SECTION 12

PASSENGER CARS

ROA MANUAL

SCHEDULE OF AMENDMENTS

SECTION 12

AMENDMENT NUMBER	PAGES AMENDED	AMENDMENT SUMMARY	DATE ISSUED

Portions of this Section of the ROA Manual highlighted by red text are superseded by the following RISSB Australian Standard:

- AS 7531 Railway rolling stock - Lighting and rolling stock visibility

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12.1 SCOPE

12.1.1 This section specifies the minimum standards for the structural design, construction, fixtures, fittings, systems and passenger comfort for locomotive hauled passenger vehicles in intersystem service which are normally required to be compatible and interchangeable with existing rolling stock.

12.1.2 Requirements for multiple-unit car sets with one or more self-contained propulsion units, self-propelled vehicles, electrically driven vehicles, etc. are not included. These vehicles are not generally used in those intersystem operations where interchangeability and physical compatibility with existing vehicles is an essential requirement. The wide variety of inter-vehicle coupling systems (mechanical, electrical and pneumatic), propulsion, control, braking and suspension systems currently in existence and which may become available for future construction precludes the specification of mandatory standards for these types of vehicles. Systems are thus provided with flexibility in the design of non-locomotive-hauled passenger vehicles to ensure optimum performance and cost efficiency to suit route-specific requirements, but shall use the minimum standards of construction, safety and passenger facilities embodied in this section, where applicable, as the reference basis for the design of all inter-urban and intersystem passenger vehicles.

12.1.3 Mandatory requirements within sub-sections are indicated by bold italic type. In addition to those shown in that format, sub-sections 12.9, 12.10, 12.11 and 12.13 are mandatory in their entirety as noted at the beginning of each such sub-section; the remainder are minimum recommended standards and practices. In order not to restrict vehicle development and the provision of enhanced passenger facilities, nothing in this section precludes the use or introduction of methods, materials or technology which differ from those specified herein, provided that the minimum standards of strength, safety and passenger comfort and facilities are maintained or exceeded.

12.2 PASSENGER CAR GENERAL PRINCIPLES AND FUNDAMENTALS

This section applies to locomotive-hauled vehicles intended for human occupation during transit and includes all those vehicles which provide seating and/or sleeping accommodation.

12.2.1 GENERAL CONSTRUCTION

All passenger carrying vehicles intended for intersystem use shall conform to the limiting Unrestricted Maximum Rolling Stock Outline as shown on diagram 18-1.

The roof shall be of elliptical or similar shaped profile.

Compartments such as toilets, showers and entrance-exit vestibules shall preferrably be located at or near the ends of the car.

All passenger vehicles shall be fitted with lifting points located in the vicinity of the bogie centres. The lifting points shall be suitably reinforced and permit the application of both jacks and lifting frames used with overhead cranes.

12.2.2 DESIGN LOADS AND STRESSES

12.2.2.1 The structure of passenger vehicles shall be capable of sustaining repetitive longitudinal coupler forces of five (5) times the vehicle mass i.e. 5g, without fatigue damage occurring to the vehicle or the coupler. When loaded to its nominal capacity the structure of the vehicle shall be capable of withstanding the following forces applied through the centre-line of the coupler without exceeding the maximum stresses for the material as specified hereunder:

Force-kN	*Max. Stress*	*Force type*
3500	*Ultimate*	*High impact*
2000	*Yield*	*Impact*
+1000 *-1000*	*Larger of 1/2 yield* *or 1/3 ultimate*	*Steady force*

The steady force used in the above stress calculations shall not be less than the maximum combined tractive effort of the number of power units expected to be used for hauling the vehicle(s).

Vehicles shall be marshalled in trains so that the trailing load on any vehicle does not exceed the rated capacity of that vehicle's draft gear.

12.2.2.2 The underframe shall be designed to act in conjunction with the body structure in resisting the forces listed above.
Vertical anti-collision members shall be provided at each end of the vehicle. These members shall withstand, without permanent deformation, a longitudinal force of 540 kN applied at a point 1650 mm above rail level combined with a lateral force of 90 kN applied to diagonally opposite corners at the same height.
The longitudinal force applied to the ends of the vehicle shall be considered to be proportionately distributed to all longitudinal members according to area.
Walls, partitions, fixtures and other interior and exterior fittings shall be designed and attached so as to withstand accelerations of 3 g laterally, 5 g longitudinally and 3 g vertically without failure of the component or fastenings, and shall be able to similarly withstand track-induced vibrations within the limits specified in 12.10.

12.2.3 COUPLER AND DRAFT GEAR

12.2.3.1 Couplers for intersystem vehicles required to be compatible with existing rolling-stock shall be of the slack-controlled type, having the AAR No. 10A contour and with bottom operated uncoupling mechanism. Couplers for other types of passenger vehicles may be of any slackless or minimum slack type approved by the operating rail System(s).

12.2.3.2 ***The uncoupling mechanism shall be a rotating handle type located on the left hand side as seen when facing the end of the vehicle. The mechanism shall be capable of lateral movement to accommodate angling of the couplers in service.***
The handle shall be located as near as is practicable to the outside of the vehicle and constructed so that rotation away from the vehicle and upwards releases the coupler knuckle. Provision shall also be made on the coupler release mechanism for a device which prevents the accidental or unauthorised operation of the release mechanism and ensures that the knuckle locking block is fully engaged.

12.2.3.3 ***The draft gear unit shall fit the standard AAR pocket dimensions of 620 mm long x 330 mm wide x 232 mm high. It shall not include friction systems for energy absorption, and shall have a minimum rated travel of 64 mm in both buff and draft.***
When fitted into the standard pocket the unit shall have a preload of 50 kN +/- 5 kN.
The reaction force at the rated travel shall be a minimum of 1000 kN.

12.2.3.4 ***For vehicles with helical steel springs in the bogie suspension, the centre line of the coupler shall be 890 mm to 900 mm above rail level with the vehicle in the new and unloaded condition when issued from a workshop. The minimum height above rail in service shall be 870 mm. For vehicles with air-spring bogie suspension the nominal coupler height when issued from a workshop shall be 885 mm.***

12.2.4 GANGWAY BEAMS

12.2.4.1 ***The lower horizontal contact surface of gangway beams for passenger vehicles shall have a minimum length of 1500 mm and a minimum vertical depth of 150 mm.***

The height of the top of this contact surface shall be 1300 mm above rail level when the vehicle is in the new tare condition.

The longitudinal force exerted by the gangway beam shall be between 16 kN and 18 kN in the coupled position.

The displacement of the gangway beam from the free to coupled position shall be at least 75 mm, and provision shall be made for an additional 65 mm displacement at the vehicle centre-line in service. The beam support mechanism shall be able to accommodate the angling of the beam experienced when negotiating the minimum curve specified below while coupled to a similar vehicle.

Adjoining beams in contact shall be free to move laterally relative to each other when the vehicles negotiate a curve of 90 m radius. There shall be no restrictions on relative vertical movement between beams on adjacent vehicles.
The contact surface of the beam shall be of a low friction self-lubricating material.

12.2.5 VESTIBULE DIAPHRAGM PLATES

12.2.5.1 ***The vestibule diaphragmplates shall have a nominal clear lateral opening of 1000 mm and a nominal width over the extremities of 1280 mm.***

12.2.5.2 ***The top surface of the vestibule plate shall have a centrally located contact area.The contact plate shall be of a low friction self-lubricating material and shall be free to move vertically and laterally relative to the adjacent plate when coupled in order to accommodate the movements resulting from coupled vehicles negotiating a curve of 90 m radius and transit over normal track.***

12.2.5.3 ***The top surface contact plate shall have a vertical depth of 150 mm between the heights of 3400 mm and 3550 mm above rail level in the new, tare condition.***
The minimum width of the top contact plate shall be 760 mm.

12.2.5.4 ***The force exerted by the top contact plate shall be within the range of 2 kN to 3 kN in the coupled position.***

12.2.5.5 ***The gangway beam and vestibule floor plate shall be capable of supporting an additional load of 200 kg without damage or interference to its normal operation.***

12.2.5.6 ***The vestibule plate shall be joined to the vehicle by a waterproof flexible concertina or curtain which totally encloses the access-way between adjacent vehicles.***
The floor (walking surface) between adjacent vehicles shall be so covered that ballast, dust and similar contaminants cannot enter the vestibule while the vehicle is in motion.
The vertical sides of the vestibule plates shall have when coupled a horizontal gap of not more than 5 mm under all conditions of operation.

12.2.5.7 ***The vestibule concertina and frame shall be so constructed and secured that no person may alight, either intentionally or accidentally, via the vestibule while vehicles are coupled.***

12.2.5.8 ***Changes in floor level shall have rounded edges on the protruding surface with a radius equal to half the depth of the floor surface material or 5 mm whichever is the lesser. There shall be no holes or slots deeper than 5 mm or wider than 100 mm in the floor surface in the vestibule or any other walkway area.***

12.2.6 EXTERNAL DOORS

12.2.6.1 Access to the interior shall be provided by doors on both sides of a vehicle. These doors shall also provide direct access from the interior to the exterior. They shall be located no more than 8 m from the end of the vehicle.

Exterior side doors shall not be directly opposite internal compartments.
Exterior doors shall have a minimum clear opening of 1800 mm high x 500 mm wide.

Vehicles specifically intended for use by disabled passengers shall have the doors designed to comply with Section 12.12.

Provision shall be made to prevent unauthorised or accidental opening of external doors in transit.

12.2.7 EVACUATION DOORS

12.2.7.1 Open plan vehicles, vehicles with enclosed compartments and compartments located at or across the end of a vehicle shall be provided with at least one door or passageway which permits easy access to the adjacent vehicle in the case of danger or an emergency. This door shall have sufficient clear glazing to permit persons to determine whether the area through the door is clear. This door shall be capable of being easily opened at all times.

12.2.7.2 Furniture, fittings or goods shall not obstruct the evacuation doors. The evacuation route shall be easily accessible to all persons in the vehicle.

12.2.7.3. The doors shall have a minimum clear opening of 1700 mm high and 430 mm wide.

12.2.7.4 No door in an evacuation route shall be locked or otherwise prevented from opening.

12.2.8 COMPARTMENT DOORS

12.2.8.1 Compartment doors shall have a minimum clear opening of 1750 mm high and 500 mm wide.

12.2.8.2 Doors to passenger, toilet and bathroom compartments shall be lockable from the inside. The lock shall incorporate a device to indicate to persons on the outside whether the the compartment is in use or vacant, and be so designed that a conductor or other authorised employee can open the door from the external side when it is locked from the internal side.

12.2.8.3 Compartment doors shall not open outwards, but provision shall be made for the door to be opened outwards in an emergency either by removing the hinges with a screwdriver or by some other suitable means.
Compartment door hinges shall be guarded or recessed to prevent passengers' fingers becoming trapped in the gap on the hinge side.

12.2.9 DOOR CLOSERS

12.2.9.1 Where fitted, hydraulic, pneumatic, spring-loaded or mechanical door closing mechanisms shall be capable of maintaining doors in the closed position while the vehicle is subject to forces normally experienced in transit.

12.2.10 PASSAGE WAYS

12.2.10.1 Passage ways (corridors) shall have a mimimum clear height of 2000 mm and a minimum clear width of 500 mm. Passage ways intended specifically for disabled passengers shall be designed to comply with Section 12.12.

12.2.11 SLEEPING COMPARTMENTS

12.2.11.1 Sleeping compartments shall incorporate provision for both seating and sleeping accommodation, which may be combined and convertible from one form to the other. Where applicable, the compartments may also include individual self-contained toilet units and shower compartments where space and vehicle design permits.

12.2.11.2 Sleeping berths may be positioned either longitudinally or laterally to suit the vehicle and compartment design. The minimum size of the berth mattress shall be 1900 mm long and 500 mm wide. There shall be not less than 660 mm vertical clearance above any berth.

12.2.11.3 Ladders shall be provided for access into upper berths in those compartments where two berths are located one above the other. The ladder steps shall be at least 300 mm wide and 100 mm deep with a vertical spacing of 150 mm to 200 mm. The distance from the floor to the first step shall be equal to the vertical distance between subsequent steps. Steps shall not overlap when viewed from above in the operating position. Ladder step treads shall have a dynamic coefficient of friction of 0.4 with any shoe sole material, bare skin, or foot with socks or stockings.
When fixed in position a ladder shall not move more than 10 mm in any direction while it is climbed, as a result of weight on the steps or of accelerations up to 0.3 g in any direction.
A vertical grab rail complying with section 7.2 of AS 1428.1 shall be provided, extending from 1600mm above the floor to the ceiling, and shall be parallel to and not less 200 mm nor more than 300 mm from the closest side of the ladder.

12.2.12 COMPARTMENTS GENERAL

12.2.12.1 These requirements apply to all compartments for passenger accommodation other than sleeping compartments described above.

12.2.12.2 The height of the ceiling and/or ceiling fixtures shall not be less than 1900 mm above the floor at any distance greater than 200 mm from the side wall, except where luggage storage racks or similar overhead cabinets are provided.

12.2.12.3 In open plan compartments where it is desirable for the occupants to be observed by a conductor or other attendant, opaque partitions shall not be higher than 1165 mm.

12.2.12.4 Overhead luggage racks and similar storage units shall be designed to retain luggage under normal train movements. The lower surface of such storage units shall be not less than 1700 mm above the floor. Sufficient space shall be provided to each passenger for the storage of personal effects.

12.2.12.5 Bins for the storage of rubbish shall be provided in each compartment and open plan vehicle.

12.2.13 SEATING

12.2.13.1 The minimum lateral space to be provided for each seated passenger shall be 490 mm. The minimum longitudinal spacing of seats shall be 1000 mm.

12.2.13.2 Seats shall be of the rotating and reclining type, with the reclining meachanism operated from the vicinity of the arm-rest within easy reach of a seated passenger.

12.2.13.3 The seat back and base shall be not less than 400 mm wide, with a free width at seat level of 450 mm extending to the top of the seat back. Arm rests which are more than 190 mm above the seat base shall not be considered when measuring this free width.

12.2.14 COLOURS AND INTERIOR DECOR

12.2.14.1 The colours used for the interior decor shall harmonise with each other and shall not cause visual fatigue.

12.2.14.2 Surfaces with which passengers are likely to be in regular or repetitive contact shall be non-abrasive and comfortable to the touch. Flat or curved surfaces shall be non-reflecting and not provide glare under the normal lighting conditions within the vehicle.

12.2.14.3 Table tops shall have a surface with a coefficient of friction not less than 0.2 when in contact with smooth glass. They shall be stain and soil resistant and capable of being easily cleaned.

12.2.14.4 Floor surfaces shall have a surface dynamic coefficient of friction of not less than 0.2 when in contact with any shoe sole material.

12.2.15 NOISE CONTROL

12.2.15.1 Noise reduction shall be achieved by isolation or absorption to a level sufficient to prevent normal conversation within an enclosed compartment from being clearly intelligible in adjacent compartments. In open areas within a vehicle, including open plan seating compartments, the noise reduction shall ensure that normal conversation is not overhead or intelligible at a distance of 10 m.

12.2.15.2 Background music may be used to assist in achieving the requirements above provided that the overall noise levels do not exceed those specified in Section 12.10.

12.2.15.3 The vehicle floor, walls and roof shall be insulated with materials which provide both thermal and acoustic insulation. Bogies, underframe-mounted equipment and draft gear installations shall be designed to provide the minimum transfer of noise and vibration through the vehicle.

12.2.16 EMERGENCY BRAKES AND ALARMS

12.2.16.1 Each vehicle shall be fitted with a manuallly operated emergency brake valve, located in close proximity to the exit doors near the end of the vehicle. Where the vehicle is not normally under the direct supervision of a conductor or similar authorised employee the valve shall be located behind a glass panel or provided with a seal to prevent unintentional operation.

12.2.16.2 The emergency brake valve shall be provided with a prominent notice located immediately adjacent which gives instructions relating to the reasons,conditions and procedures for operating the valve, including a warning of the consequences of mis-use.

12.2.16.3 Wherever practicable, vehicles shall be marshalled in a consist so that the emergency valve ends of two adjacent vehicles are not coupled together.

12.2.17 **ACCESS STEPS**

12.2.17.1 Side access steps for entering the vehicle from ground level shall be immediately above each other, with a minimum width of 450 mm. The tread shall be flat with a minimum depth of 250 mm; the vertical distance between consecutive treads shall be within the range of 150 mm to 200 mm. Step and recess design shall be such as to preclude the retention of water and other contaminants.

12.2.17.2 Steps shall have a coefficient of friction of not less than 0.4 when in contact any shoe sole material. Steps which are expected to be used when wet shall satisfy these conditions while in the wet state.

12.2.18 OBSTRUCTIONS

12.2.18.1 There shall be no sudden changes in floor level less than 100 mm nor greater than 200 mm. Joints in carpet and flooring shall be not greater than 6 mm high or shall incorporate fittings normally encountered in domestic installations.

12.2.18.2 Ramps inside vehicles shall have a slope of not greater than one in ten. Handholds shall be provided in the vestibules between vehicles and the floor surface shall be illuminated. Areas at different levels shall be in contrasting colours to enable the ready identification of changes in height in low levels of ambient light. The handhold shall be a vertical rail attached to the exterior wall of each vehicle adjacent to the opening side of the door, and shall extend from 900 mm above the floor and be 600 mm long. The design of the handhold and its attachment shall comply with clause 7.2. of as 1428.1.

12.2.19 OTHER EQUIPMENT

12.2.19.1 Refrigerated storage facilities shall be provided for perishable foodstuffs and beverages where meals and similar facilities are provided in transit. All food storage, preparation and serving areas and equipment shall comply with Australian Health Authority Standards.

12.2.19.2 Vehicles which are provided with on-board storage of fuel for vehicle-mounted power generation units shall be fitted with filling points on both sides of the vehicle. These filling points shall be compatible with those used for refuelling of locomotives.

12.2.19.3 All L.P. Gas installations shall comply with the requirements of Section 19.

12.3 GLAZING

12.3.1 SCOPE

This section specifies the minimum strength and physical properties of glazing required to minimise the risk of injury to persons occurring as a result of objects striking windows or which may be sustained by falling against a window or internal glazing.

12.3.2 DEFINITIONS

END FACING GLAZING
End Facing Glazing is glazing at any location where a line perpendicular to the plane of the glazing material makes a horizontal angle of 50^{o} or less with the longitudinal centreline of the carriage, except that glazing on end doors of non-self propelled vehicles shall be considered as side facing glazing.

SIDE FACING GLAZING
Side Facing Glazing is glazing at any location where a line perpendicular to the plane of the glazing material makes a horizontal angle of more than 50^{o} with the longitudinal centreline of the carriage, plus glazing on end doors of non-self propelled vehicles.

INTERIOR GLAZING
Interior Glazing is glazing used in walls, partitions and doors which is exposed on both sides to the interior of the vehicle.

DECORATIVE GLAZING
Decorative Glazing is glazing used in walls, partitions and doors which is exposed on one side only to the interior of the vehicle.

12.3.3 STANDARDS

Standards referred to in this section are:
Standards Australia:
AS 2080 - Safety Glass for Land Vehicles.
AS 2208 - Safety Glazing Materials for use in Buildings.
Federal Railroad Administration (U.S.A.):
FRA Standard 49 CFR Part 223 - Safety Glazing Standards for Locomotives and Passenger Cars.

12.3.4 GLAZING SPECIFICATIONS

Forward Facing glazing shall comply with the requirements of Section 13.6.2.3.1 of this manual.
Laminated Side Facing glazing shall comply with the relevant requirements of AS 2080 for safety glass or standard laminates, and shall satisfy the impact resistance requirements of either AS 2080 0R FRA Standard 49 CFR Part 223 for Type 2 regimen.
Heat Treated Side Facing glazing shall comply with the relevant requirements of AS 2080.

12.3.5 CHAMFERED EDGES

All glazing shall have sharp edges removed by polishing or by grinding at approximately 45° to a width of approximately 1 mm.

12.3.6 FOGGING

Double glazed units shall be so constructed and mounted as to ensure that fogging or condensation does not occur between the panes at any time during the life of the glazing unit.

12.3.7 INTERNAL OR DECORATIVE GLAZING

Internal and Decorative glazing shall be of thermally toughened or laminated glass, and shall be in accordance with the relevant portions of AS 2208.

12.3.8 RADIO FREQUENCY TRANSMISSION

End Facing and Side Facing Glazing shall permit the passage of radio frequency electro magnetic transmissions.

12.4 STANDARD FOR RETENTION TOILETS AND SERVICING ARRANGEMENT

12.4.1 CONNECTIONS

(a) Retention toilets require two connections:

Effluent discharge connection.
Fresh water flush connection.

(b) The effluent discharge connection is used to remove the accumulated effluent from the hold-over tank.

(c) The fresh water flush connection is used to flush out the hold-over tank and to partially fill the hold-over tank with clean water.

(d) Effluent discharge connections shall be labeled on vehicles with the word 'EFFLUENT' or similar.

(e) Fresh water flush connections to be labeled on vehicles with the word 'FLUSH' or similar.

12.4.2 CONNECTOR TYPES AND SIZES

(a) The effluent discharge connection shall be an 80 mm diameter Kamlok male adaptor.

(b) The fresh water flush connection shall be a 20 mm diameter Kamlok male adaptor.

12.4.3. CONNECTOR LOCATIONS

(a) Effluent discharge connections shall be located:

On both sides of the vehicle.
Approximately 980 mm above rail height.
Approximately 1800 mm from coupler centre line.
Approximately 1360 from the track centre line.

(b) Fresh water flush connections shall be located:

On both sides of the carriage.
Approximately 860 mm above rail height.
Approximately 1800 mm from coupler centre line.
Approximately 1360 mm from the track centre line.

12.4.4 OTHER CONSIDERATIONS

(a) The capacity and the frequency of servicing of retention toilet systems depends on:

The number of passengers carried.
The distance travelled and travelling time.

(b) A sight glass or similar device shall be fitted to indicate the level of effluent in the hold-over tank.

12.5 WATER FILLING

12.5.1 APPLICATION

The requirements of this section are applicable to all new and rebuilt vehicles in which water is stored or transferred for the purpose of hygiene or human consumption.

They specify the:

(a) Materials to be used for the storage and transfer of water
(b) Method of filling storage tanks
(c) Method of draining the water system
(d) Method of treatment to prevent the build-up of water-borne bacteria
(e) Filling and draining requirements for vehicles in service

12.5.2 DEFINITIONS

`Water' is any water stored or used on the vehicle for whatever purpose.

`Drinking water' is water specifically intended for drinking by passengers and staff.

`Vehicle' is any passenger carrying vehicle used in intersystem traffic.

12.5.3 MATERIALS

12.5.3.1 Pipes used in the water system shall be of either:

(a) Food and beverage grade natural rubber hose
(b) Copper to AS 1432
(c) Stainless steel (food grade)
(d) Materials which comply with AS 1164, Plastic Containers for Sterile Goods
OR
(e) Any other material certified by State Health Authorities as suitable for the storage or transfer of potable water

12.5.3.2 All piping and fittings for both hot and cold water systems shall be suitable for carrying water at a temperature of 65^{o}C. Hot water piping and fittings shall be suitable for the maximum water temperature produced by the water heating system. In service, the temperature of the hot water shall not be greater than 60^{o}C as it leaves the faucet inside the vehicle. Hot water pipes exposed within the vehicle shall be insulated or fitted with protective covers.

12.5.3.3 Thermostats on the hot water system shall be set to maintain the water temperature between 55^{o}C and 60^{o}C.

12.5.3.4 All piping, fittings, valves, filters, etc. shall be readily available commercial items.

12.5.3.5 Storage tanks shall comply with the applicable requirements of AS 1056, Automatic Electric Storage Water Heaters.

12.5.3.6 Materials and mountings shall be selected to ensure that the installation and equipment will withstand the vibration, movement and impacts from ballast, etc experienced during normal rail operations.

12.5.4 WATER FILLING

12.5.4.1 The filling points for the water system shall be located on both sides of the vehicle, as far as is practicable from the fuel filling points and waste drains, and clearly labelled `Water'. If a manually operated valve is used to close or open the filling pipes it shall be located as close as possible to the open end of the pipes.
The water inlet pipes shall be fitted with spring-loaded or clip-on caps, permanently attached to the vehicle, which shall be used to seal the inlet when filling is complete. The caps shall prevent the entry of rain, foreign objects, dust and other comtaminants.

12.5.4.2 Three-way valves used to vent air pressure from the system prior to filling shall be located adjacent to the filling pipe on each side of the vehicle, arranged so that the air pressure can be vented or applied by operating one of the valves on either side of the vehicle. A pressure gauge shall be provided adjacent to each three-way valve to indicate the air pressure in the system.
The valve handle shall be in the horizontal position when the pressure is released. Markings shall clearly show `WATER PRESSURE ON' in the `On' position and `WATER PRESSURE OFF' in the `Off' position.
The piping for venting air from the tanks during the filling operation shall be not less than 15 mm nominal bore, and fast acting dump valves of 40 mm nominal bore are recommended to ensure an adequate rate of venting.

12.5.4.3 The drinking water system shall incorporate a filter positioned so that only the drinking water passes through it. The filter shall be located on the vehicle so that it is readily accessible for service or replacement without requiring a pit or similar facilities.

12.5.4.4 The water distribution system shall be pressurised by electrically operated pumps for both the hot and cold water systems. The pump operation shall be controlled by pressure switches installed in the delivery lines; the switches shall be set to maintain the system pressure within the range of 80 kPa to 120 kPa.

12.5.5 WATER QUANTITIES REQUIRED

12.5.5.1 All passenger vehicles for long distance or intersystem use shall have water available for drinking; this water shall be provided to passengers at a temperature not greater than 15^{o}C. The drinking water distribution system shall be pressurised by an electrically driven pump seperate from the pumps used for the hot and cold water systems for ablutions.

12.5.5.2 Vehicles carrying passengers on journeys which take more than four hours shall be provided with facilities for making tea, coffee and other hot beverages, either by on-train staff or by the passengers themselves.

12.5.5.3 Vehicles used for journeys whose duration is 10 hours or longer shall be provided with private washing facilities. Vehicles used for overnight jouneys of any duration shall provide shower facilities for the passengers. The water storage capacity shall be sufficient to permit each passenger to shower once in each 24 hour period or part thereof. The required water capacity depends on the system pressure and shower rose construction. The shower rose shall be selected so as to minimise water consumption. Faucets for shower control shall be of the type fitted with a timing device to prevent over use of the available water supply.

12.5.5.4 Total water storage capacity shall be based on an allowance of one (1) litre per passenger for each eight (8) hours of the journey. On long distance journeys additional water may be taken on en route to maintain the supply.

12.5.6 DRAINAGE OF STORAGE TANKS

12.5.6.1 The main storage tanks shall each be fitted with a drain of 50 mm minimum diameter, located as far as is practicable from the inlet point.

12.5.6.2 The pipe system and any auxiliary storage tanks shall drain into the main storage tanks. Where this is not practicable each storage tank and pipe section shall be fitted with individual drains. The piping system shall not have dead (undrainable) sections, and shall not include one-way or non-return valves which prevent natural drainage.

12.5.6.3 A notice shall be located adjacent to the filling points on both sides of the vehicle indicating the total number and location of water drains on the vehicle which are required to be opened in order to completely drain the water system. Opening of all these drains shall enable all water in the storage tanks and piping system to be removed.

12.5.7 SERVICING AND REFILLING

12.5.7.1 Hoses used for the filling of water tanks shall be certified as suitable for the transfer of water for human consumption.

12.5.7.2 ***The hose ends shall be plugged or capped when not in use to prevent the ingress of foreign objects and other contaminants. Hose ends shall not be permitted to be in contact with the ground, surface water, or other contaminating substances. Before filling commences, the unconnected hose shall be flushed with clean water from the supply system and the inlet pipe on the vehicle washed clean before opening the filling valve.***

12.5.7.3 ***Vehicles which have been idle or in service without the water being used for more than two months shall be completely drained and flushed with clean water before before being re-used. A vehicle shall be completely drained of water and flushed clean prior to a planned or known period of non-use. All vehicle water systems shall be drained amd flushed clean at least once every 12 months.***

12.5.7.4 ***After the annual drainage the vehicle's piping and storage system shall be either:***

(a) flushed with hot water at a temperature of 70^{o}C for a period of not less than 30 minutes

OR

(b) flushed with a suitable anti-bacterial agent which shall remove legionella and other water- borne bacteria.

The anti-bacterial agent shall be compatible with the piping and tank materials. A suitable agent is a sodium hypochlorite solution at a minimum level of 5 mg/l free chlorine residual, maintained for a period of at least six hours at a pH of 7.0 to 7.6. With good pH control corrosion of materials such as steel and copper is minimal. After treatment with any such solution the complete water system shall be flushed with clean water until no residual chemicals remain.

12.6 FIRE PROTECTION

12.6.1 PURPOSE AND SCOPE

12.6.1.1 The section presents guidelines for the materials, portable safety equipment and emergency alarm systems provided in new or refurbished passenger cars.
The requirements specified herein may be modified where an effective, sensitive and reliable smoke detection and alarm system is installed, enabling the fire rating of materials, barriers, etc. to be reduced.

12.6.1.2 Because a moving train prevents immediate passenger evacuation from a fire except along the train itself, fires in trains are particularly dangerous.

Resistance to fire of the materials and structure has to be such that a fire does not spread so rapidly as to jeopardise the escape of passengers.

Passengers in sleeping cars may take longer to disembark and hence more stringent standards should apply.

12.6.1.3 There are special risks with electrical equipment, under-floor power units, fuel tanks and the use of cooking equipment, both electrical and gas.

12.6.1.4 Considering the risk of fire on passenger trains there is a need for specified safety equipment and emergency warning systems to be installed on all passenger cars, together with a minimum training programme for all on train staff to utilise all safety equipment and emergency warning systems located on the passenger cars.

12.6.1.5 This section provides guidance for the design and construction of railway passenger stock in respect of fire and special provisions for fire protection and for means of escape in order to minimise the hazard to passengers and crew.

This guidance covers new vehicles and changes to existing vehicles where these effect their resistance to fire.

12.6.2 FIRE HAZARD ASSESSMENT

12.6.2.1 Vehicle Categories

Sleeping cars require a higher resistance to fire than other vehicles and are designated as Category 1.
All other vehicles are designated Category 2.

12.6.2.2 Design Considerations

The following factors should also be taken into account when selecting products -

(a) the position of the material in the vehicle
(b) how materials are combined and the possible effects of adhesives, cleaning agents etc.
(c) the interaction of the material with adjacent materials in a fire situation
(d) the mechanical strength of components in a fire
(e) the effect of air flow, either through open windows caused by train movement or due to air conditioning/ventilation
(f) the possible accumulation of dust or litter adjacent to the material
(g) the proximity of possible ignition sources e.g. diesel, electrical or gas equipment.

12.6.3 PREVENTING OR DELAYING THE SPREAD OF FIRE AND ITS PRODUCTS

12.6.3.1 Apart from the exceptions given in 12.6.3.5 transverse and longitudinal fire barriers shall be provided at the ends of coaches or within their length, to prevent or limit the spread of fire or combustion products from one vehicle to another or along the insides of vehicles, so that passengers can escape from the scene of the fire before the vehicle comes to a stand.

A fire barrier shall extend to the vehicle's outer walls, roof and to the floor, or any underfloor barrier provided; it shall have as few apertures as practicable and these shall be sealed to the same standard of integrity as the rest

of the barrier. Transverse fire barriers shall provide a minimum integrity of 20 minutes on Category 1 vehicles, and 10 minutes on Category 2 vehicles, when tested in accordance with BS 476:Part 22.

12.6.3.2 Transverse and longitudinal fire barriers shall extend through voids between the trim ceiling and the vehicle roof. In sleeping cars the void shall also be divided by sealed vertical barriers into spaces which are not more than 3 m in length.

12.6.3.3 Doors fitted within transverse or longitudinal fire barriers shall have the same standard of fire resistance (see 12.6.3.1) and be fitted with flexible edge seals to control smoke movement at ambient temperatures. Where air louvres need to be incorporated for air conditioning or ventilation purposes, they shall be as near to the floor as practicable, and any drop lights shall be self-closing.

Such doors shall normally be kept closed or be self-closing. Alternatively, they may be held open and automatically released when a fire alarm or passenger alarm is operated; such an arrangement may be used on sleeping car vehicles. Power operated doors shall close when power is interrupted, and a means of manually opening the doors shall be provided.

12.6.3.4 Corridors in sleeping cars shall be divided into portions not exceeding 18 m in length by transverse fire barriers (12.6.3.1) with smoke control doors (12.6.3.3). Transverse fire barriers shall also be provided each side of any cooking area, and to separate the Conductor's compartment from the passenger accommodation.

12.6.3.5 If the floor construction itself does not provide an effective horizontal fire barrier, an additional barrier shall be provided to separate passenger/crew accommodation from underfloor fire sources. An indicative fire resistance test, exposing a representative sample of the complete barrier to the time/temperature conditions specified in BS 476:Part 20, shall be carried out, and the integrity and insulation criteria given this test shall be complied with for 30 minutes.

In the case of underfloor mounted diesel engines, this construction shall be designed so that oil cannot seep above it. Where ducts and trunking penetrate a fire barrier, the ducting shall be capable of maintaining its integrity in a fire situation. The ducts shall also be fire-stopped into a barrier, and shall be as few as possible in number.

12.6.3.6 Heaters, in passenger and crew areas, shall be so designed or protected that the air flow around them cannot be accidentally obstructed, and in any case no part of the external surface of the heater shall exceed 150°C even if ventilation holes in the casing guarding the heater become accidentally blocked. All combustible material in the vicinity of heaters shall be protected.

12.6.3.7 Automatic shut down of ventilation upon alarm activation shall occur to ensure that ventilating fans do not recirculate combustion products to passengers in the event of a fire; this particularly applies to sleeping cars.

12.6.3.8 In compartments where smoking is allowed, an appropriate number of integral ashtrays shall be provided, but preferably not as part of upholstered seats or furnishings.

12.6.3.9 All airconditioning filters used on passenger cars shall be readily removable for ease of cleaning and must, when tested in accordance with AS 1441 - Method 13, give results of:

duration of flaming	0
duration of afterglow	0
length of material which burns, chars or melts	120 mm

12.6.4 SPECIAL PROVISIONS FOR INTERNAL COMBUSTION ENGINES

12.6.4.1 Horizontal fire barriers shall be in accordance with 12.6.3.6.

12.6.4.2 All engine compartments/bays shall be provided with an automatic fire detection system with 'maximum temperature' detectors, with or without 'rate of temperature rise' elements. The system shall be sensitised whenever a vehicle is in normal service. Engine compartments shall also be fitted with a suitable automatic fire extinguishing system, in accordance with the relevant Part of BS 5306.

Where the engine is not enclosed, the fire extinguishing system shall not operate until the train speed is so reduced that the fire extinguishing media is not dispersed.

12.6.4.3 Fuel and lubricating oil systems and pipework, including compressors, shall not be sited, where practical, in the same equipment bay as electrical equipment. The ends of equipment bays containing engines and fuels shall constitute a fire barrier in accordance with 12.6.3.1.

12.6.4.4 The design of oil and fuel tanks shall ensure that during filling or draining, or in the event of leakage from a tank or its pipework, flammable liquids cannot seep into any electrical equipment or into any insulating or lagging material which may act as a wick. Leaks shall be collected in a drainage tank of adequate capacity which can be easily emptied during servicing.

12.6.4.5 Absorbent lagging shall be covered by an impervious sheath which shall itself be flame retardant. It is advisable to leave valves and flanges unlagged because of the risk of leakages and to facilitate inspection and maintenance.

12.6.4.6 Oil and fuel tanks shall be so located or protected that they or their piping cannot be punctured or fractured by failed mechanical equipment, or by debris thrown up from the track.

12.6.4.7 All pipework must be fitted securely to avoid fatigue, fracture, etc.

12.6.5 SPECIAL PROVISIONS FOR ELECTRICAL EQUIPMENT AND WIRING

12.6.5.1 Electrical installations shall be in accordance with section 12.4 of this manual.

12.6.5.2 Means shall be provided, in case of fire, to isolate all electrical supplies to the train (either on the train or externally to the train) and to isolate equipment of large current-carrying capacity.

12.6.5.3 Electrical surface creepage and electrical clearance distances shall comply with AS 3300.

12.6.5.4 All lamps and lamp fittings shall comply with relevant Australian Standard and shall be placed or guarded to prevent ignition of any materials fitted or placed nearby.

12.6.5.5 Vehicles with high-voltage (e.g. 1000 V D.C.) equipment liable to be exposed in a fire shall have switches isolating all high voltage circuits located close to a fire extinguisher. A readily understood notice shall be clearly displayed close by.

12.6.5.6 Boxes containing batteries liable to give off flammable gases shall be safely ventilated and the interior and exterior shall be clearly marked to show that smoking and the use of naked flames is prohibited. The design of the battery circuits shall take into account the high level of current flow resulting from a short circuit.

12.6.5.7 All passenger and crew areas shall have emergency lighting available for at least 20 minutes after the main lighting system has failed. The level of illumination shall be not less than 30 lux in the vicinity of emergency exit doors, and not less than 5 lux along passenger and crew walkways.

Section 12.6.5.7 superseded by AS 7531

12.6.6 SPECIAL PROVISIONS FOR COOKING EQUIPMENT

12.6.6.1 General

All LP Gas equipment, installations and appliances shall be in accordance with section 19 of this manual.

12.6.7 AIDING PASSENGER AND ON TRAIN STAFF ESCAPE

12.6.7.1 All trains shall have doors which can be used for emergency exit.

12.6.7.2 Where accommodation for disabled people is provided, their egress in emergency shall be considered.

12.6.7.3 In addition to provision on intermediate vehicles, there shall be emergency doors on both sides of the train, at each end of each group of vehicles having through access beyond which there is no access into the remainder of the train. These doors shall be located not more than 6 m from the dead end.

12.6.7.4 In the case of power operated doors, and where end egress is not available, provision shall be made for emergency doors to be opened by passengers from inside the vehicle. Automatic smoke-stop doors (see 12.6.3.3) inside a vehicle shall be able to be opened from either side, even if the power or operating mechanism has failed. How a door opens (i.e. by pushing or by sliding) shall be indicated on the door.

12.6.7.5 Swinging doors shall, where possible, open towards the nearest external door but may be arranged to open in both directions. It shall be clear how a door can be opened by hand.

12.6.7.6 Adequate provision shall be made for the stowage of passenger luggage clear of the main vestibules, exits and passages.

12.6.7.7 It is important that passengers are made aware of the proper action to take in the case of fire. The location of the emergency alarms and of fire extinguishers shall be clearly indicated by notices. Where certain doors are to be used as emergency exits, these too shall be clearly indicated as such. Other instructions may best be given to passengers by the train crew using the public announcement (PA) system. These may include instructions to disembark from one or other end of a train, or on the safe side of a train away from adjacent lines, the availability of fire extinguishers and their locations, and the location and use of devices to be used to break or otherwise open windows for emergency evacuation of a train in which the end doors are obstructed. Instructions to remind train crews to give such advice shall be provided adjacent to the PA system microphone or at some other suitable place.

12.6.7.8 All relevant safety features located on the train together with all relevant safety and evacuation procedures shall be announced or issued:

(a) shortly after boarding the train at the commencement of the journey,
(b) at the time each passenger receives their destination ticket.
(c) relevant safety instructions shall be prominently displayed in compartments and public areas.

12.6.8 SMOKE DETECTION AND ALARM EQUIPMENT

12.6.8.1 Smoke detection and alarm equipment shall be installed in sleeping carriages, dining, guard, sit up and special carriages. Kitchen areas shall be fitted with appropriate fire detecting equipment.

12.6.8.2 A high degree of reliability is required and all equipment shall be constructed from high quality, long life component parts and materials.

12.6.8.3 All component parts and materials shall be in accordance with current Australian Standard specifications where such are applicable, and in their absence with British Standard or other internationallly recognised specifications where such can be used.

12.6.8.4 The smoke/fire detection system shall be independent of any existing communications, paging or PA system. However, the possibility of interfacing warning signals between this system and any existing system in order to enhance the facilities shall be considered.

12.6.8.5 The system to be installed in each car shall have the capability to initiate the automatic shut down of the air conditioning system in the car under threat and operating in a stand alone mode, i.e. detect smoke/fire and operate local alarms independently of all other cars in the consist.

12.6.8.6 The operation of the alarms in the car shall not in any way be dependent on an inter car communication system or an interface referred in section 12.6.8.4.

12.6.8.7 This system must give an audible warning whenever smoke or fire is detected. A time delay shall be specified between the detection of smoke or fire and the operation of the audible alarm. This warning must be audible in all compartments, toilets, showers and corridors of the car where the alarm condition exists.

12.6.8.8 A fire alarm bell or similar device to the requirement of test specification AS 1603.4 clause 4.2.4 shall be used for the purpose.

12.6.8.9 The power supply for each system shall be uninterrupted for the duration of a journey regardless of any interruption to the Head End Power system.

12.6.8.10 The system shall initiate the automatic shutdown of the air conditioning system in the car where smoke is detected.

Simultaneously, the system in all other cars in the consist shall receive a signal providing a visual indication of an audible alarm on a monitoring panel, indicating the vehicle in which the smoke has been detected. This alarm on the control panel is in addition to the fire alarm referred to in section 12.6.8.6.

12.6.8.11 All wiring shall be in accordance with Australian Standards. The wiring may be subject to induced voltage from AC power circuits. The system shall be immune to electrical interference.

12.6.8.12 The system shall be such that it does not cause any radio interference and that the installation will not be affected by UHF and VHF transmission.

12.6.8.13 The integrity of the wiring shall be monitored by the system, e.g. current loop, end of line resistance etc. or alternatively an addressable system with a cycling time of not less than 500 m/s shall be used.

12.6.8.14 The detectors used will comply with Australian Standard AS 1603 as applicable.

12.6.8.15 Type, location, number of detectors in location and details of the panel will be determined for each installation by railway officials.

12.6.8.16 It is recommended that all enclosures that will be occupied shall be protected, e.g. cabins, toilets, kitchens, crew areas, etc.

12.6.8.17 It is recommended that all sleeping cars and kitchen areas be fitted with air sampling smoke detection system to provide early warning of smoke emission. The system shall have continuous air flow and read operation monitoring with a minimum of 3 adjustable smoke level and alarm time delay settings.

12.6.8.18 A controllable visual and audible signal display shall be provided to indicate smoke levels. The signal shall be relayed to the head conductors cabin if there is no response within two minutes.

12.6.9 FIRE EXTINGUISHERS

12.6.9.1 The combined extinguishers in each car shall have sufficient capacity to give effective protection in an emergency, taking into account the degree of flammability and combustibility of the materials used in the construction of the vehicles. Each sitting car shall be fitted with at least one fire extinguisher while the sleeping and dining cars shall be fitted with two fire extinguishers. Each extinguisher shall have a minimum capacity of 2.25 kg.

Extinguishers shall be visible, easily accessible and placed at a distance from areas presenting a fire risk, to be effective in an emergency. They may be stored in cupboards with the door locked, and access gained by the breaking of a glazed panel. Fire extinguishers shall not be stored where they are exposed to excessive heat. Cars fitted with L.P.G. equipment shall be provided with one extinguisher for each installation.

12.6.9.2 Portable Fire Extinguishers.

The 2.25 kg dry chemical fire extinguisher is the most versatile. It is rechargeable, portable, of a stored pressure type and light enough to be carried to the source of the fire by all personnel. The extinguisher shall be classified for use on 'Class A' fires (carbonaceous fires), 'Class B' fires (flammable liquids) and 'Class E' fires (live electrical equipment).

12.6.9.3 Fire Extinguisher Standard

12.6.9.3.1 Dry Chemical Extinguishers

The 2.25 kg AB(E) Powder, Dry Chemical extinguisher fitted with a nozzle type 'D', shall be charged with dry chemical powder and have a fire rating classification of not less than 2A 20B(E). Rating of fire extinguishers shall be in accordance with AS 1850 and shall include class 'B' and 'C' type fires. Identification colours for portable fire extinguishers shall be in accordance with AS 1849. Each extinguisher shall comply in every respect with the appropriate Australian Standard Code with latest amendment viz:

AS 1846 - Dry Chemical

A certification label shall comply with the requirements of AS 1851 Part 1. Recharged extinguishers shall comply with the requirements of AS 1851 Part 1. The operating instructions on recharged extinguishers shall be clear and legible. A metal tag as required in AS 1851, Part 1 shall be attached to each extinguisher. Extinguishers shall be provided with a hose and an ON/OFF (quick acting) valve. It shall be possible to stop and restart the extinguisher by hand during fire extinguishing activities.

It must operate without being turned upside down. All extinguishers shall be suitable for use near live electric installations.

12.6.9.3.2 CO_2 Extinguishers

All CO_2 extinguishers fitted shall be in accordance with the current standard, AS 1847.

12.6.9.4 Maintenance

Fire extinguishers must be inspected at regular intervals. The date of the next inspection must be shown on each extinguisher. The extinguisher must be checked for pressure and weight every 6 months and compared with that stamped on the extinguisher label. A pressure test must be conducted very five years in accordance with AS CA 18. The extinguisher must be recharged after use, sealed and ready for use.

12.6.9.5 Staff Training

In order to increase the effectiveness of fire fighting methods, it is necessary that the staff be trained in the functioning and handling of fire extinguishers.

12.6.9.6 Fire Extinguisher Locations

12.6.9.6.1 Internal Location

Interior installed extinguishers shall be mounted on a robust support bracket and preferably secured in a robust compartment fitted with a drop down door. To gain access to the extinguisher in case of fire a glass panel in the door to the box shall be shattered to gain access to the door release mechanism.

12.6.9.6.2 External Location

All carriages equipped with a diesel alternator unit shall have a Dry Powder fire extinguisher mounted in a metal box painted red and labelled 'Fire Extinguisher'. The box shall be secured to the underframe at a convenient location to enable access in case of a fuel tank or engine fire.

12.6.9.6.3 Saloon and Compartment Carriages

All sitting carriages shall be fitted with at least one (1) No. 2.25 kg dry powder type fire extinguishers located internally within the vestibule at one end of each carriage.

12.6.9.6.4 Dining and Kitchen Carriages

All Dining carriages and carriages fitted with Kitchens must have a fire extinguisher mounted in the saloon area and an easily accessible fire extinguisher mounted in the kitchen section. CO_2 extinguishers are preferred in kitchen areas.

12.6.9.6.5 Sleeping Carriages

All sleeping carriages shall have two (2) dry powder type fire extinguishers. A fire extinguisher shall be located adjacent to the Conductor's compartment, an additional fire extinguisher being mounted internally at the opposite end of the carriage or one at each end of the car if there is no conductors compartment.

12.6.9.6.6 Signage

Suitable signage must be placed on the external face of the fire extinguisher cupboard door to indicate the location and operation of the fire extinguisher. A suitable sign shall be placed in a position as to be visible for the full length of the carriage to indicate the position of the fire extinguisher to staff and passengers.

12.7 COMMUNICATIONS EQUIPMENT

12.7.1 Two train lines shall be provided for a crew intercommunication system.

12.7.2 Two train lines shall be provided for a public address system.

12.7.3 The public address and inter-communication system train lines shall be incorporated in the control jumper.

12.7.4 The public address, intercommunications and entertainment system cables shall not be incorporated in the same conduit, jumper or cable duct as any other cable carrying greater than extra low voltage (i.e. 32V AC or 130V DC).

12.7.5 The amplifier(s) shall preferably be located in the buffet/dining car and/or the guard's compartment.

12.7.6 The public address and intercommunications amplifier shall have a constant 70 volt line output.

12.7.7 The sound level of all sitting car speakers shall be set by utilizing a tapped transformer fitted to each speaker.

12.7.8 The provision of individual speaker volume control in sleeping compartments shall be provided. It shall be possible to hear public adress announcements when the volume control switch is in the 'on' or 'off' position.

12.7.9 The control cabinet for any of the above systems shall be easily accessible for testing, setup, repairs and operation.

12.7.10 Equipment associated with the above system, other than cables, shall be removeable and replaceable without dismantling the bodywork of the vehicle.

12.8 FIRE RESISTANCE/TOXICITY OF FITTINGS

12.8.1 PURPOSE AND SCOPE

Because a moving train prevents immediate passenger evacuation from a fire except along the train itself, fires in trains may be particularly dangerous. Materials used in the construction of carriages therefore have to be selected with particular care so that they do not easily ignite, nor release heat rapidly, nor emit more than minimum smoke and harmful combustion gases.

12.8.2 FIRE HAZARD ASSESSMENT

12.8.2.1 Sampling and Testing

Test results will be acceptable only if carried out in a laboratory registered with the National Association of Testing Authorities (Australia) and the results submitted in a 'NATA' endorsed report.

12.8.2.2 Vehicle Categories

Vehicles predominantly operating undergound and sleeping cars require a higher resistance to fire than other vehicles and are designated category 1. All other vehicles are designated category 2.

12.8.2.3 Fire Load Density

The amount of combustible products used in vehicle construction shall be limited to the minimum practicable. Limiting the fire load density limits the overall potential severity following an out break of fire, although it cannot control the likelihood of a fire occurring or spreading , or its rate of increase.

12.8.2.4 Product Characteristics

The main characteristics by which the fire behaviour of products used in the construction should be judged are:

(a) ignitability
(b) rate of surface spread of flame
(c) rate of heat release
(d) smoke generation
(e) the nature of combustion gases and their proportions under given exposure conditions
(f) the release of harmful products

12.8.2.5 Design Considerations

The following factors shall also be taken into account when selecting products:

(a) the quantity of material which is required to be used
(b) the position of the material in the vehicle and its configuration and orientation
(c) combinations of materials and the possible effects of adhesives, cleaning agents, etc.
(d) the interaction of the material with adjacent materials in a fire situation
(e) the mechanical strength of a component in a fire
(f) the effect of airflow, either through open windows caused by train movement, or due to air conditioning ventilation.
(g) the possible accumulation of dust or litter adjacent to the material
(h) the proximity of possible ignition sources, e.g. diesel or electrical equipment
(i) electrical cables shall not provide a spread of flame in the event of a fire.

12.8.3 ASSESSMENT OF PRODUCTS

Products shall satisfy the recommended test compliance criteria.

It should be appreciated, however, that fire is a complex phenomenon; its behaviour and its effects depend on a number of interrelated factors. The behaviour of materials or combination of materials in a fire depends upon the characteristics of the fire, the method of use of the material and the environment in which they are exposed. Relatively small-scale tests such as those described in the Appendix deal only with a simple representation of a particular aspect of the potential fire situation, typified by a defined heat source, and cannot alone provide direct

guidance on behaviour or safety in a fire. Tests as defined may be used for comparative purposes so as to ensure the maintenance of a designated level of performance considered to have a bearing on fire performance generally but do not necessarily give an absolute indication of the fire hazard associated with the use of the material in its end product form.

The overall assessment will be modified by various factors such as the following:

(a) unusual behaviour which leads to the result obtained being considered unreliable by the technically competent authority.

(b) aspects of the design configuration which present the material to a possible fire source in a way different from that of the test method.

It is recommended, therefore, that the advice of a technically competent authority should be sought as to the extent of large-scale testing which should be carried out in order to avoid unreliable interpretation of small-scale test results.

12.8.4 SMOKE AND TOXIC GASES

Small samples may be tested to give an indication of the emission of smoke using the method described in AS 1530.3 This method does not however give a reliable indication of the behaviour of a large sample or group of components.

Although limiting the emission of toxic gases is very important, there is at present no suitable method relating gas emission to toxic hazard. Until one is available, the designer should be aware that some products may rapidly generate carbon monoxide and other toxic gases in a fire, and that it is important these products are avoided, especially in category 1 vehicles.

12.8.5 SPECIAL PROVISIONS FOR CLEANING

The design of the vehicle shall be such as to avoid the creation of ledges, cavities and similar features which allow the accumulation of litter, oily waste and similar combustible material.

Air conditioning and ventilation systems and ducts shall be designed so that they can be easily cleaned.

Heater enclosures shall be designed to inhibit the ingress of dirt or litter and prevent the retention of any that does enter.

12.8.6 SPECIAL PROVISIONS FOR ELECTRICAL EQUIPMENT AND WIRING

All cables shall be of sufficient capacity for their intended duty.

All lamps and lamp fittings shall comply with BS4533:Part 101 and shall be so placed or guarded as to prevent ignition of any materials fitted or placed nearby.

12.8.7 SPECIAL PROVISION FOR COOKING EQUIPMENT

All cooking appliances, irrespective of type, shall be adequately insulated to prevent conduction of heat to adjacent surfaces and equipment; all surfaces surrounding cooking appliances shall be adequately insulated against the effects of heat radiation from appliances.

Each cooking area shall be provided with a fire blanket in accordance with AS 3504 and a suitable fire extinguisher as above.

12.8.8 GENERAL

Adequate provision shall be made for the stowage of passenger luggage clear of the main vestibules, exits and passages.

Each passenger-carrying vehicle shall contain an easily accessible fire extinguisher in accordance with the appropriate ROA requirements.

Each sleeping car or dining car shall be fitted with an automatic smoke or heat detector which shall be sited in accordance with the ROA requirements. Upon operation, it shall give an automatic alarm in the affected compartment.

It is important that passengers are made aware of the proper action to take in the case of fire. The location of the emergency alarms and fire extinguisher shall be clearly indicated by notices. Where certain doors are to be used as emergency exits, these too shall be clearly indicated as such.

12.8.9 ADDITIONAL TESTING

It is usual to carry out large scale testing of new components assembled in their final form to assess their fire behaviour in as realistic a manner as possible.

It is not expected that a full-scale test of a new passenger vehicle need be carried out as a matter of routine.

Components suitable for testing in isolation are:

(a) seating
(b) bedding and mattresses
(c) corner samples of floor, lower wall trim and lower end bulkhead, ceiling, upper wall trim and upper end bulkhead trim, including curtains and blinds, as built into the car.

Where, in the opinion of the technically competent authority the proposed construction represents a significant departure from the normal practice, a full-scale fire test on the actual unit or part of a unit may be deemed to be necessary. This will ensure that no unacceptable risk has been introduced due to such factors as incorporation of newly developed materials or products, interaction between components which might accelerate fire growth or the effect of ventilation conditions.

It is essential that carpets and other floor covering materials are of limited flammability and do not encourage fire spread. Flooring shall be tested in conjunction with any backing or adhesive used in the horizontal position which may effect the fire performance and shall withstand the following sources of ignition:

(a) burning debris falling from the ceiling,
(b) radiated heat from a ceiling, or a seat on fire,
(c) radiated heat from an underfloor electrical or oil fire.

The former may include an electric arc to the underfloor metal plating which may burn through the floor locally. In this case the flooring or carpeting shall not allow any local fire to spread.

Because of special risks associated with fire in sleeping cars, the technically competent authority shall ensure that the minimum of combustible materials is used in the bedding. Tests based on BS 6807 may be used. In particular, the emission of toxic decomposition products shall be minimised. Fire tests undertaken shall be photographed at regular intervals to record and help assess the rates of fire development and smoke emission.

12.8.10 RECOMMENDED COMPLIANCE CRITERIA FOR FLAMMABILITY AND SMOKE EMISSION TESTING

Flammability Test Method and Requirements

Australian Standard AS 1530.3 is acceptable but the equipment for testing is complicated and requires excessive time to monitor tests. Tests EC/F/1, EC/F/2, EC/F/3 and EC/F/4 are to visually determine the flammability of materials. The main aim with these tests is to reduce the propagation of flame, resulting in less smoke and toxicity.

The following four test methods adapted from the Australian Standards or developed specifically for individual items are based on direct ignition. Many standards, both Australian and overseas are based on radiant panel tests, ie. spread of radiant heat, for flammability evaluation but this is not considered appropriate as fires in service are normally started by direct ignition, typically by burning newspaper.

The test methods are appended, but may be summarized as:

EC/F/1 - Vertical burn test for rigid and flexible foams. Must be self extinguishing within 5 seconds of removal of ignition source.

EC/F/2 - Full size burn test on foam seating materials.

EC/F/3 - As for EC/F/2 but using a completed seat, i.e. foam and covering. A newspaper configuration placed on the seat is used as the ignition source for these methods. Must be self extinguishing within 60 seconds of paper being consumed (both methods).

EC/F/4 - Vertical burn test on coated fabrics. Measure duration of flaming, duration of afterglow and length of material which burns, chars or melts.

These test methods may be used to successfully screen potential supplies, and for production control purposes. Material such as fibreglass mouldings, poly-urethane and fabrics have been shown in a number of these tests to burn fiercely and to be completely consumed if they have not been fire retarded. Insufficiently retarded materials behave in proportion to the degree of treatment.

12.9 ELECTRICAL WIRING

Compliance with the minimum requirements of this sub-section is mandatory.

12.9.1 SCOPE

12.9.1.1 This section specifies the minimum requirements for the design and installation of electrical conductors and cables in passenger vehicles.

12.9.1.2 It has particular reference to those performance aspects which:

(a) Ensure safety of passengers and personnel.

(b) Promote the effective and efficient use of wiring.

(c) Extend the sevice life of wiring.

(d) Facilitate maintenance at minimum cost.

12.9.1.3 The standards specified herein shall at all times be complemented by good workmanship and accepted electrical installation practice.

12.9.1.5 All installations shall be in accordance with the requirements of AS 3000 and AS 3100 where applicable.

12.9.2 DEFINITIONS

Extra-Low Voltage	A voltage not exceeding 32 V alternating current or 115 V direct current.
Low Voltage	A voltage exceeding extra-low voltage, but not exceeding 250 V.
Medium Voltage	A voltage exceeding low voltage, but not exceeding 650 V.
High Voltage	A voltage exceeding 650 V.
High Voltage Auxiliary Circuits	High voltage wiring and cabling of equipment other than traction circuits.
Auxiliary Control Circuits	Low voltage wiring and cabling other than traction control
Communication Circuits	Wiring for radio or public address equipment

12.9.3 CABLE-CONTROL AND POWER

12.9.3.1 Conductors

12.9.3.1.1 Conductors shall consist of high conductivity annealed copper wires and conform to the requirements of AS 1125 unless specified otherwise.

12.9.3.1.2 Cables shall have no fewer than 19 strands, each of which shall have a diameter of 0.5 mm, 0.4 mm, 0.3 mm or 0.25 mm. Conductors shall be tinned if insulated with rubber or rubber like materials.

12.9.3.1.3 Size of conductors unless specified otherwise shall be:

Area sq. mm	Stranding
1.5	30/.25
2.5	50/.25
6	84/.30
10	80/.40
16	126/.40
25	196/.40
50	396/.40
70	360/.50
95	475/.50
120	608/.50
150	756/.50
240	1221/.50
400	2013/.50

12.9.3.1.4 Current Ratings

12.9.3.1.4.1 The current rating of cables shall be determined in accordance with the conditions in which the cable will operate. It shall not exceed the maximum rating guaranteed by the manufacturer.

12.9.3.2 Insulation (Single Core Cable)

12.9.3.2.1 General

12.9.3.2.1.1 All cable exposed to the elements shall have a weather resistant and ozone resistant sheath. The location of such cable shall be clearly defined and approved by the Engineer.

12.9.3.2.1.2 All cables used shall be of a flame retardant type. These shall exhibit properties of low smoke, low acid-forming fumes and zero emission of halogens and toxic gases in fire situations; the cables shall also be drip free and show low flammabilility characteristics.

12.9.3.2.2 Extra Low Voltage

12.9.3.2.2.1 Cables used for extra low voltage circuits shall be ethylene proylene rubber (EPR) insulated and ethylene acrylic (EA) or ethylene methyl acrylate (EMA) sheathed; cross-linked polyolifin cables are also acceptable. Ethylene vinyl acetate (EVA) sheathed cables are unacceptable.

12.9.3.2.3 Low, Medium and High Voltage

12.9.3.2.3.1 Cables used for low, medium and high voltage circuits shall be EPR insulated and chloro sulphonated poly ethylene (CSP) sheathed or as specified for low voltage cables.

12.9.3.2.4 High Temperature Cable

12.9.3.2.4.1 These cables shall be approved by the System concerned, and shall be insulated and sheathed to conform with the appropriate Australian Standard and shall have strandings as nominated above.

12.9.3.2.5 Screened Cable (Multi-core Cable)

12.9.3.2.5.1 Multi-core cable with or without screening shall be approved by the System concerned. Screening shall only be used for earth connections and screening shall not be considered as a spare wire.

12.9.3.2.6 Control Jumper Cables

12.9.3.2.6.1 Details of jumper cables and weather proofing arrangements shall be approved by the System concerned.

12.9.4 CABLE INSTALLATION

12.9.4.1 General

12.9.4.1.1 Connections shall only be made at proper switch terminals, multi-pin plugs, or in connection boxes of an approved design. Adequate protection shall be afforded to cables to prevent the possibility of chafing occurring, particularly where entering boxes and where in restricted enclosures. Care shall be taken not to overcrowd junction boxes.

12.9.4.1.2 Where cables are installed in confined spaces (eg. ducts, equipment cubicles etc.) there shall be no undue pressure placed on the cables in order to fit lids, covers etc. or other equipment that impinges on cabling.

12.9.4.1.3 Where it is necessary to protect cables and an approved type of edge protection cannot be fitted, an approved form of robust rubber or equivalent material shall be used. This shall be mechanically fixed in an approved manner.

12.9.4.1.4 The minimum bend radius of the cable shall be as specified by the cable manufacturers. Power cables and shielded cables are of particular importance. As a general guide the minimum bending radius for single core cables shall be five times the outer diameter (O.D.) of the cable.

12.9.4.1.5 Cable installation shall ensure that the cable is protected from damage due to pedestrian traffic, other components or material, or construction and maintenance activities.

12.9.4.2 Cable Terminations

12.9.4.2.1 Crimp type terminals are the preferred method of terminating all cables. The crimp terminal shall be approved by the System concerned and shall be checked for correct application.

12.9.4.2.2 Terminals which do not require crimps may be approved and shall be checked for correct application.

12.9.4.2.3 Terminals applied to cables up to at least 120 mm shall have an insulation support.

12.9.4.2.4 The current rating guaranteed by the manufacturer shall not be exceeded.

12.9.4.2.5 Routine checking of crimps and crimping tools shall be prescribed for each type and size of crimp used. Checking may be by any method bearing valid relationship to the type test. It shall be demonstrated that the routine check discriminates between acceptable and unacceptable crimps.

12.9.4.2.6 Operators performing crimps shall be fully trained in correct application and shall have reached adequate proficiency before being permitted to perform crimps.

12.9.4.2.7 Approved multi-pin plugs shall be used where required, particularly for apparatus or circuits which need to be disconnected frequently for inspection or maintenance.

12.9.4.2.8 No splices shall be permitted in wire of any circuits in any duct or conduit. Specific approval of the Engineer is required in each individual case to make a splice in a junction box or equipment case.

12.9.4.2.9 No soldering or solder type joints shall be permitted on wiring terminating at terminal boards or at terminals on apparatus.

12.9.4.2.10 The use of flat, quick-connect (push-on) type terminals is not recommended; screw type terminals are preferred.

12.9.4.2.11 No electrical terminal, irrespective of the method of securing, shall be painted over.

12.9.4.2.12 Where multiple or common terminations are required, this shall be done with an approved terminal strip.

12.9.4.2.13 Lugs shall not be cut, filed or physically altered to permit fitting to a termination.

12.9.4.2.14 Cable terminations which have one or more wire strands which have been cut or nicked during stripping or fitting of the lug or termination are not acceptable. No wire strands of the conductor shall protrude outside of the barrel

of the lug or termination.

12.9.4.2.15 The number of lugs under one termination shall not exceed two. Lugs terminated at one point shall have identical mounting surfaces both in area and thickness irrespective of the cable size.

12.9.4.2.16 Lugs shall be arranged so that they are fully seated and are not distorted or bent.

12.9.4.2.17 In all cases, it shall be assured that sufficient spare loom or cable is available to enable the cable termination to be replaced/repaired three times.

12.9.4.3 Marking and Numbering

12.9.4.3.1 Each terminal and each end of each wire or cable shall be fitted with a permanent label. This labelling shall show the wire numbers corresponding to those shown on schematic diagrams for particular circuits concerned. Cable markers shall be placed on cable (including spare cables) so that they can be easily read without the need to unduly adjust the cables.

12.9.4.3.2 Any wire connection to earth shall be marked by means of green plastic tubing at least 30 mm long placed over the wire and retained directly before the terminal.

12.9.4.3.3 A run of wire shall be considered to be from termination to termination without the wire being joined by a splice, terminal strip or any other method. Wire numbers shall not be repeated on different wire runs.

12.9.4.3.4 When two or more runs of wire are joined at the same termination, the wire numbers of each run of wire shall be distinguished by placing a numerical suffix after a decimal point (dot) following the 'main' wire number which shall be common (eg. 283.1, 283.2 or 283.01, 283.02 etc.). The method chosen shall be consistent throughout the vehicle.

12.9.4.3.5 Distinct wire runs may include alpha characters as either suffixes or prefixes in the wire number (eg. 283a, 283b or A283, B283). Wire runs having wire numbers including alpha character suffixes or prefixes shall be used in distinct circuit areas and shall not be distributed throughout different circuits on the vehicle. For instance, wire numbers 283a and 283b could be used on either side of the relay contact in the auxiliary compressor circuit but a wire in the traction motor blower control circuit shall not be marked 283c. Wire runs with different supply voltages, even if they are in the same distinct circuit area, shall have different numerical wire numbers and shall not be distinguished simply by a change of suffix or prefix of the same numerical wire number.

12.9.4.3.6 All spare cables shall be labelled at both ends. The spare cable wire numbers shall each be prefixed by 'SP'.

12.9.4.4 Wire Harnesses

12.9.4.4.1 Cables or wires arranged in bundles shall be pre-fabricated in bench-assembled, completely interchangeable harnesses. Where a number of pre-fabricated looms are grouped together in ducts, it shall be possible to remove and replace any single loom without unduly disturbing the others. Each loom is to be identified at its ends. In conduits, wire may be loomed but shall be drawn in so that they can be replaced individually.

12.9.4.5 Connectors

12.9.4.5.1 Plugs/receptacles with solder pot connections shall not be used at any location; only plugs/receptacles with crimped and/or screw connections capable of individual removal and replacement will be approved.

12.9.4.5.2 Where the plug/receptacle is to be used in a location where it may be exposed to the elements or fuel and oil, an environmental plug/ receptacle shall be used according to the manufacturer's recommendations and any departure from these recommendations requires approval.

12.9.4.5.3 Plugs and receptacles shall not be mounted in the vertical down position to prevent the entry of condensate or moisture into the plug/receptacle via the cable.

12.9.4.5.4 Any plug/receptacle mounted on the axle or any other place likely to encounter recurring high 'g' forces requires specific approval as to the method of mounting and any modifications which may be necessary.

12.9.4.5.5 In all cases, it shall be assured that sufficient spare loom or cable is available to enable the connector to be easily dismantled, the cable severed at the plug/receptacle entry and be replaced in this manner three times.

12.9.4.5.6 Where it is possible to use a vehicle in service with uncoupled plugs hanging loose, or with exposed connections on unused receptacles, or where equipment will be frequently disconnected, permanently fixed dummy sockets/covers shall be provided to protect the plug/receptacle and to cover any exposed connections.

12.9.4.6 Damaged Cable Covering

12.9.4.6.1 Where any cable covering is found to be damaged from cuts, tears, crushing, etc., the run of cable shall be removed and replaced.

12.9.4.6.2 However, where the replacement of cable is difficult and the damage is to the sheath only, approval may be given to permit sleeving of the damaged cable with a 'heat-shrink' sleeve, depending on the extent of damage. No cable may be sleeved or otherwise repaired without approval.

12.9.4.7 Safety Wires

12.9.4.7.1 These should be kept separate as far as possible from other wiring i.e. any long lengths shall be run in separate conduits or ducting and separate terminal panels or at least distinct areas of common terminal panels shall be used.

12.9.4.8 Interference-sensitive Wiring

12.9.4.8.1 Where interference-sensitive wiring is installed, it shall be twisted screened cable. The screen shall be continuous through any intermediate connections and shall only be earthed at one end. Precautions shall be taken against the possibility of a screen being earthed at both ends on any single run between terminals. To terminate the screen, the shield strands shall be twisted for the required length, sheathed and have the specified insulated crimp connector fitted.

12.9.4.9 High Temperature Wiring

12.9.4.9.1 Where high heat radiating equipment is used, high temperature insulated cable shall be connected to the equipment. Use of other than high temperature cable shall require approval. It is not permissible to run low temperature cable above or in close proximity to hot equipment. The insulation of cables shall not be affected by high heat radiating apparatus.

12.9.4.9.2 The use of plastic items in the vicinity of heat generating electrical devices, (i.e. dynamic brake resistors, high power rating resistors, etc.), used for cable termination, support or identification shall be avoided. This precludes the use of nyloc nuts, cable spiral wrap and cable markers that are affected by heat.

12.9.4.10 MU Jumper Cables

12.9.4.10.1 Where MU plug and receptacles are provided with a permanently wired jumper cable, a dummy receptacle shall be provided to receive the plug of the jumper cable when not in use. The design shall prevent water entry into the plugs. The plug and receptacle combinations shall be certified to the International Protection (IP) rating IP56 as defined in AS 1939,
(i.e. 5: Protected against dust. Prevent entry in sufficient quantity to interfere with satisfactory operation, and 6: Protected against jets of water of similar force to heavy seas).

12.9.4.10.2 Receptacles and dummy receptacles shall be so arranged that the jumper cables can be plugged in and withdrawn by a person standing on the ground.

12.9.4.10.3 Lengths of cables and location of permanent attachment shall be such that an unplugged cable shall not fall within 200 mm of top of rail.

12.9.4.10.4 Plugs and receptacles shall be waterproof and keyed to ensure incorrect insertion cannot be made.

12.9.4.10.5 Plugs when in position shall be suitably locked in the receptacles to prevent them becoming loose and falling out. Such locking shall not, however, prevent their being withdrawn without damage in the event of the vehicle being driven apart.

12.9.4.10.6 Design of the plugs shall be such as to facilitate rapid coupling and uncoupling of vehicles.

12.9.4.10.7 Attaching of the jumper cables to the vehicles and plugs shall be effected so as to grip the outer sheath of the cables in such a manner as to prevent tension being exerted on the terminals.

12.9.4.10.8 Suitable terminal boards shall be provided to facilitate removal and replacement of jumper cables and wiring to receptacles when necessary.

12.9.4.10.9 The housing of plugs and receptacles shall be split into two sections and designed to enable the front portion to be unscrewed and replaced or repaired if necessary without disconnecting the control wires.

12.9.4.11 Spare Cables

12.9.4.11.1 Spare cables shall be provided for future use in all conduit/duct runs as follows:

(a) At least one spare cable, of each wire size or cable type, per eight utilised cables of that type in any loom. If there are less than eight utilised cables in any loom, at least one spare cable of each wire size or cable type shall still be provided.

Where screened/twisted pair cables are utilised in any loom, complete spare screened/twisted pair cables shall be provided according to the minimum spare cable requirements detailed above. No unutilised wire or screen from a partially utilised screen/twisted pair cable shall be deemed to fulfil the requirements of a complete spare cable mentioned above.

(b) All spare cables coming from any duct or conduit shall be bound together and left such that all spare cables can be located easily and quickly. To ensure easy access, standard locations for spare cables shall be used consistently throughout the manufacture of all vehicles. The spare cables shall be numbered using a system that identifies each cable and its run. The individual cable markers shall be able to be easily read while the spare cables are still bound together.

(c) Any cables which will be difficult to access on a completed vehicle shall be provided with the same minimum spare cable requirements mentioned above.

(d) All spare cables shall be long enough in order to be properly terminated, (see Cable Termination Section 12.9.4.2), to the termination that requires the longest length of cable within an enclosure. This length shall allow for the spare cables to be strapped to the appropriate wiring looms of the cable runs within the enclosure.

12.9.4.12 Spare Terminations in Plugs and Terminal Strips

12.9.4.12.1 All equipment cabinets, junction boxes, terminal boards etc. to which spare cables run shall have sufficient unused termination points to terminate at least 50% of the spare cables entering the enclosure, or likely to enter the enclosure if the spare cables are bound together outside the enclosure, to separate termination points. Where only one spare cable is provided, at least one spare, separate termination point shall be provided. Each of these separate termination points shall permit the termination of at least two spare cables, and comply with the Cable Termination Section 12.9.4.2.

12.9.4.12.2 Where connectors such as those specified in the Connectors Section 12.9.4.5 of this document are utilised, spare connections shall be provided as follows:

(a) For eight or less utilised connections, at least two spare connections shall be provided.

(b) For greater than eight utilised connections, two spare connections plus at least one spare connection per eight or part thereof utilised connections shall be provided.

12.9.5 CONDUITS, DUCTS, CABLE SUPPORTS AND JUNCTION BOXES

12.9.5.1 General

12.9.5.1.1 Initial conduit and duct design shall be generous to allow for additional cables which may be necessary to install during prototype development.

12.9.5.1.2 All cables external to equipment cases shall be run in steel conduit or closed steel ducting (cable troughing) of adequate size such that the ratio of the sum of the effective cross sectional area of the cables to the minimum internal area of the duct or conduit does not exceed 0.4. This requirement shall be strictly enforced to ensure the ease of future access to the conduit or ducting as well as providing adequate protection for the cable. Cables in ducts or conduit shall be adequately derated for the ambient conditions applicable.

12.9.5.2 Conduit

12.9.5.2.1 All rigid conduits shall be galvanised steel, seamless, oil proof and have threaded and painted ends and comply with AS 2052. PVC conduits shall not be used.

12.9.5.2.2 The ends of all conduits shall be bushed to provide a smooth entry for the cable and in particular bushings used for power cables in conduit shall be of an approved design. Where power cables leave conduits and are subject to flexing, an approved bush shall be used.

12.9.5.2.3 Use and type of metallic, flexible, liquid tight conduit shall require approval and precautions taken to prevent any flexible conduit from 'kinking'. Flexible conduit shall be cleated at points not greater than 400 mm apart. Flexible conduit shall only be approved for use when absolutely necessary, and only then for short distances.

12.9.5.2.4 Wires run in conduit shall not be bound together but be capable of being individually drawn through.

12.9.5.2.5 The securing or suspension of conduits to or from other conduits or pipes which have been secured to the body is not acceptable.

12.9.5.2.6 Conduits shall be supported with correctly curved, full saddles unless approved otherwise by the Engineer. When securing the saddles, deformation of the conduit shall be prevented, even if the securing means is over tightened. The saddle shall also not be distorted during such a tightening process. Conduits shall not be welded for support.

12.9.5.2.7 Conduit fittings shall be smooth and free from burrs. This also includes the inspection outlet.

12.9.5.2.8 The use of multiple conduit fittings is to be avoided where a single fitting could be used.

12.9.5.3 Ducting

12.9.5.3.1 All electrical ducts shall be made of Galvabond grade GC, coating class Z300 steel sheets. PVC ducting shall not be used.

12.9.5.3.2 All ducting shall have a smooth interior, with a removable section such that access to cables is possible throughout the length of the duct. Entry into a duct shall be made in such a manner that there is no likelihood of damage occurring to any cabling and also such that access is available to manipulate the cables or looms or to add or remove wires in the cables or looms that are leaving or entering the duct without disturbing the main cabling in the duct. Where protective surfaces of ducts have been damaged, (i.e. welding, grinding etc.), the affected surface shall be properly prepared and treated with an approved paint system. This applies to both the outside and the inside of ducts.

12.9.5.3.3 Lids of ducts shall be easily removable and replaceable. Lids of ducts shall not require the application of any undue mechanical assistance when being removed and replaced. There shall be no likelihood of damage occuring to any cabling when removing and replacing lids of ducts. All fasteners required to secure lids of ducts shall be external to the duct.

12.9.5.3.4 The actual entry into a duct shall be an approved bushing or be lined in an approved manner so that chafing or damage to cable cannot occur during installation, service or maintenance.

12.9.5.3.5 Where wiring ducts are used, separate ducts shall be provided for wiring of high voltage and low voltage circuits.

12.9.5.3.6 Where a cable is run in a vertical duct, care shall be taken to prevent damage to loose cable.

12.9.5.3.7 The ducts shall be attached securely to the vehicle structure. Externally mounted ducts and internally mounted ducts near doorways shall be rendered water resistant. Where glands are used to provide a waterproof entry, they shall not bear the weight of the cable.

12.9.5.3.8 Cables installed in ducts shall not rely on the lid of the duct for support. Cables shall be fixed so that on removal of any lid, the cables shall remain within the duct. Cables shall be installed in the duct neatly and systematically to avoid damage.

12.9.5.3.9 Ducts shall be free from swarf before the laying of cables. If fitting work is performed near open ducts with cables in them, precaution shall be taken to prevent the ingress of swarf into the ducts and cables. At all stages of manufacture, ducts with cables in them shall be kept free from swarf.

12.9.5.4 Support of Cables Not in Conduit, Flexible Conduit or Ducting

12.9.5.4.1 All open power cabling shall be adequately supported by clamps or cleats. Cleats shall be designed to clamp suitably the particular cable used. It shall be ensured that open cabling does not and cannot rest or rub on any part of the body, in particular metal parts, other than where it is held in the cleats. The maximum clamp/cleating distance shall not exceed 400 mm, except where a flexible lead is connected to a moving part. If metal cleating is used, suitable packing made of an approved insulating material shall be used between the cleat and the cable and shall project at least 6 mm each side of the cleat.

12.9.5.4.2 This packing shall be mechanically fixed to the cleat so that the cleat and insulation cannot be separated if the cleat is removed from the cable. Adhesive bonded or adhesive type cleats shall not be used.

12.9.5.4.3 Wooden cleats shall not be used. Where metallic clamps or bars are required, stainless steel bars or clamps shall be used to ensure that a magnetic path is not created.

12.9.5.4.4 All cable bundles within equipment cases and not in conduit or ducting shall be made rigid, if necessary by the use of stiffeners attached to the equipment case frame. Stiffeners shall be covered with an approved insulating covering.

12.9.5.4.5 A cable not in a conduit shall not depend for its support on crimped or soldered connectors but shall be adequately supported by other means.

12.9.5.4.6 A suitable, mechanically secure object such as a stiffener, looming bar or screwed or riveted cable tie anchor shall be used when a cable tie is used to support a cable. Adhesive-backed cable tie anchor pads shall not be used.

12.9.5.4.7 The drawing of cables through loosely clamped cleats should be avoided. Where it is absolutely necessary, care shall be taken to avoid 'tearing' or 'cutting' of cable sheath or insulation on the edge of cleats.

12.9.5.5 Junction Boxes

12.9.5.5.1 All junction boxes shall be designed and constructed such that easy access to all terminals is maintained. A high standard and consistency of workmanship is required.

12.9.5.5.2 The IP rating for junction boxes mounted on the under frame shall be IP56.

12.9.5.5.3 Cables shall not be run over the top of terminals or in any way restrict access to them for testing or disconnection purposes. Direct point to point wiring of junction boxes shall be avoided. Due regard shall be given to the ease with which a tradesman may at a later time, disconnect, connect and trace wires on the terminal boards. Cables shall be adequately supported on taped loom bars so that no strain is imposed on the terminations.

12.9.5.5.4 A minimum of 150 mm shall be allowed between rows of terminal strips for wiring access.

12.9.6 BARE CONDUCTORS

12.9.6.1 All surfaces in contact of electrical connections e.g. copper to copper, copper to brass etc. shall be properly plated and the type of plating shall be approved.

12.9.6.2 Copper to steel connections shall be made by brazing a suitable piece of copper onto the steel as a connection base, and suitably tinning the connection area.

12.9.6.3 Copper connections shall be such that there shall be no possibility of loosening of joints or of damage by expansion or overheating of insulated parts.

12.9.6.4 Provision shall be made on all roof connections to allow for expansion, contraction and vibration to avoid undue strain being imposed on roof insulators.

12.9.6.5 All flexible braided copper leads on pantographs, switches, contactors etc. shall have entry to the lugs bell mouthed.

12.9.6.6 Bare conductors mounted on the inside of doors of low and high voltage cubicles shall be suitably protected for the safety of maintenance personnel.

12.9.7 ELECTRICAL CUBICLES AND ENCLOSURES

12.9.7.1 All electrical cubicles or enclosures shall be located and sealed so as to be protected from external contaminants such as dirt, oil, rain and cleaning solutions and from contamination which might occur from failure of water, oil or fuel systems on the vehicle.

12.9.7.2 The sealing shall be of sufficient quality to prevent water entry due to hosing down of the enclosure. Enclosures located on the underframe shall withstand high pressure steam cleaning without leakage. (Refer to the Junction Boxes Section 12.9.5.5 for IP rating). The use of filling or sealing compounds such as silicon rubber shall be minimised.

12.9.7.3 Seals shall be made of approved moulded material, and fitted into the equipment box in such a manner that they cannot be dislodged and have a life of at least twelve years.

12.9.7.4 Removable lids or covers shall be jig assembled to ensure interchangeability. Covers which swing from a top hinge may be held in the open position by a prop or latch which automatically locks in place when the door is opened. Small cabinet covers with hinged covers shall use brass hinges and brass or plated nuts and bolts. If doors will be required to be removed from an enclosure for any maintenance purposes, they shall be constructed such that the use of tools is not necessary for their removal.

12.9.7.5 Cable entry into cubicles or enclosures shall be such that cables will not be damaged during installation, removal or in service. All entries of cables and conduits into external boxes shall be weatherproof and shall not enter into boxes vertically, so that moisture cannot run down the cable and enter the box. It shall also be ensured that the bend radius of cables is not less than the minimum allowed and cables shall not be exposed to chafing or sharp edges.

12.9.7.6 Access into the cubicles or enclosures shall be sufficient to allow reasonable access to equipment and cables within to enable servicing and maintenance to be carried out. In particular, items such as fuses, fusible links and cable connection points, which may have to be removed in service, shall be located in easily accessible positions. The access seals and door catches shall be of an approved type, capable of easy release without tools except in the case of safety interlocked high tension chambers. On underfloor boxes, catches shall be arranged so that it is obvious from a normal standing position whether they are fastened or not.

12.9.7.7 All electrical enclosures shall have a component layout decal fitted in a place which can be easily read when the door is open, or cover is removed, and each component or group of components shall be identified by number or appropriate code.

12.9.7.8 Enclosures which have two (or more) doors shall have the doors separately identified so that confusion will not arise.

12.9.7.9 Temperatures within electrical cabinets or compartments shall be no greater than 10 C above the outside ambient temperature.

12.9.8 PROTECTION

12.9.8.1 All circuits shall be protected by magnetic circuit breakers. Fuses may only be used where approved by the System concerned. Each non-earthed pole of the circuit shall be protected. The right hand terminal (facing the rear of the apparatus) or the top terminal shall be connected to the incoming live wires.

12.9.8.2 Circuits supplying different types of equipment shall not be combined and protected by the same circuit breakers.

12.9.8.3 The rating and capacity of circuit breakers and other protective devices shall be standardised as much as is practicable. Their rating and their installation and location in the circuit shall be such that the local circuit breaker nearest the fault shall isolate the fault and not cause a more serious isolation than necessary.

12.9.8.4 Care shall be taken in the supply to any circuits which have inductance or capacitance. The rating of any interlocks in these circuits shall not be exceeded. Large coils etc. require protection such as the use of diodes.

12.9.8.5 All D.C. power sources, including batteries, shall be protected by an HRC fuse in the positive line.

12.9.9 SAFETY AND EARTHING

12.9.9.1 Safety

12.9.9.1.1 All installations shall be so arranged that no person can come inadvertently into contact with live parts. Live parts however, may be exposed:

(a) In a compartment to which only authorised persons have access, except where bare conductors are mounted on the inside of doors of low and high voltage cubicles. (Refer to Bare Conductor Section 12.9.6).

(b) Where live parts are isolated by virtue of height or location.

12.9.9.1.2 Where a danger of contact with high voltage could exist, warning signs shall be affixed in a prominent position.

12.9.9.1.3 Circuit breakers that are required to be reset by non-electrical staff shall be mounted external to electrical cabinets and all connections fully protected against accidental contact.

12.9.9.1.4 Plugs which could be disconnected and present any exposed pins at high voltage shall be avoided where possible. If it is not possible to avoid this, then appropriate warning signs shall be displayed on the plug or adjacent to the receptacle, whichever has the live pins.

12.9.9.1.5 The earth side of all low voltage circuits shall be connected to an earth bus bar which shall be bonded to the vehicle underframe.

12.9.9.1.6 No earthing of any part of any circuit, neither a.c. nor positive or negative d.c., other than for an earth protection circuit shall be permitted unless requested and approved by the Engineer.

12.9.9.2 Earthing

12.9.9.2.1 All metal enclosures, doors, sheathing, conduit and metallic accessories forming part of the wiring system shall be earthed to the underframe of the vehicle. Whilst conduit carrying high voltage cables shall be earthed, conduits carrying low voltage cables may not need to be directly earthed if they are metallically connected to the vehicle underframe.

12.9.9.2.2 An external three phase, shed supply used to provide power to a vehicle's auxiliary circuits during maintenance periods shall provide an earth for the vehicle supply socket.

12.9.9.2.3 Where small individual pieces of equipment, that are required to be earthed, are supplied with power via a plug,

the earth shall be wired via that plug.

12.9.9.2.4 Where a component is welded to the underframe or welded to body parts which are in turn welded to the underframe, it shall be considered as effectively earthed.

12.9.9.2.5 On rolling stock, earth straps shall be fitted between vehicle body, bogies, axle boxes and traction motors.

12.9.9.2.6 Where the component is bolted, attached through rubber couplings or semi-permanently attached to the underframe, it shall not be considered effectively earthed and it shall be bonded to the underframe by an earth strap.

12.9.9.2.7 Unless otherwise approved, the size of earthing conductors shall be in accordance with Section 5.5.3 of AS 3000 Part 1. See also Marking and Numbering Section 12.9.4.3 for the marking details of earth conductors using green tubing.

12.9.9.2.8 The terminal to which the earth strap is connected on the item and the body shall be either stainless steel or brass and securely welded, brazed or silver soldered to the component or body. The fastener, nut and washer used shall also be stainless steel or brass.

12.9.10 DIELECTRIC TESTS

12.9.10.1 Dielectric tests shall be performed as routine tests on equipment.

12.9.10.2 The main purpose of this test is to check that the cables of the various circuits of the vehicle are in good condition and have not been damaged during installation.

12.9.10.3 High-potential tests shall be carried out using either a.c. or d.c. voltage and shall be for a duration of one minute. Equipment case wiring shall be tested before and after installation in the vehicle.

12.9.10.4 Tests made with alternating voltage shall have a sine wave form at a frequency between 25 and 100 Hz. The test voltage shall be rms. In the case of d.c. tests, the test voltage shall be 1.5 times the rms test voltage.

12.9.10.5 Wiring shall be tested in accordance with the following tables:

RMS TEST VOLTAGE (Volts)

Circuit	Equipment Case	Vehicle Wiring Wiring Before Installation on Vehicle	Including Equipment After Installation on Vehicle
Traction Control		1500	1000
Auxiliary Control		1500	1000
Traction		2.5u + 2000	85% x (2.5u + 2000)
H.V. Auxiliary	2u + 1500	85% x (2u + 1500)	

u = supply voltage to earth of the equipment

12.9.10.6 When the above tests are being carried out, the following circuit conditions must be observed:

(a) All meters, instruments, batteries and electronic equipment shall be disconnected.

(b) All circuits not under test shall be connected to earth.

(c) The tests shall be made between each pole and earth and between poles.

12.9.10.7 Insulation Resistance Tests shall be carried out before and after the hi potential tests with a 1000 V megger tester. There shall be no change in the value of insulation measured before and after the hi potential test.

12.9.10.8 The minimum acceptable value of insulation resistance for each of the groups of circuits is:

	MEGOHMS	
Circuit	**Equipment Case Wiring Before Installation on Vehicle**	**Vehicle Wiring Including Equipment After Installation on Vehicle**
Auxiliary Control	50	2
H.V. Auxiliary	50	5
Heating Elements	-	2

12.9.11 PHASE ROTATION

12.9.11.1 The phase rotation for the Head End Power jumper cable wiring shall be clockwise, i.e. Red-White-Blue.

12.9.12 HEAD END POWER RECEPTACLE POSITIONS

12.9.12.1 The position of the Head End Power receptacles at the end of the vehicle shall be approximately 900 mm from the centre line of the vehicle and approximately 900 mm from the rail level.

12.10 PASSENGER COMFORT INDEX AND MEASUREMENT, NOISE LEVELS AND VIBRATION

Compliance with the requirements of this sub-section is mandatory.

12.10.1 REFERENCES

AS 1269 : "Acoustics - Hearing Conservation Code".
AS 2377 : "Methods for Measurement of Airborne Sound from Railbound Vehicles:
AS 2399 : "Personal Noise Dosemeters"
AS 2670 : "Vibration and Shock - Guide to the evaluation of human exposure to whole-body vibration"

12.10.2 RIDE QUALITY

12.10.2.1 Passenger vehicles in all types of service shall be designed to provide smooth acceleration and deceleration without noticeable impacts.

12.10.2.2 For the Reduced Comfort Boundaries in table 1, vibration shall be measured in three orthogonal axes (preferably simultaneously) using accelerometers placed between the seat and the driver/passenger. Instrumentation and analysis methods are to be in accordance with AS 2670. The mass of the driver/passenger under which the accelerometer is placed shall not exceed 85 kg.

12.10.2.3 The ride quality parameters in Table 12-1 shall be observed.

TABLE 12-1
RIDE QUALITY PARAMETERS

Parameter	Commuter	Medium Distance	Long Distance
Ride Index (a)	2.80	2.75	2.75
Acceleration (b)	0.3 g	0.3 g	0.3 g
Reduced Comfort Boundary (c)	1 hr	12 hrs	24 hrs
Fatigue-Decreased Proficiency Boundary (d)	8 hrs	8 hrs	8 hrs

Notes:

(a) Ride index, lateral or vertical,shall not exceed the indicated values (See 12.10.5 for ride index algorithm).
(b) The peak acceleration (0-20 Hz band), laterally or vertically, over uneven track, points and crossings shall not exceed the indicated values.
(c) In all service conditions, including when the train is stationary, vibration at any passenger seat or standing position shall not exceed the indicated "Reduced Comfort Boundary" of AS 2670 in any axis.
(d) In all service conditions, including when the train is stationary, vibration at any crew seat or standing position shall not exceed the indicated "Fatigue-Decreased Proficiency Boundary" of AS 2670 in any axis.

12.10.3 INTERIOR NOISE

12.10.3.1 All noise levels shall be measured at ear level (seated and standing) in accordance with AS 1269.

12.10.3.2 Internal noise from cars is to be measured with equipment and environmental conditions as defined in AS 2377 for both stationary and pass-by tests.

12.10.3.3 For L_{eq} measurements a personal noise dosemeter to AS 2399 or equivalent integrating sound level meter shall be used.

12.10.3.4 Internal noise shall be non-tonal. Evaluation shall be on the basis of 1/3 octave band analysis to comply with requirements for non-tonality.

(a) No third octave band below 160 Hz shall exceed either adjacent band by more than 15 dB.
(b) No third octave band in the range 160 Hz to 400 Hz shall exceed either adjacent band by more than 8 dB.

(c) No third octave band above 400 Hz shall exceed either adjacent band by more than 5 dB.

Unless otherwise stated, the overall linear noise level shall not exceed the overall A-weighted noise level by more than 15 dB.

TABLE 12-2 : MAXIMUM INTERNAL NOISE LIMITS IN A-WEIGHTED SOUND PRESSURE LEVEL (RE 2 x 10^{-5} Pa)

Condition, Location	Commuter	Medium Distance	Long Distance
Stationary, passenger (b)	65 dBA	60 dBA	55 dBA
Stationary, crew (b)	65 dBA	70 dBA	65 dBA
Maximum Speed, passenger (c)	70 dBA	70 dBA	60 dBA
Maximum Speed, crew (c)	70 dBA	70 dBA	70 dBA
Operating Speeds, passenger (dA)	75 dBA		
Operating Speeds, crew (dB)	80 dBA		

Notes:

(a) All levels quoted in Table 2 are with doors and windows closed and air-conditioning operating at full cooling load.
(b) Measured when train is stationary, in open country.
(c) Measured when train is at maximum speed, engine(s) at full load, in open country.
(d) Measured in normal operation (includes underground operation).
A - L_{eq}, fast response
B - L_{eq}, slow response
(e) Under all conditions, noise at infrasonic frequencies on a 24 hour exposure basis shall not exceed that set out in Table 3.

TABLE 12-3: MAXIMUM INFRASONIC LIMITS IN LINEAR SOUND PRESSURE LEVELS (RE 2 x 10^{-5} Pa)

1/3 Octave Band Centre Frequency	Commuter	Medium Distance	Long Distance
1 Hz	130 dB	128 dB	126 dB
5 Hz	124 dB	122 dB	120 dB
10 Hz	121 dB	120 dB	118 dB
20 Hz	118 dB	118 dB	117 dB

Notes:

(a) Internal pressure change rates shall be limited to a maximum of 0.5 kPa/second.
(b) For Infrasonic frequencies use 3 dB increase in allowable exposure level for each halving of exposure time.
(c) Allowable levels between specified frequencies shall be determined by linear interpolation.
(d) Commuter values based on electric carriages, medium distance values based on self propelled diesel railcars and long distance values based on diesel hauled carriages.

12.10.4 EXTERNAL NOISE

12.10.4.1 External noise from cars shall be measured with equipment and environmental conditions as defined in AS 2377 for both stationary and pass-by tests.

12.10.4.2 External noise shall be non-tonal. Evaluation shall be in accordance with section 12.10.3.4.

12.10.4.3 Stationary measurements shall be carried out around a 7.5 m. contour according to Appendix A of AS 2377 to determine the location of the most significant noise source(s) of the train. These measurements shall be made for conditions (g) - (j) of Table 12-4.

12.10.4.4 Measurements shall be made on the 15 or 30 m contour developed as per the 7.5 m contour with the microphone 1.5 m above ground level. The measurement shall be perpendicular to the centre of the train on both sides and at any other points on the 15 or 30 m contour corresponding to the maximum levels.

12.10.4.5 Pass-by noise shall be measured in accordance with AS 2377 paragraph 9, with conditions (a) - (f) of Table 12-4.

TABLE 12-4 : MAXIMUM EXTERNAL NOISE LIMITS FOR SOUND PRESSURE LEVEL (RE 2 X 10^{-5} Pa)

Condition, Location	Commuter	Medium Dist.	Long Dist.
Normal service, 15 m from CL(a)	80 dBA	93 dBA	
Maximum ascent, 15 m from CL(b)	80 dBA	85 dBA	
Maximum descent, 15 m from CL(c)		85 dBA	
Normal service, 30 m from CL(d)		85 dBA	
Normal service, 15 m from CL(e)		80 dBA	
Normal service, 15 m from CL(f)		85 dBA	
Stationary, 15 m contour (g)		65 dBA	
		82 dB Linear	
Stationary, 15 m contour (h)		70 dBA	75 dBA
Stationary, 15 m contour (i)		85 dBA	85 dBA
		95 dB Linear	
Stationary, 30 m contour (j)	50 dBA		
Stationary, 30 m contour (k)	40 dBA		

Notes:

(a) In open country, 15 m from track center line, fast response.
(b) 60 km/h ascending maximum gradient at full power in open country, 15 m from track center line, fast response.
(c) 60 km/h gradient with full dynamic brake, in open country, 15 m from track centre line, fast response.
(d) Maximum noise level at 30 m from track centre line for conditions (a) - (c).
(e) All speeds, engine at idle.
(f) All service conditions.
(g) Stationary, no load conditions, engine at idle, 15 m contour, fast response.
(h) As per (g) except with full load conditions (air conditioning, compressors etc. at full load).
(i) As per (h) except with engine(s) at full load.
(j) Stationary, full load conditions (air conditioning, compressors etc. at full load), 30 m contour, fast response.
(k) As per (j) but train stabled with cleaning facilities operating.

12.10.5 RIDE INDEX ALGORITHM

12.10.5.1 Acceleration data is weighted by the function

$$RI_i = 7.07\ (V_i)^{0.1}$$

Where the i-th value refers to the peak amplitude of a frequency component derived from a FFT analyser.

Use Table 12-5 to obtain values of V_i

TABLE 12-5 : VALUES OF V_i FOR RIDE INDEX EVALUATION

Frequency	Vertical	Lateral
0 - 6 Hz	0.325 FA^3	4.32 A^3
6 - 20 Hz	400 A^3	650 A^3/F^3
20 - 100 Hz	A^3/F	A^3/F

Notes:

(a) F = frequency (Hz)
(b) A = amplitude, g (1 g - 9.8 m/sec^2)

12.10.5.2 The total ride index is computed from the i-th values by:

$$RI_{total} = \Sigma_{i=1}^{i=n}[(RI_i)^{10}]^{0.1}$$

Notes:

(a) Frequency analysis will utilise FFT analysis of at least 400 lines with a 0.25 Hz resolution. Data is to be averaged over 32 averages to minimise statistical error (15 averages is acceptable for comparative evaluations only).
(b) Frequency band for analysis is from 0.5 to 50 Hz inclusive.
(c) Weighting filters implementing the above weighting are acceptable, provided:
    Integration is performed over 10-15 second periods
    The integrated values are recorded over at least 3 km of track and reported as mean and variance.
(d) Data from accelerometers for analysis shall come from testing at substantially constant speed (nominal +/- 5 km/h).

12.11 PASSENGER VEHICLE AIR CONDITIONING EQUIPMENT

Compliance with the minimum requirements of this sub-section is mandatory.

12.11.1 UNIT TYPE

The air conditioning unit shall be a self-contained roof- mounted unit incorporating all refrigeration and electrical components. Where space precludes the use of such a unit, a split system may be used with the compressor and condensor mounted on the underframe.

12.11.2 POWER SUPPLY

The electrical power supply shall be 415 Volt 3 phase, 50 Hz (± 5% Voltage ± 2% Frequency).

The control system shall be 110 Volt DC nominal.

12.11.3 RATING CONDITIONS

The cooling capacity of the unit shall be rated at the following conditions:

External Ambient-	35°C dry bulb.
Air onto evaporator coil-	26°C dry bulb. 20°C wet bulb.

These conditions shall be used for the comparison of the cooling capacity of all units throughout Australia. In addition, Systems shall quote the specific conditions for their particular operating environment for the guidance of manufacturers and suppliers.

12.11.4 CAR INTERIOR DESIGN CONDITIONS

(a) Cooling

The Design Internal Condition dry bulb temperature Ti shall be:

where the external dry bulb temperature, T_a, is greater than 36^oC:

$Ti = (Ta/_3 + 12)$

Where Ta is less than 36°C Dry bulb:

Ti = 24°C

The internal Relative Humidity shall be maintained at or below 65% RH for all internal dry bulb conditions.

(b) For long distance Cars on services of more than 8 hours duration, the cooling equipment shall maintain internal conditions at 24^oC dry bulb and a maximum of 60% relative humidity under all ambient conditions.

(c) Heating shall be designed to maintain the internal temperature within the range of 17°C to 22°C.

12.11.5 HIGH AMBIENT CONDITIONS

As a minimum requirement,the unit shall be capable of running in ambient temperatures up to 45°C without tripping safety controls or capacity unloading.

The unit shall continue to operate without shutdown in ambient temperatures up to 53°C.

NOTE: The maximum operating ambients may be higher for some areas of Australia, and operating conditions may include heavy rain and high levels of air-borne dust and sand. Systems shall specify the parameters appropriate to their requirements.

12.11.6 AIR VELOCITIES

The air velocity in supply air ducts shall be within the range of 4 m/s minimum, 8 m/s maximum,If possible the duct should taper away from the air conditioning unit so that air velocity is maintained in the duct as air is discharged.

The discharge velocity at diffusers shall be a maximum of 5 m/sec.

The design air velocity over passengers shall be 0.15 m/sec, with an absolute maximum im service of 0.3 m/sec.

The Return Air Grille velocity shall be a maximum of 2.5 m/sec.

12.11.7 FRESH AIR

The quantity of fresh air to be delivered by the air conditioning unit shall not be less than 5 litres per second per seated passenger.

12.11.8 NOISE LEVEL

12.11.8.1 Bench Test

The external noise level shall be measured for the unit standing alone, not fitted to a car.

The unit shall be hard mounted to a suitably rigid frame, so that no significant vibrations are set up in the frame. Supply air and return air openings shall be suitably baffled to minimise noise eminating from these areas. Maximum noise level with the unit mounted 1.0 to 1.5 metres above a reflecting plane operating in free field at full cooling capacity and design conditions shall be 65 dBa at 7.5 m from the centre line of the unit.

12.11.8.2 Internal

Internal noise level shall be measured with the unit fitted to the car, but without the return air grille fitted.

The maximum noise level shall be 65 dBa when measured 1 metre below the centre of the unit return air opening. Measurements shall comply with the requirements of Section 12.10.3.

External

The external noise level shall be a maximum of 65 dBA when measured 7.5 metres from the centre line of the unit. Measurements shall comply with the requirements of Section 12.10.4.

12.11.9 REFRIGERANT

The refrigerant used shall be R22, R134A or other approved non-ozone depleting chemical.

12.11.10 UNIT SHAPE

Wherever practicable the exterior of the unit shall conform with the car roof profile.

12.11.11 UNIT RETURN AIR OPENING

The return air opening shall be located on the lower face of the unit.

To allow access to electrical components and controls, the typical free area of the opening shall be as follows:

Length : 1200 mm
Width : 400 mm

12.11.12 CONDENSER AND EVAPORATOR COILS

(a) Condenser

Condenser coils shall incorporate copper tubes expanded into copper fins. Fin pitch shall not be less

than 3 mm. End plates shall be brass.

(b) Evaporator.

Evaporator coils shall incorporate copper tubes expanded into copper fins. Fin pitch shall be not less than 2.5 mm. Air velocity through the evaporator coil shall not exceed 2.8 m/s locally, or 2.5 m/s average. End plates shall be brass.

12.11.13 CASE MATERIAL

The case of the unit shall be constructed from Stainless Steel grade 304 or similar corrosion resistant material.

12.11.14 PIPEWORK

All piping shall be refrigeration grade copper tube to AS1571.

12.11.15 CONDENSATE

The condensate drains shall be capable of draining effectively with the air conditioning unit tilted to an angle of up to 6° laterally.

12.12 TOILET AND DISABLED PASSENGER FACILITIES

12.12.1 REFERENCES

12.12.1.1	AS 1428.1 Design for Access and Mobility	Part 1 General Requirement for Access - Buildings.
12.12.1.2	AS 1428.1 Supplement 1	
12.12.1.3	UIC Code 563-3	1st Edition Indications for the layout of coaches suitable for conveying disabled passengers in their wheelchairs.

12.12.2 WHEELCHAIR AND OCCUPANT CHARACTERISTICS

12.12.2.1 Wheelchair Dimensions

Figures C1 and C2, AS 1428.1 Supp. 1 show an A80 wheelchair which is dimensionally as large as 80% of the wheelchairs currently in use in Australia.

12.12.2.2 Wheelchair Mass

Manual wheelchairs are typically 20-35 kg.
Motorised wheelchairs are typically 45-80 kg.

12.12.2.3 Occupant Reach Limits

Figure C2, AS 1428.1 Supp. 1 and Appendix 3, UIC 565-3 show the reach limits of a wheelchair occupant.

12.12.3 ACCESS RAMPS

(a) SLOPE:

Unaided use:

Maximum gradient of 1 in 8 for ramps less than 1520 mm long.
Maximum gradient of 1 in 14 for ramps greater than 1520 mm long.

Assisted use: Maximum gradient of 1 in 6 .

(b) KERBING:

Kerbing on the sides of ramps shall be provided complying with Clause 6.3(f) of AS 1428.1.

(c) LEDGES AND STEPS:

No ledge or step in a ramp shall exceed 3 mm.

There shall be no blending of surfaces.

12.12.4 FLOOR SURFACE

12.12.4.1 Maximum Height Variations

Any variations shall be less than 30 mm with edges as rounded as possible.

12.12.4.2 Surface Features

Surfaces shall:

(a) be slip resistant, wet or dry. Static coefficient of friction to be at least 0.4 between surface and synthetic sole shoe.
(b) consist of a large number of small projections
(c) be non-reflecting and glare free.
(d) be hard wearing.
(e) be anti-static.

12.12.4.3 Materials

Suitably textured short-pile carpet, cork, linoleum or vinyl are suitable floor covering materials in dry locations.

Suitably textured concrete, bituminous concrete, natural stone, paving bricks or slip resistant tiles are suitable in wet locations.

12.12.5 DOORS AND DOORWAYS

(a) Doorway opening width

Minimum clear doorway opening is 760 mm for frontal approaches.

(b) Circulation space at doorway

Swinging doors shall comply with Figure 13, AS 1428.1.

Sliding doors shall comply with Figure 15, AS 1428.1.

(c) Door glazing

Positioning of glazing shall comply with Clause 8.5.1 and Figure 17, AS 1428.1.

12.12.6 HANDRAILS AND GRABRAILS

(a) Location

Handrails or grabrails shall be provided at all entrance zones. Refer to Section 7(f) of this report for details on grabrails in toilet compartments.

(b) Construction

Use tubing of 30 - 40 mm diameter. Shall comply with Clauses 7.1 and 7.2 and Figure 10 in AS 1428.1.

(c) Handrail height

The top of the handrail shall be 865 - 900 mm above the floor.

12.12.7 TOILETS

(a) Unisex toilets

These are preferred as they allow an assistant of the opposite sex to accompany the disabled person into the toilet.

(b) Transfer from wheelchair to toilet bowl

Figure C11, AS 1428.1 Supp. 1 shows alternative wheelchair positions for transfer to the toilet bowl and the percentage of users for each position.

(c) Toilet bowl position and dimensions

These shall comply with Figure 19, AS 1428.1 or Appendix 7, UIC 565-3 for bowls allowing frontal and side access. Figure 19 has a longer minimum distance between the front edge of the bowl and the back wall to allow for improved side access.

(d) Toilet bowl seat

The seat shall be continuous and not slotted.

(e) Flushing control

The control shall be hand operated. Location of the controls shall comply with Figure 20, AS 1428.1.

(f) Grabrails

Figure 22, AS 1428.1 and Appendix 7, UIC 565-3 show approved grabrail systems for handicapped toilets.

(g) Toilet paper dispenser

Location of the dispenser shall comply with Figure 21, AS 1428.1.

(h) Circulation space

Pathway through the toilet door to the bowl shall be unobstructed and require minimal wheelchair manoeuvring.

The compartment shall allow room for an assistant to aid the disabled person when in the toilet.

(i) Communications

Toilet compartments shall be fitted with an emergency alarm and loudspeaker connected to the public address system.

(j) Examples

Refer to Supplementary Appendix 1, UIC 565-3 for examples of disabled accessible toilets on some existing European rolling stock.

12.12.8 WASHROOMS

(a) Washbasin

Washbasin layout shall comply with Figure 24, AS 1428.1.

(b) Water taps

Taps shall comply with Clause 12.3, AS 1428.1.

(c) Mirrors

A vertical mirror where provided shall be at least 350 mm wide and shall start no more than 900 mm above floor height and finish no less than 1850 mm above floor height.

(d) Other fixtures

Fixtures such as shelves, soap dispensers, hand dryers, disposal units and switches shall have their operative component or outlet located 900 - 1100 mm above floor height.

12.12.9 PASSENGER COMPARTMENTS ADAPTED FOR WHEELCHAIRS

(a) Holding of wheelchairs/occupants

It is not required to provided locking or holding devices between wheelchair and vehicle.

(b) Parking wheelchairs

Wheelchair parking areas shall allow wheelchairs to be parked in a longitudinal direction.

(c) Seating

A seat shall be provided for a travelling companion for each wheelchair bound passenger.

(d) Examples

Refer to Supplementary Appendix 1, UIC 565-3 for examples of passenger compartments for wheelchair bound passengers on some existing European rolling stock.

12.13 BRAKE SYSTEM

Compliance with the minimum requirements of this sub-section is mandatory.

12.13.1 Passenger vehicles shall be provided with an air brake system complying with the requirements of Section 7 wherever applicable. The brake system shall be controlled by a diaphragm type control valve with timings selected to suit passenger train service. The brake system may also incorporate graduated release, electro-pneumatic control, and control of brake cylinder pressure by means of a relay valve.

12.13.2 The equipment shall ensure that direct release of the air brake occurs within 6 to 8 seconds of the brake pipe pressure being restored.

12.13.3 Bogie brake systems may be of either the on-tread or disc system. Disc brake systems may have the disc mounted on either the wheel web or on the axle.

12.13.4 Each vehicle shall be fitted with an effective manually operated parking brake, which shall be fitted on the outside of the vehicle to enable its application and release while the vehicle is locked to prevent access to the interior. The mechanism may be of the transverse or end-mounted type.

Spring parking brakes may be fitted to the vehicle and shall comply with the requirements of Section 13.10.2.2. When spring parking brakes are fitted, indicators shall be provided to indicate the position of the mechanism, regardless of how the mechanism has been operated.