructure both forward and to the side of the train should be visible. This may require the use of a screen wash/wipe system, mirrors or on-board closed-circuit television (CCTV). The need to observe other trackside equipment should be taken into account.

6.10.2. Heating and ventilation

6.10.2.1. Heating and ventilation or air-conditioning should maintain conditions in the train crew workstations so that the train crew can perform their duties effectively. The system should take account of the full range of climatic and operating conditions that will foreseeably be experienced.

6.10.2.2. Where air-conditioning is provided, harmful quantities of the refrigerant should not be released inside the train crew areas in the event of a failure.

6.10.2.3. Attention should be paid to safeguarding train crew from surfaces, which may be hot or become hot in the event of a failure.

6.10.3. Operation

6.10.3.1. Where necessary for safety, train crew doors and windows should be proved closed before the train can operate.

6.10.3.2. Where facilities exist to override any safety system, they should not be readily accessible under normal operations. These facilities should only be available under a sealed release system. When override facilities are in use, there should be clear visible warning that this is the case. Appropriate functional limitation may be required to ensure safety is maintained.

6.10.3.3. Where appropriate, controls should be interlocked to prevent damage or danger.

6.10.3.4. Controls that may need to be operated to prevent or minimise danger, should not be locked in the potentially unsafe position.

6.10.3.5. Controls should be positioned so that train crew are unlikely to move them accidentally to an unsafe position.

6.10.3.6. Controls or devices for isolating on-board signalling equipment, which should not be operable without the driver's knowledge, should be suitably sealed and/or alarmed or otherwise controlled to ensure safety.

6.10.4. Compatibility

6.10.4.1. Where vehicles are intended to couple, controls and their method of operation should be compatible with existing trains and vice versa.

6.10.5. Security

6.10.5.1. The driving cab should be secure and prevent unauthorised access by passengers.

6.10.5.2. Where appropriate, there should be some means of guarding the controls of safety-related equipment against unauthorised or inadvertent access, operation or action.

6.10.6. Instrumentation, Indication and Controls

6.10.6.1. Key indications and controls, including those identified below, should be visible under all lighting conditions. Consideration to sun-glare should also be given.

6.10.6.2. Instrumentation or indication should be provided to show at least the following, as applicable:

(a) train speed;

(b) brake system integrity;

(c) status/position of external doors;

(d) status of safety systems;

(e) status/integrity of essential lights;

(f) status of line power;

(g) status of traction power;

6.10.6.3. Controls, alarms, etc which have an influence on safety should be:

(a) readily accessible to the driver or crew member;

(b) easily identifiable;

(c) easily operated; and

(d) easily heard or within the normal field of vision, as appropriate.

6.10.6.4. The above guidance should also apply to controls provided on automatically operated trains to allow them to be driven in non-automatic mode. It may be necessary to duplicate certain controls at alternative positions.

6.10.6.5. The activation of equipment should require the minimum effort appropriate to its function. Controls should be ergonomically sited and operable, according to the duty and the method of operation.

6.10.6.6. The siting and operation of any item of control equipment should not require or cause staff to endanger themselves or others.

6.10.6.7. Any safety-related equipment should indicate clearly by sight the position of its controls or state. Where appropriate, such indication should be present within the cab.

6.10.6.8. Controls and instruments should be visible and function correctly at all times including temporary interruptions or failure of the main power source.

6.10.6.9. Audible warnings should be effective under all operating conditions.

6.10.6.10. Controls and indications should be distinguishable to minimise the risk of confusion, consideration should be given to colour, labelling and position.

6.10.6.11. Surfaces around controls should be designed to discourage objects being placed on them.

6.10.6.12. Consideration should be given to the use of a system to automatically select head, marker and tail lights or remind the driver to do so.

6.10.7. Traction control systems

6.10.7.1. A train should not be able to start without the operative(s) at their correct stations, e.g. it should not be possible during automatic train operation (ATO) for an operative to issue commands to the control system and then vacate the cab.

6.10.7.2. The risk that the traction power will be applied when not demanded by the train driver or automatic driving control, or will fail to shut off when so demanded should be minimised.

6.10.7.3. The risk that the train will operate in the opposite direction to that selected by the train driver should be minimised.

6.10.8. On Train Monitoring and Recording Systems

6.10.8.1. Trains should be provided with a data recorder to continuously gather vital operational data so that the information is available in the event of an incident or accident. It should be enclosed in a sealed and tamper resistant case.

6.10.8.2. Remote or local download data facilities on the data recorder should not cause any loss of the original data.

6.10.8.3. Consideration should be given to recording the following, as applicable:

(a) the speed of the train;

(b) the direction of travel selected;

(c) the location of the train (if available);

(d) the power controller position and power equipment response;

(e) the brake controller position and brake equipment response;

(f) the Continuous Automatic Warning System (CAWS) and ATP operation/signal output, if present;

(g) the Drivers Safety Device operation;

(h) the vigilance equipment operation;

(i) the isolation of safety systems;

(j) the status of headlights;

(k) the status of line power;

6.10.8.4. The above list is not exhaustive and consideration should be given to recording other signals which will also aid any investigation and the assessment of driver competence.

6.10.8.5. All data should be date and time stamped. The data should be recorded over a period of time, dependant upon the operational needs of the organisation recording it. The final period of data recorded should be capable of indefinite retention.

6.11. ON-TRACK MACHINES

Principle 6.11 On-track machines

On-track machines which may run on the operational railway should be compatible with the standards of other rolling stock and the infrastructure.

6.11.1. Types of On-Track Machine

6.11.1.1. On-track machines includes a wide range of specialist equipment used in the maintenance and renewal of infrastructure and includes:

(a) equipment that may be fitted with flanged wheels and able to run on the track within an engineers possession of a section of line;

(b) rail mounted equipment some of which may be capable of operating within the engineers possession under its own power but is transported to and from the site of work as an unpowered vehicle;

(c) rail mounted equipment that can travel under its own power on lines open to other traffic.

Note 1: On-track machines which come under the above type (a), such as rubber tyred excavators and small cranes which have been adapted by the addition of retractable flanged wheels, are to be compatible with the infrastructure within which they are working.

Note 2: On-track machines which can travel either under their own power or hauled as part of a train, types (b) and (c) above, require in so far as is appropriate to be designed to be compatible with other trains using the railway network.

6.11.2. Operation Outside Engineers Possession

6.11.2.1. On-track machines [illegible] for moving outside engineers possession of the line should meet the following requirements:

(a) Not exceed the permitted swept envelope for the lines over which it is authorised to travel;

(b) Have all moveable equipment which can exceed that swept envelope secured so as to prevent movement;

(c) For vehicles which may be hauled as part of the train have buffing and coupling systems compatible with the standard in use on that railway;

(d) Have longitudinal end strengths compatible with other trains using the line;

(e) Have a braking capacity compatible with the requirements of the gradients of the line and the signalling system in use.

6.11.2.2. On-track machines which are capable of moving under their own power, 6.11.1.1 (c), should in addition to 6.11.2.1 also meet the following requirements:

(a) Have driving positions which meet the requirements for visibility in use on that railway;

(b) Have driving cabs and other compartments where staff may travel which provide an appropriate level of protection for the staff;

(c) Have signalling and train protection systems fitted which are compatible with the systems in use on the lines over which it is authorised to travel.

(d) Should have appropriate train crew facilities. On-board machinery should be securely fenced, guarded and controlled so as not to present hazards to those who have to operate it.