RCAR

Research Committee for Automobile Repairs

VEHICLE DESIGN FEATURES FOR OPTIMUM LOW SPEED IMPACT PERFORMANCE

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PERFORMANCE

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Acknowledgement

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Vehicle Design Features
for Optimum Low Speed Impact Performance

1.0 INTRODUCTION

Every year Insurance Companies throughout the world pay out huge sums of money in motor claims. A significant proportion of this payment relates to the repair of damaged vehicles. Returning the vehicle to its pre-accident condition on behalf of the policyholder is a costly and time consuming business and quite naturally insurers have striven to control this cost over the years. To achieve this objective the international Insurance Industry has always looked to its Research Organisations in various parts of the world to help in the fight to reduce or at least contain these repair costs.

The RCAR (Research Committee for Automobile Repairs) is an international body consisting of individual national Insurance Research Centres and Repair Committees concerned with motor repair research, training, and the pursuit of activities of common technical interest.

The overall objective of the Committee is to improve the level of safety, security, quality, design and method of repair of motor vehicles in order to reduce costs to the insurance industry and to the motoring public.

At the 1994 Annual RCAR Meeting held at Zaragoza in Spain, a decision was made to issue a Design Guide clearly indicating those features that optimize a vehicle's low speed impact performance. It was also agreed that this Guide would be used to provide a common world-wide standard that vehicle manufacturers and insurers would recognise and pursue.

2.0 SCOPE

The contents of this document can be applied to all private cars, car derived vans, "crew bus" and "people carrier" type vehicles of the monocoque design. Certain aspects can also be applied to "off road" passenger vehicles incorporating ladder type chassis frames.

3.0 PURPOSE

Given the international nature of vehicle design and production, the purpose of this document is to assist vehicle manufacturers everywhere to optimize the D&R features of their products by incorporating design features which enhance low speed crash performance. The main objective is to reduce overall crash repair costs and improve the vehicle's grouping without compromising occupant safety, crashworthiness and other statutory design requirements. It is recognised that local market conditions may require a more definitive set of principles than those herein. Each market should develop and expand the major concepts as required.

4.0 DAMAGEABILITY AND REPAIRABILITY

D&R can be summed up in the following way:

4.1 Damageability

This is the measure of a vehicle's ability to withstand the forces of a low speed impact, and is determined by noting which body structures and other components are damaged as a result of the impact. To improve damageability, the following questions must be addressed:

Should the structures and components have been damaged in the first place, and what can to done at the design stage to reduce or avoid damage altogether, especially where very expensive items such as ABS units, engine management computers and vital mechanical components are concerned?

4.2 Repairability

Having damaged certain components and structures during a low speed impact, the following questions must be addressed in order to improve repairability:

How easily, quickly and cost effectively can the damaged structures and components be repaired or replaced?

It is absolutely essential for manufacturers to incorporate the low speed insurance crash test into their new vehicle development programme in order that these questions can be considered and acted upon before the vehicle's design and packaging is signed off and fixed.

5.0 D&R VERSUS SAFETY

There is absolutely no conflict between good D&R design and vehicle safety. **Naturally safety and statutory design requirements take precedence over any D&R feature that may be mentioned in this document or considered desirable for a particular vehicle.** D&R features are usually associated with low speed crash performance and therefore the question of compromising safety rarely occurs. However, when contemplating a repair procedure, the safety and integrity of such a repair should be carefully considered.

6.0 THE INSURANCE CRASH TEST

The low speed insurance crash test has been adopted by The Research Committee for Automobile Repairs (RCAR). Therefore in countries where crash test results are considered for grouping or classification purposes, the insurance test is carried out to a uniform standard.

The standard insurance test reflects the typical low speed impact and provides the average level of damage that insurers are experiencing and paying for every day. The test is conducted as follows.

The subject vehicle is prepared and adjusted to its normal kerb weight by the addition of ballast as appropriate, plus a 75 kg dummy. The vehicle is then accelerated to a speed of 15 kph and allowed to impact into a specially shaped former on the front driver's side, 40% offset. Provided there is no major damage carried through to the rear, the vehicle is then placed on the crash pad and a 1000 kg mobile barrier is accelerated to a speed of 15 kph into the rear, 40% offset, with the vehicle's handbrake in the off position. The rear impact may be carried out on the driver's or passenger's side, depending upon the statistical information available for each country.

The results of the crash test, comprising parts cost and the labour utilization required to restore the vehicle to its pre-accident condition, indicate the D&R status of the vehicle.

Many manufacturers have incorporated the insurance test into the development programme for new models, and as a consequence they have been able to provide their engineers and marketing people with valuable information. The test serves to forewarn of any difficulties or problems that may arise with a production standard vehicle, and thus provides the opportunity to eliminate such difficulties at an early stage.

For more details of the insurance crash test parameters, see Appendix 1.

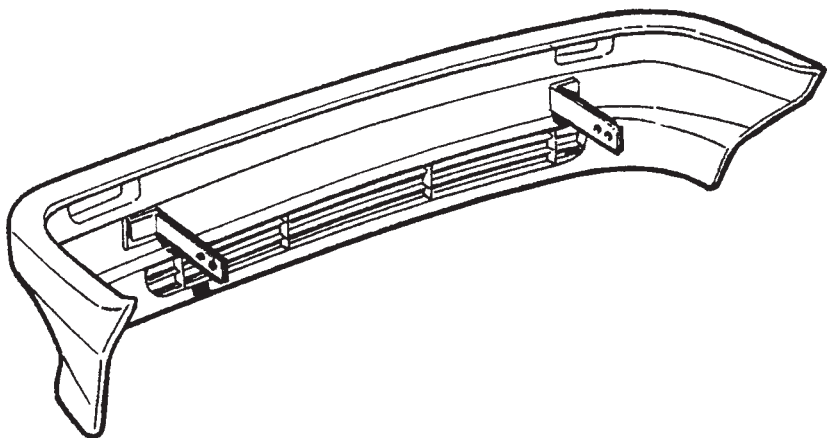
7.0 OPTIMUM D&R FEATURES

Over the years the RCAR's individual Members' knowledge and experience of the features which contribute to good D&R have increased, and the following points represent some of the more important items.

7.1 Bumper Systems

Bumper systems should play an important role in energy management during vehicle accidents, and the type and quality of bumper varies throughout the whole range of vehicles on the world's roads.

A modern polycarbonate bumper system

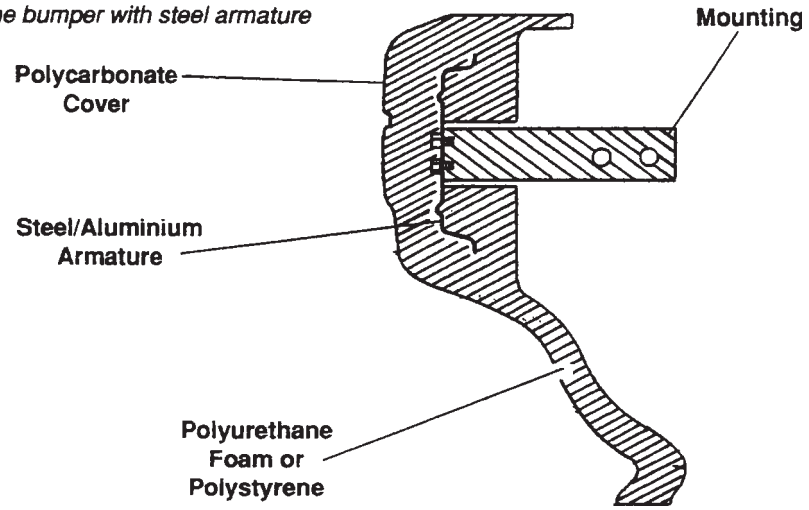


Modern bumpers are usually manufactured from a thermoplastic polycarbonate material and are generally designed to withstand impacts of up to 4 kph in Europe and 8 kph in North America. However, since there is no particular European standard, the energy absorbing capabilities of bumpers are infinitely variable in this market.

The RCAR would like to see more control in this area, and indeed it would be beneficial to the policyholder, the insurer and the manufacturer if bumpers could withstand impacts of up to 15 kph without initiating damage to the body structure beyond the bumper mounting system. This would involve the addition of energy absorbing materials such as polyurethane foam or polystyrene, and mechanical devices such as steel or aluminium armatures.

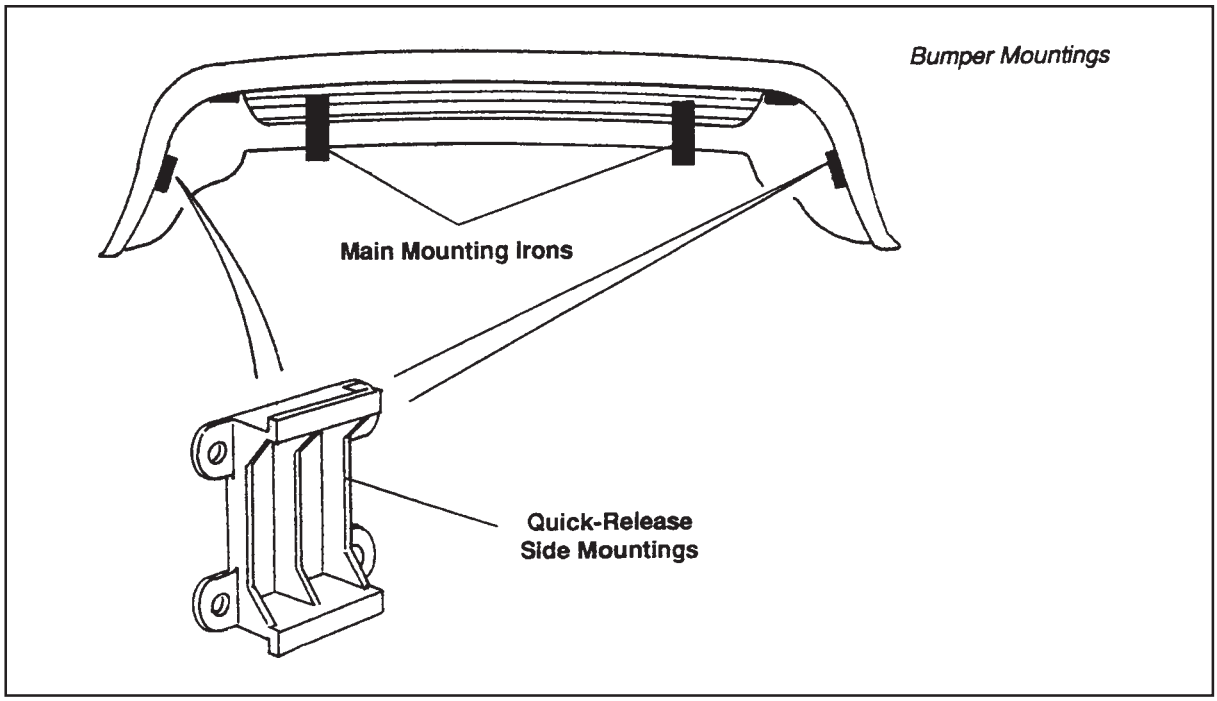
The incorporation of crush tubes or crash boxes at the bumper mounting points, or the provision of the bumpers with a stroking capability for energy absorption and instant recovery, is a further important consideration. Naturally this would mean an increase in unit price for the bumper assembly, but the RCAR believes that insurers would be willing to pay the increased price since it would be offset by reduced damage to the structure of the vehicle and thereby contain repair costs considerably.

A typical polyurethane bumper with steel armature

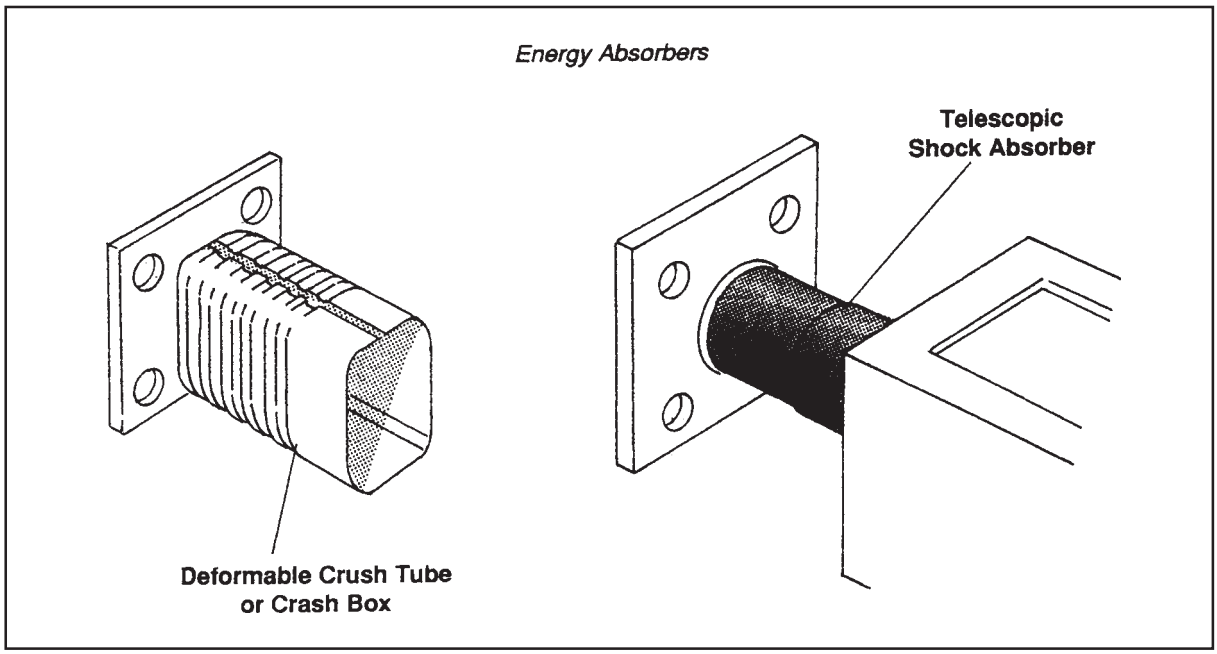


Bumper side mountings are also important and should be of the quick release type and not bolted to the front and rear wing as with some designs; this only encourages damage to these components during bumper displacement.

The main bumper mountings should be capable of transmitting impact forces into the chassis rail/longitudinal area for maximum energy absorption and they should not be an integral part of the bumper if at all possible, but separate items that can be replaced easily in the event of damage.



Hydraulically damped stroking bumpers and mechanical crush tubes have long been used in the North American market, and manufacturers should give consideration to the use of this type of bumper for Europe and the rest of the world. There is often a distinct improvement in D&R where deformable crush tubes have been employed, and they are effective and cheap to replace. With†the stroking type bumper, recovery should be expected after a deformation of say up to 50 mm. However, these systems are expensive to replace if bumper deformation exceeds the design limit.

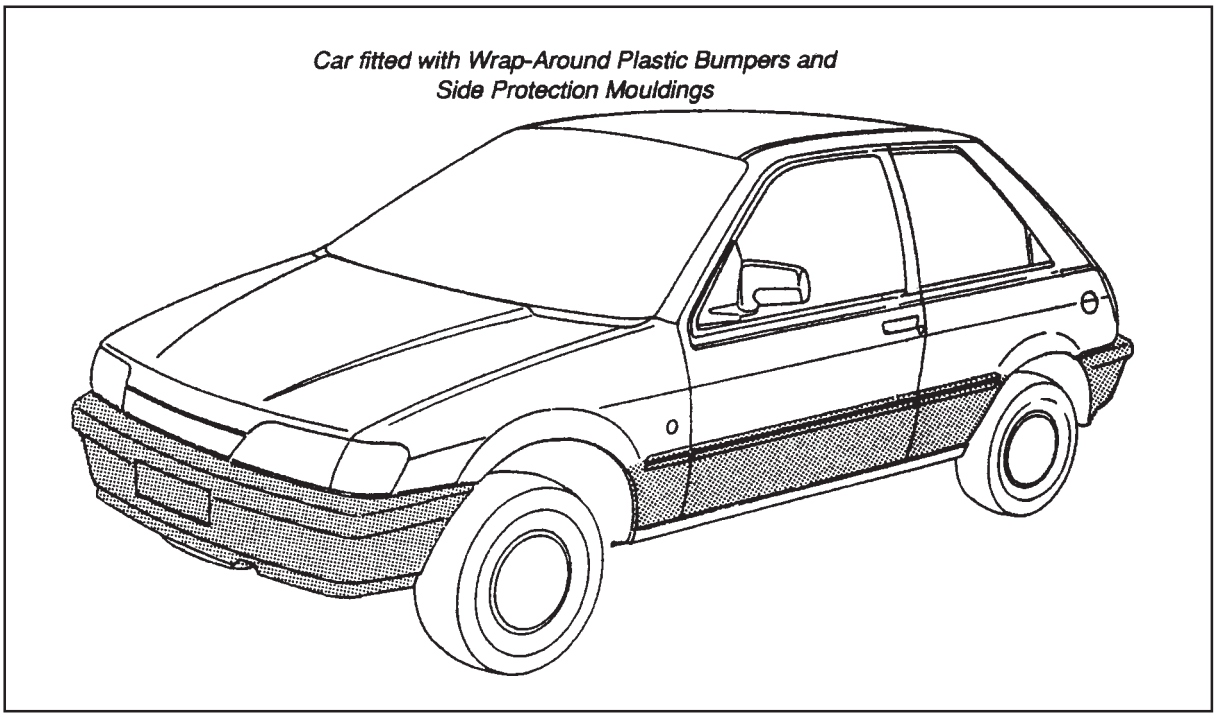


Thermoplastic bumper cover material is repairable and therefore it is desirable that this is used in the manufacture of bumpers so that repair operations can be carried out using hot air welding equipment and/or adhesives. Research has shown that in many instances correctly repaired bumper covers retain up to 90% of their original strength.

Where mottled or grained surface patterns are employed, the possibility of repairs to bumper covers is reduced because of cosmetic considerations, and therefore it is preferable not to use this type of finish. The covers should be separate from the main bumper structure to facilitate minor damage repair, and all bumper components should be serviced. Painted bumpers are preferred rather than coloured through units.

Most modern vehicles incorporate large wrap around type bumpers. They not only enhance the appearance of the vehicle but afford much greater protection during minor parking impact situations. Where the same bumper material is extended to the lower door and sill areas, it gives even greater protection in the event of low speed damage. These plastic side covers can help to reduce repair costs by acting as cosmetic finishers to cover joints in the sill and pillar areas, and this provides the option of leaving such joints cosmetically unfinished, with the additional savings in labour and materials, and obviating the necessity of heavy stone chip in these areas.

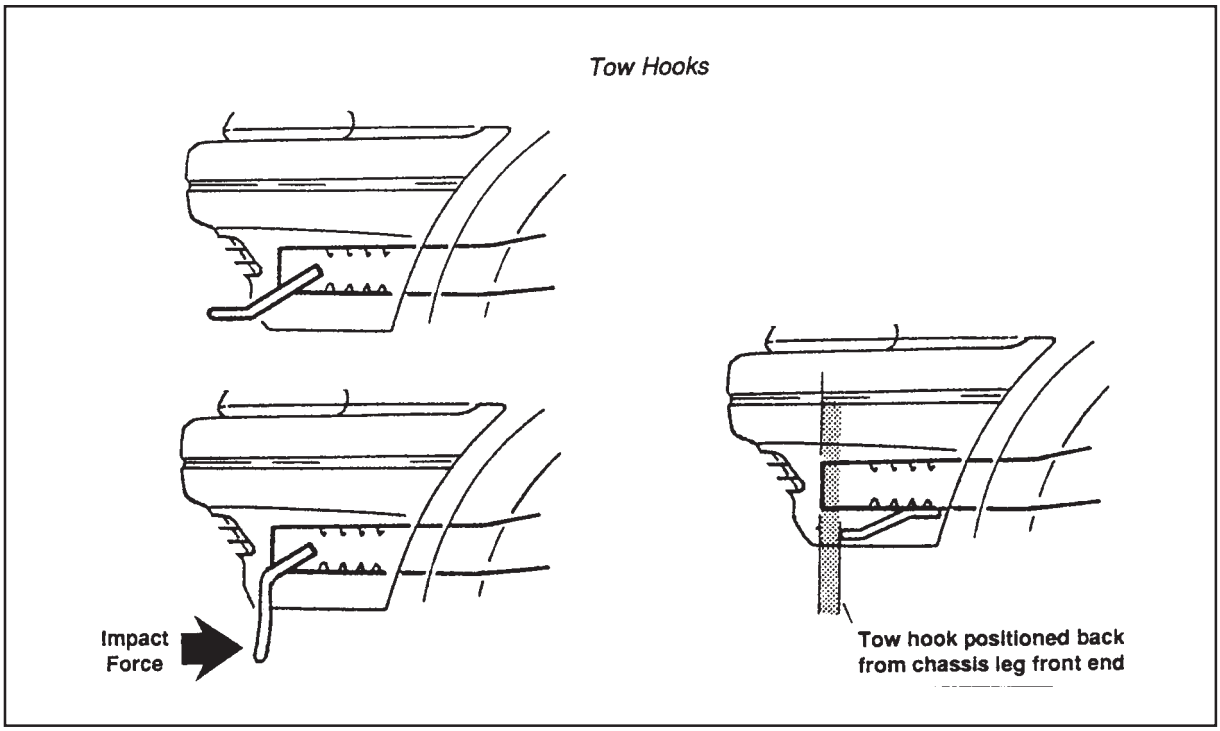
All plastics employed on the vehicle should be clearly identified using the universally accepted code for the purpose of repair and/or recycling.
(See Appendix 2)



Car fitted with Wrap-Around Plastic Bumpers and Side Protection Mouldings

7.2 Tow Hooks

Front and rear tow hooks are a major cause of extensive damage during the insurance crash test. Therefore with right-hand drive vehicles, tow hooks should be situated remote from the vulnerable front right-hand corners and rear left-hand corners of right-hand drive vehicles. The requirement is of course opposite for left-hand drive vehicles.



Where it is not possible to alternate the positioning of the tow hook in accordance with the steering configuration, then front and rear tow hooks should be designed such that they collapse downwards and, if necessary, break off under 15 kph impact conditions.

Some manufacturers manage to position their tow hooks well in board of the front and rear chassis rails or longitudinals, such that they do not influence and accentuate the damage caused by the 15 kph impact.

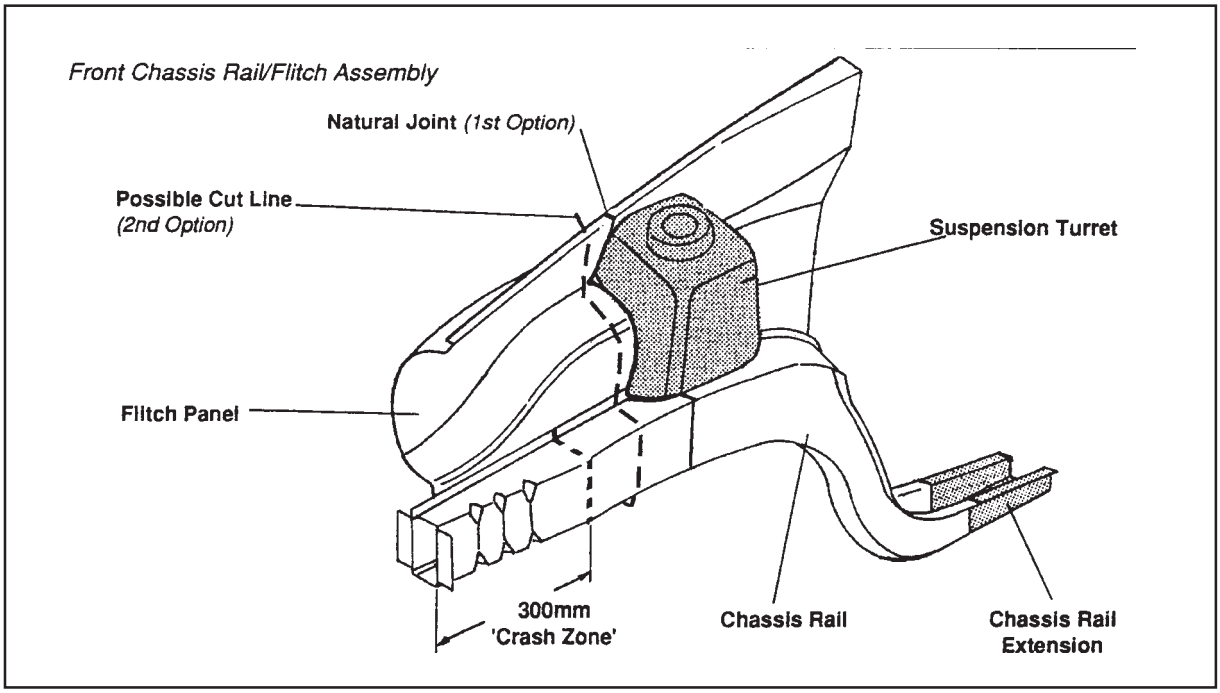
When tow hooks protrude forward of the chassis rail through the bumper cover, they tend to create a turning moment about the centre line of the chassis rail/longitudinal and thereby cause excessive damage to this component. This often necessitates greater repair effort and cost than would be the case if the towing hook were not present.

A few innovative designers have produced an ideal solution whereby the towing eye or hook forms part of the vehicle tool kit and is not actually mounted on the vehicle until required. This tends to solve most of the damage problems caused by fixed tow hooks and is not an inconvenience for the vehicle owner since modern vehicles are highly reliable with the incidence of towing very rare indeed.

7.3 Front Chassis Rail/Longitudinal and Flitch Assembly

The front chassis rail/longitudinal and flitch assembly should be capable of absorbing the energy of a 15 kph insurance impact without deformation beyond the suspension turret or inboard of the suspension mounting areas where these have been reinforced to withstand bumper reactions. Convolutions, crush initiators or voids should be employed within the rail and flitch area to absorb and maintain the damage forward of these areas. The crush should be truly progressive and predictable, beginning at the front end of the rail and extending rearwards to the bulkhead.

It is preferable for frontal damage to be contained within 300 mm of the front of the chassis rail, or at least within the front portion of the chassis rail outboard of any mounting points, thereby enabling repair to be carried out without the removal of the engine/transmission unit.



It follows that the design of the chassis rail/flitch assembly should be such that it can be cut at some convenient low load bearing point and a part panel fitted.

With some designs, the use of reinforcements and the engine mounting positions preclude this most important repair procedure, thereby demanding full chassis rail replacement with an inevitable increase in repair costs.

It is often possible to take advantage of a natural joint in front of the suspension turret and this makes the whole repair operation in this area less time consuming. There should of course be sufficient room within the engine compartment after the front panel and wings have been removed to accommodate such a repair without the need to remove the engine/transmission unit.

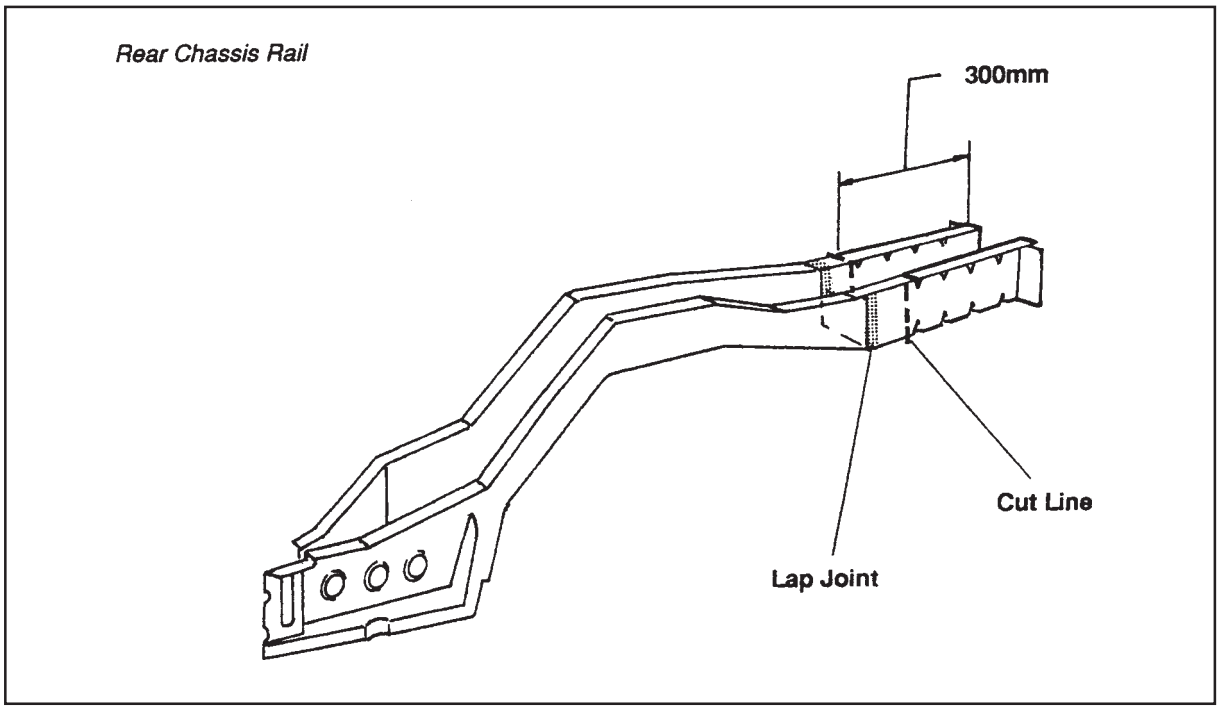
To further reduce the repair costs, engine mountings should not be integrally cast with the main engine block; they should be bolt-on units, as should all engine accessory mounting brackets.

Because of cosmetic considerations, butt welded joints, fully dressed and lead/plastic filled, are a desirable method of joining the new part chassis rail assembly to the original.

In order to accommodate more serious levels of damage, the chassis rail/flitch assembly should be easy to remove from the bulkhead/sill area and, where possible, be attached by means of a top hat section beneath the floor pan.

7.4 Rear Chassis Rail

The rear chassis rail should be of a top hat type section and externally mounted to the boot floor and heelboard area. It should incorporate convolutions and/or voids to manage energy absorption during a 15 kph impact and maintain deformation within 300 mm of the rear of the vehicle. Where the rail incorporates rear suspension spring seats, it should have sufficient stiffness and/or reinforcements in that area to prevent any damage beyond or in the region of the spring seats.



A service part chassis rail sjould be made available, and reinforcements should be positioned such that a part rail repair can be easily accomodated. A natural lap joint is preffed at the outer section , with an extension which is conveniently located within at least 300 mm of the rear panel.

7.5 Rear Flitch/Inner Wing Assembly

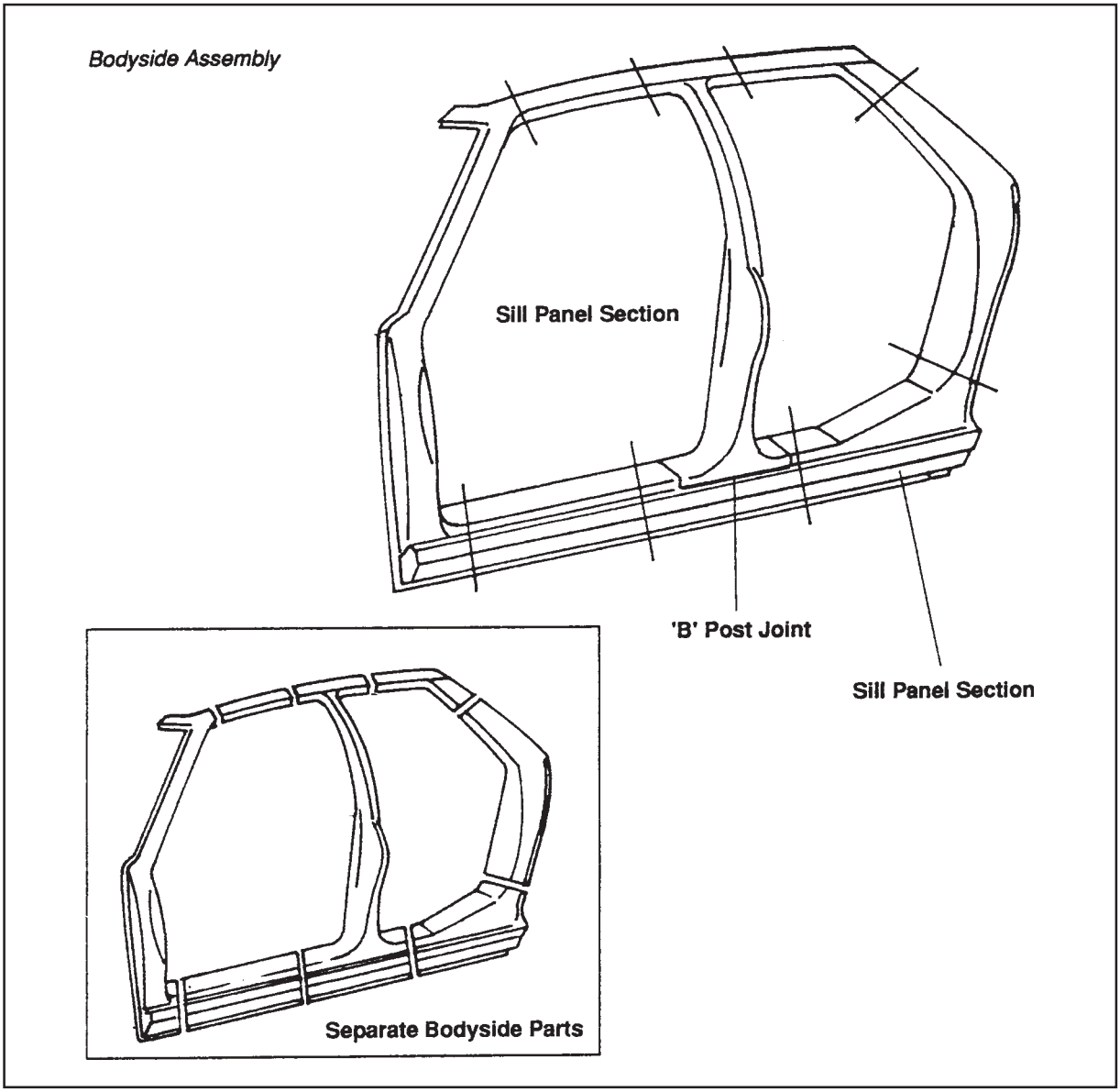
The outer wheel arch should be available separately since it is often required in combination with the rear quarter panel. The flitch assembly should incorporate convolutions and coincide with those of the chassis rail and boot floor where appropriate.

7.6 Sill Assembly and Door Posts

The sill assembly carries a large proportion of the vehicle load and is therefore an extremely important panel. Complicated joints should be avoided at the A, B and C Posts, and sill sections should be available as service parts.

Wherever possible, reinforcements in frequent damage areas, i.e. between the A and B Posts, should be avoided, although it is appreciated that seat belt anchorages and side impact protection reinforcements are required at the lower part of the B and C Posts. Where the reinforcements are unavoidable, a repair method should be clearly detailed to deter repairers from inadvertently damaging the reinforcement.

Some manufacturers are able to construct roof support posts utilizing simple internal closing panels, which obviate the need for complicated joints at the roof and sill areas.

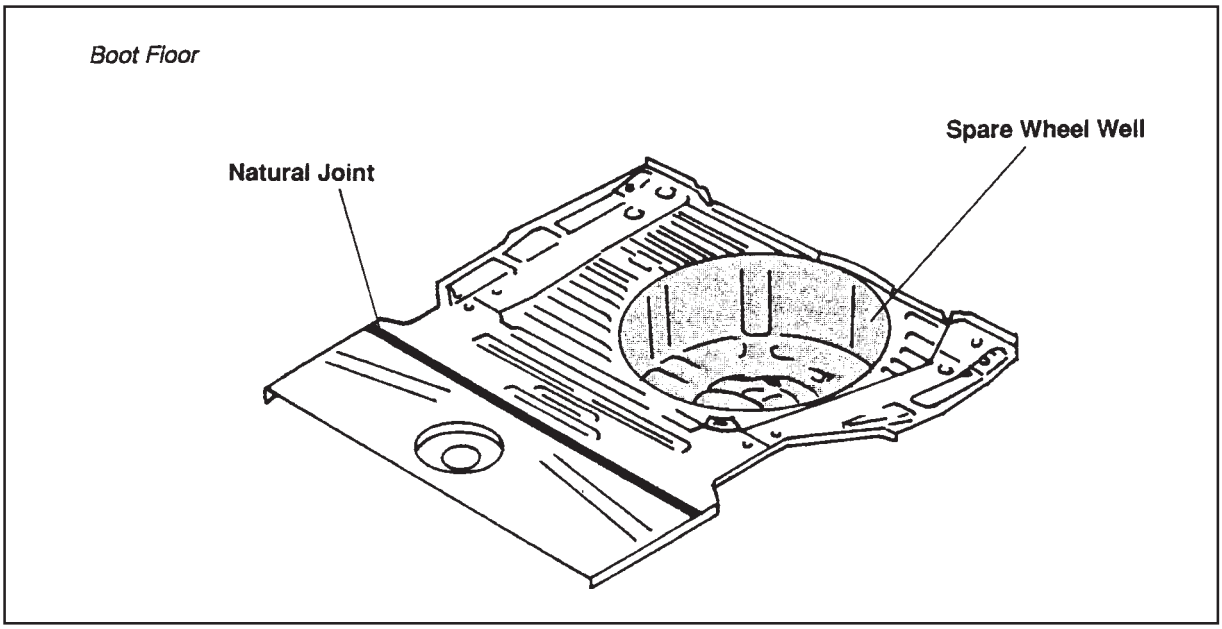


Modern manufacturing techniques favour full side assemblies in the manufacture of uni-construction bodies, and these should be available to the body repairer as an assembly and as sectioned parts. The exact cut lines need to be determined by discussion prior to finalised tooling plans or marketing arrangements.

7.7 Boot Floor

The boot floor should be available as a part panel, complete with all necessary bracketry for underbody components such as exhaust pipes, or have a natural joint which is roughly aligned with the rear suspension lateral centre line, and should be capable of removal without serious dismantling of the adjacent wheelarches or rear panels.

Where the boot floor incorporates a spare wheel well, plenty of clearance is required between the well sides and the tyre to prevent energy from a rear impact being transmitted via the spare wheel.



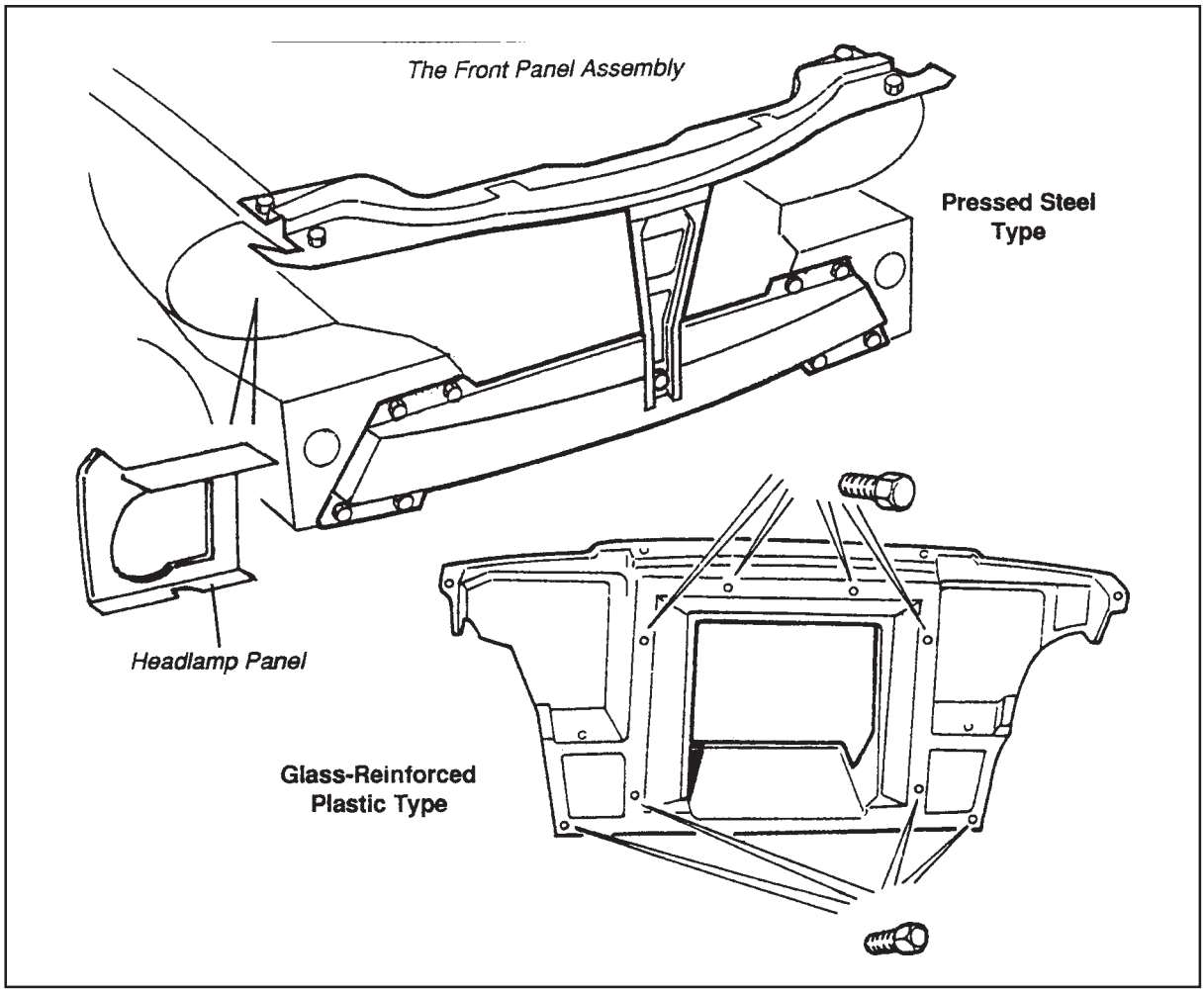
7.8 Cosmetic Panels

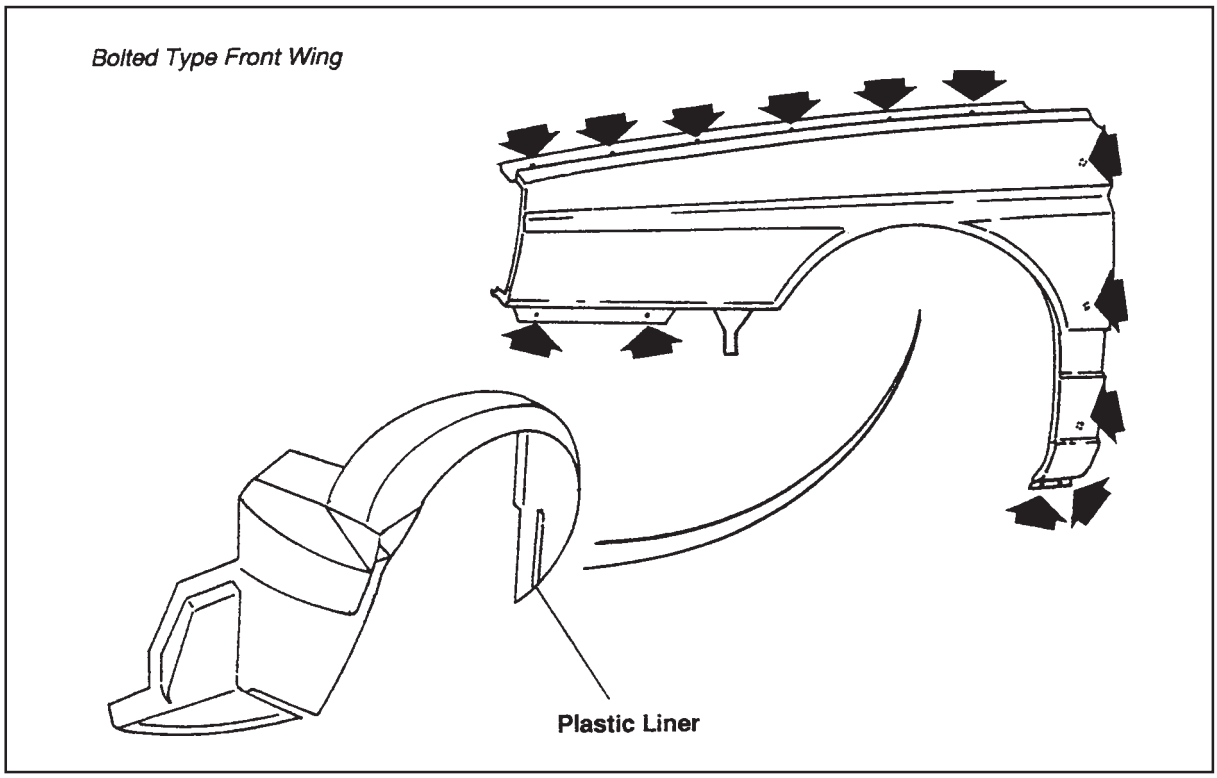
7.8.1 Front Wing and Front Panels

It is desirable for the front wing and front panels to be bolt-on units. Where it is not possible to bolt the front panel, it is important to ensure that it can be sectioned and removed/replaced without too much disturbance to other panels on the vehicle. It is also an advantage to have headlamp mounting panels available in part panel form, thus enabling small, highly economical repairs to be carried out.

Where glass reinforced plastics are used in the construction of front panels, the material should have sufficient energy absorbing characteristics to protect the chassis rail/flitch area. Unfortunately, repairs tend to be no cheaper with this material than for conventional mild steel panels due to the pricing policy of the manufacturer.

Integral front panels should not extend below the top of the bumper line in order to reduce the amount of damage during frontal impacts. If necessary, a separate economy lower front panel should be employed.


The Front Panel Assembly
Pressed Steel Type
Headlamp Panel
Glass-Reinforced Plastic Type

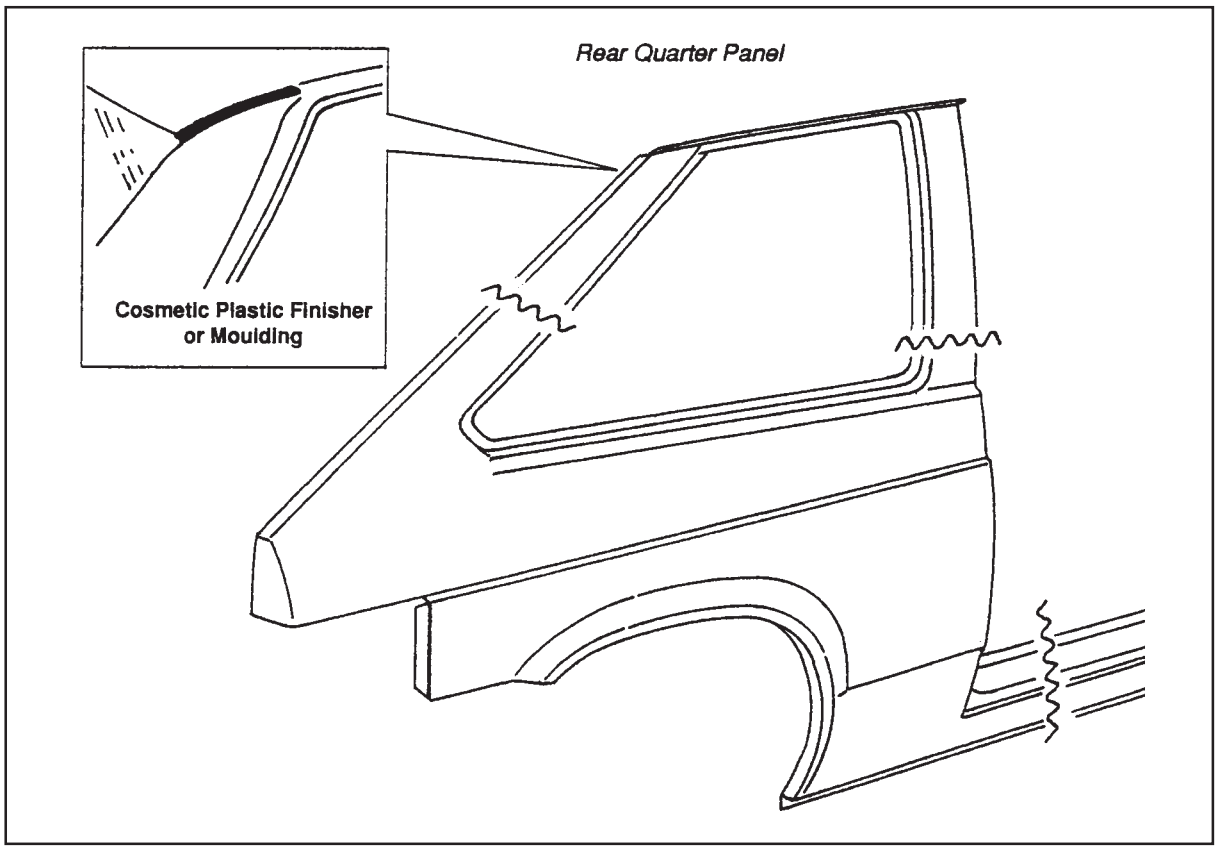

Bolted Type Front Wing
Plastic Liner

As mentioned earlier, front wings should be of a bolt-on type for ease of replacement. Almost all manufacturers employ this method of fixing since front wings no longer form a structural part of the body, and it should not be necessary to remove road wheels, doors, or dash assemblies in order to remove front wings. Where bolts are situated on the A Post, they should be easily accessible through an open door gap, and fixing holes should permit minor realignment and adjustments. The front wing and A Post assembly should be of such a design that they do not encourage the collection of road dirt, and in any event a plastic liner is a highly desirable finisher which should be securely clipped to the underside of the wing.

7.8.2 Rear Quarter Panel

The rear quarter panel should be serviced in a convenient way, with joints for panel replacement permissible anywhere between the quarter light aperture and the roof rail, and at the lower edge of the sill assembly, thereby obviating the need for the repairer to enter into the complicated roof joint area.

Where the quarter panel joins the roof, a cosmetic plastic moulding is the easiest way of masking a simple flanged joint in this area. The service replacement panels should have sufficient excess material attached to enable repairers to cut at the most convenient place. Any separate drain channels should be serviced with the main panel or attached to it to avoid the necessity of transfer from the damaged panel to the new during repair. Where possible, removal of the rear screen should be avoided when changing the quarter panel.



7.8.3 Rear Panel

The rear panel should be serviced as an assembly and be of a simple design with straightforward lap joints into the rear wing/quarter panel, with good access for repair.

If the rear panel consists of more than a simple inner and outer component, then any additional parts should be serviced separately. This panel should terminate at the bumper line or be designed in such a way as to prevent damage at speeds up to 15 kph.

7.8.4 The Bonnet

There should be good access for minor damage repairs, utilizing traditional panel beating techniques. Hinges should be adjustable and bolted both to the bodyshell and the bonnet, with good bolt access to accommodate panel alignment. It is desirable that the bonnet does not drop over the front panel to the bumper, since this area is often damaged in very minor impacts. Where this design has been adopted, the grille should be mounted in such a way as to limit damage to the bonnet in the event of minor impacts.

The bonnet frame should incorporate convolutions to ensure that the component folds prior to being propelled back into the windscreen under impact conditions. For the same reason, the hinges should incorporate safety catches or hooks. There should of course be a safety latch on the bonnet opening catch, and a sound deadening material should be replaceable and serviced separately.

7.8.5 Doors

Doors should incorporate quick release hinges which are bolted to the door frame and the A and B Posts. The hinges should be adjustable and serviced separately. The bolts should be readily accessed for door adjustment without the necessity of removing front wings or dash assemblies. Doorskins should be available for either welding or bonding to the door frame, the choice of repair method being left to the repairer. Where a door incorporates electrical components, the wiring loom should be of the quick release type to allow door removal without having to cut through interconnecting wires.

Window mechanisms should be manufactured in such a way that the complete assembly can be removed in one operation. The door frames should incorporate large holes for dismantling purposes and minor in situ panel beating repairs to the external panel.

7.8.6 Tailgate/Boot Lid

Similar comments to those attributed to the bonnet apply here. There should be plenty of access for minor damage repairs to boot lids and lower tailgate sections. Where rear wash/wipe is a feature, the service panel should be pre©drilled to accept the necessary components.

Tailgate skins should be made available if appropriate. There should be good access to the boot/tailgate hinge assemblies, and bolted hinges are preferred for the maintenance of good alignment. It should not be necessary to disturb the headlining when making adjustments to the tailgate alignment.

Wiring looms should be adequately protected against constant opening and closing of tailgate/boot lids, and plug-in type connectors should be available for complete component removal.

7.9 Engine Compartment

Engine compartment packaging is always a problem for the engineer. Styling demands shorter, lower bonnets and this trend further reduces the space available for important expensive components.

Plenty of space around the engine/transmission unit, especially at the front, is highly desirable for good D&R. Vulnerable items such as radiators, oil coolers, and air conditioning condensers should be situated sufficiently rear of the front panel in order to avoid damage during a 15 kph impact. However, these items should also be situated sufficiently forward of the engine/fan assembly to avoid damage from that direction caused by forward movement of the power unit under impact conditions.

Crash vulnerable items such as engine management control systems, onboard computers and ABS units should be situated well away from the front of the vehicle. Many manufacturers locate computers and control modules in the passenger compartment where they are as safe from damage as the passenger.

Batteries which are poorly located at the front of the vehicle present particularly difficult conditions in the event of damage due to acid spill. It is important that this item is located in the least vulnerable position to avoid major acid damage to other components. Slightly inaccessible positioning should not present too much of a problem for vehicle owners since modern batteries are virtually maintenance free and last the life of the vehicle. A separate, energy absorbing battery box should also be considered.

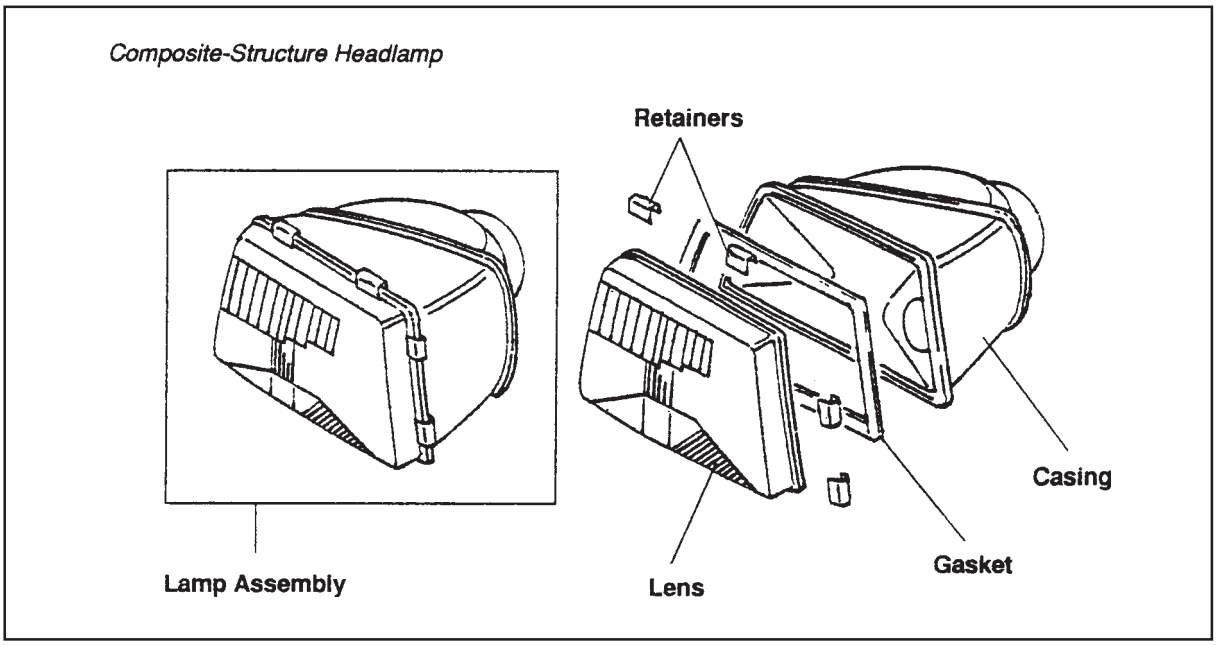
Alternators, distributors and fuel injection equipment should also be located in positions where damage can be avoided during a 15 kph impact.

A bolt on front panel and front crossmember facilitates easy removal of the engine/transmission unit in the event of major repairs to that area, and the engine/transmission suspension assembly should be capable of being removed as a unit in front wheel drive arrangements. Engine subframes enhance this capability.

All electrical cables and looms in the engine compartment should be connected to the main harness by means of connectors to ease engine/transmission unit removal and the replacement of damaged harnesses. Where possible, fuse boxes and relays should not form an integral part of the wiring harness, thereby allowing quick, cost effective renewal.

7.10 Headlamps

Modern headlamps are large expensive items. It is possible for savings to be made by utilizing a separate glass lens attached by clips and sealed with a gasket, thus enabling this item to be replaced without the expense of purchasing a complete headlamp assembly. Many manufacturers are now adopting this design and this trend is welcomed.



The plastic material used in the manufacture of headlamp casing should be of a thermoplastic type, not thermoset, so that minor repairs are possible in the event of mounting lug damage. Concealed headlamps are to be discouraged on the grounds of high cost and longer replacement times.

7.11 Side Lamps

Side lamps should be capable of being removed and replaced quickly, and should have a spring or clip type fitting to enable them to be displaced without damage in the event of adjacent panel repair. They should not be situated within the bumper assembly due to the high incidence of damage in this area.

7.12 Rear Lamps

Modern rear lamp clusters are large expensive items, and these should be manufactured from an impact resistant plastic material. In the interests of economy during repair, the possibility of separate units for tail lamp, reversing lamp and high intensity lamp should be considered. Quick type attachments for an easy remove and replace facility are preferred.

7.13 Front and Rear Screens

The rubber gasket mounted screen glass has now been largely superseded by the bonded system, which keeps costs low for the manufacturer, but often presents the repairer with additional problems.

Where screens are bonded, mouldings should be easily replaceable, without having to remove the screen, and they should be available as separate parts. There should be good access around the screen aperture to facilitate cutting equipment, such as knives or oscillating blades.

The rake angles of modern windscreens tend to prohibit the use of dynamic and heat assisted removal techniques, and repairers are being forced to return to the cheesewire arrangement, which is time consuming and often requires the use of two operators.

Screen replacement kits should be available, incorporating all the necessary material for screen replacement. The kits should have a long shelf life with the "best before" date clearly stamped on the packaging, together with the usual Health and Safety warnings.

7.14 Interior Trim

Most interior trim is manufactured from thermoplastic material and fitted with screws and/or plastic fixings. This is preferable to adhesives and glues, and the plastic fasteners or fixings should be universal and easily available in all export countries.

Carpets tend to be one-piece moulded assemblies nowadays and this does cause considerable difficulty when inspecting damaged vehicles. Considerable interior trim dismantling has to be undertaken to inspect toe boards, transmission tunnels, and spare wheel wells. It would be more convenient if carpets could be manufactured in two halves, or even four quarters, corresponding with each passenger footwell, and equipped with suitable cosmetic jointing strips.

Seats and squabs should be of material which provides an easy clean facility, and seat and squab covers should be available separately. For safety reasons, seats should not use inflammable infill.

Consideration should be given to the sequence of interior trim removal in the event of panel replacement. For example, it should not be necessary to strip out a complete rear end to replace one quarter panel due to trim overlaps.

Headlinings should be easily replaceable, and reusable if undamaged. Luggage compartment casing boards should not overlap in such a way that a complete strip out is required for single side repair.

Bulkhead insulation/trim should be in two parts for removal separately for flitch/chassis repairs and welding operations on the right or left hand side.

7.15 Galvanized Body Panels

Many manufacturers use both single and double sided galvanized panels in the construction of their vehicle bodies. The use of this material considerably reduces the incidence of corrosion, but does present a problem for the body repairer during panel replacement and repair operations. When repair or replacement takes place, inevitably some of the galvanized material has to be removed to facilitate spot and MIG welding. Similarly, material is removed in the process of panel beating minor dents.

Few manufacturers have given thought to the reinstatement of galvanized material after repair operations, and this could lead to serious corrosion problems later in the life of the vehicle. It is essential, therefore, that weld-through primers are utilized in bare metal areas and between the flanges of the panels to be spot welded. Additionally, etch primers should be employed over bare metal areas exposed as a result of metal finishing, thus ensuring comprehensive protection against the onset of corrosion.

7.16 Bonding and Special Fasteners

It should always be possible to remove and replace cosmetic and structural body panels utilizing conventional workshop tools and methods. If special fasteners or adhesive bonding is employed in the construction of the vehicle, then the manufacturer should advise on the optimum repair methods for the construction method employed. It is preferred that no additional, expensive tools or special equipment is required to cope with bonded panels or those attached by means of special fasteners.

7.17 SRS Systems

The passenger side airbag, when fitted, should not be an integral part of the dash assembly. This arrangement necessitates the complete renewal of the dash unit in the event of passenger airbag deployment. A passenger airbag in modular form, fitting neatly into a pocket in the dash assembly, is less expensive to replace and reduces labour costs for this operation.

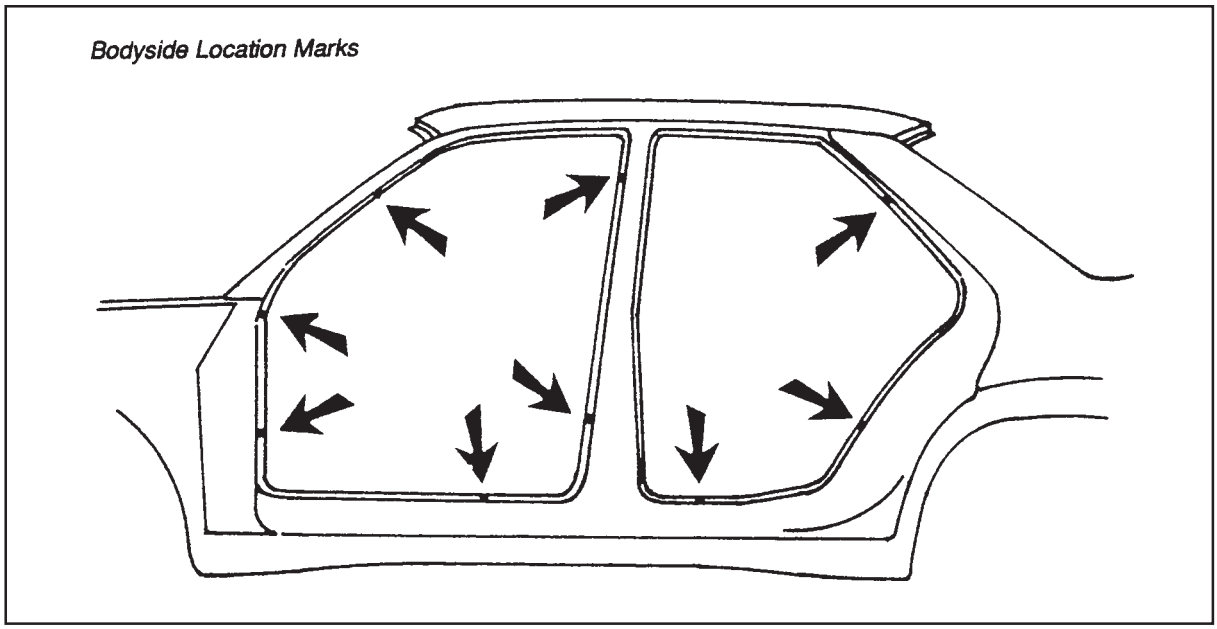
There should be some form of indicator on the seat belt tensioner mechanisms to show that they have been deployed, and seat belt webbing should have some form of stress indicator to assist in the replacement decision.

7.18 Miscellaneous : Panel

7.18.1
All cosmetic crash vulnerable panels should have location marks for ease of fitment.

7.18.2
Pressing lines should be kept to a minimum to avoid extended paint preparation times and enhance the use of mechanical flatting aids. However, mouldings can assist as break lines during painting.

7.18.3
All service panels should be adequately packaged to prevent transit damage.



7.18.4
The black electrophoretic primer should be of such quality as to require minimum preparation prior to refinishing.

7.18.5
Replacement panels should be identifiable as genuine products.

7.18.6
All integral panels, particularly door, tailgate, quarter panel, etc., should have good internal access for repair to their exterior surfaces.

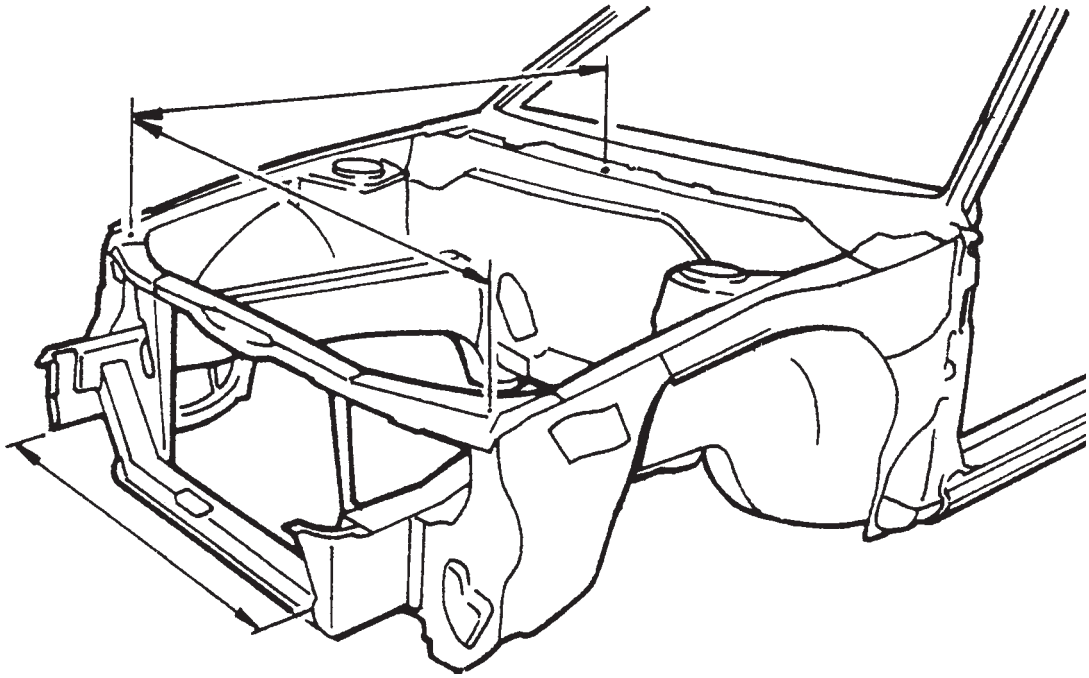
7.18.7
Panel joints and lapping should be arranged in such a way that crash vulnerable panels are easy to remove.

7.18.8
Manufacturers should supply detailed information regarding HS or HSLA steels used in the construction of their vehicles, enabling repairers to identify any special welding operations that may be required.
(See Appendix 3)

7.18.9
The engine compartment, boot/tailgate apertures and underbody areas should have reference points for dimensional checks.

7.18.10
The straightening of accident damage requires the vehicle to be clamped firmly to a straightening jig or bench, usually by means of the sill flanges. Manufacturers should ensure that they confer closely with the equipment manufacturers to ensure that this important repair procedure can continue to be employed by repairers, and that the clamping arrangements on the vehicle are sufficiently strong to withstand the forces involved.

Dimensional Reference Points

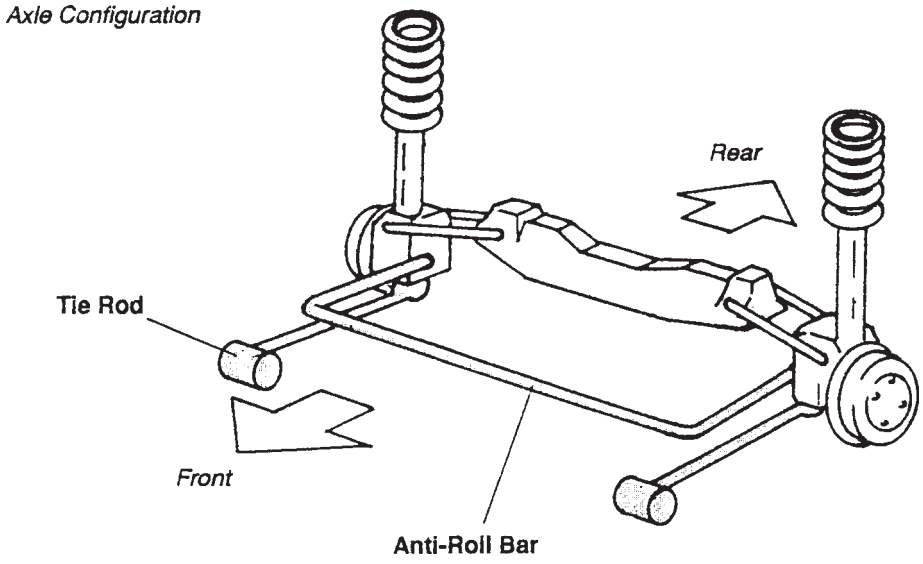


7.19 Miscellaneous : Mechanical

7.19.1
Front anti-roll bars and tie rods should face rearwards to prevent damage in a frontal impact.

7.19.2
Rear anti-roll bars and tie rods should face frontwards to avoid damage in a rear impact situation.

Axle Configuration



7.19.3
Steering racks should be situated as far from the front panel as possible.

7.19.4
The fixings for engine subframes, suspension anchorages and other vital mechanical fixing points should be located well away from crash vulnerable areas where possible.

7.20 Miscellaneous : Paint

7.20.1
Whilst 3-coat pearl effect paints have immense customer appeal, they are expensive to repair and should therefore be confined to the top of the range models. It would be inappropriate to introduce them into the cheaper ranges since repair costs would then be disproportionate to the vehicle's value.

7.20.2
If coloured primers are used they should be identified by code in the same way that the vehicle colour is identified and made available.

7.20.3
If the engine compartment is of a different colour to that of the vehicle, it should be identified and coded.

7.20.4
If coloured lacquers are used, the code should be identified as above.

7.21 Miscellaneous : Electrical

7.21.1
Wiring looms should have quick release plugs for various sections of the vehicle, i.e. engine compartment, interior and boot area, and these loom sections should be made available as separate parts.

7.22 Miscellaneous : Plastics

7.22.1
Where possible, all plastics utilized on the vehicle should be of the thermoplastic type and readily repairable using hot air fusion techniques and adhesives.

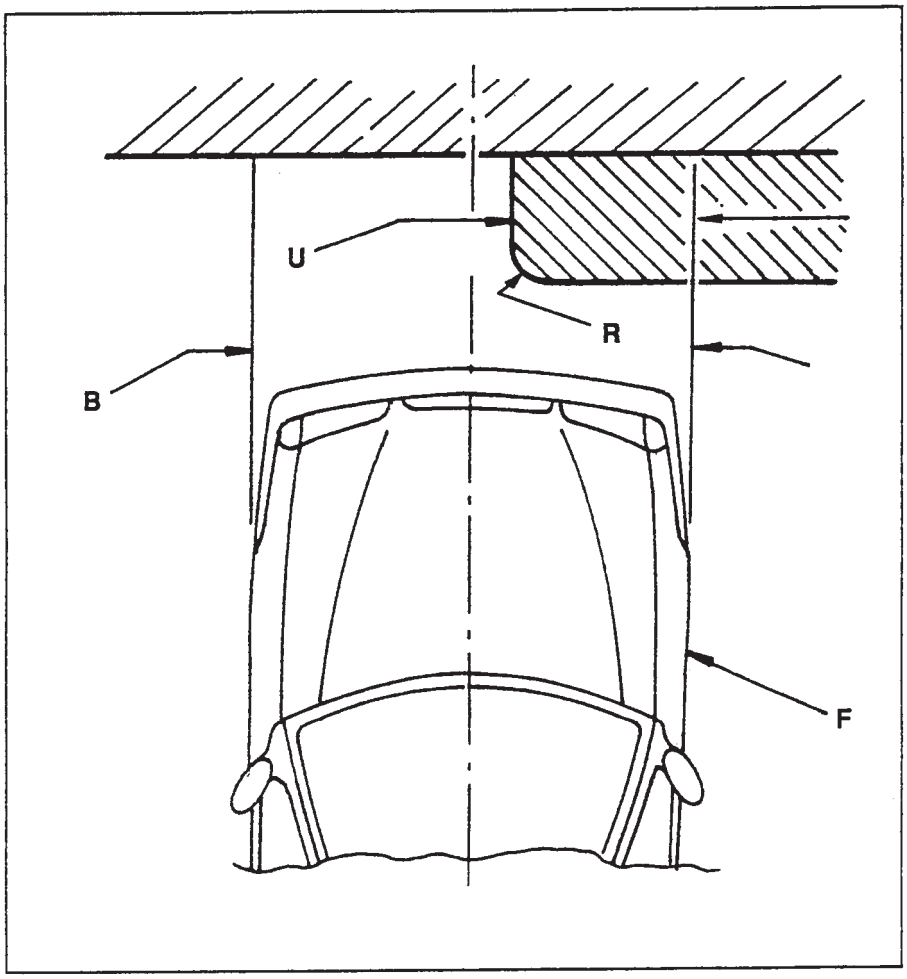
THE INSURANCE CRASH TEST PARAMETERS

STANDARD INSURANCE FRONT IMPACT

Height of barrier exceeds height of subject vehicle.

Subject vehicle permitted free movement.

Subject Vehicle Mass: Net weight +75kg for driver and equivalent with full fuel tank.

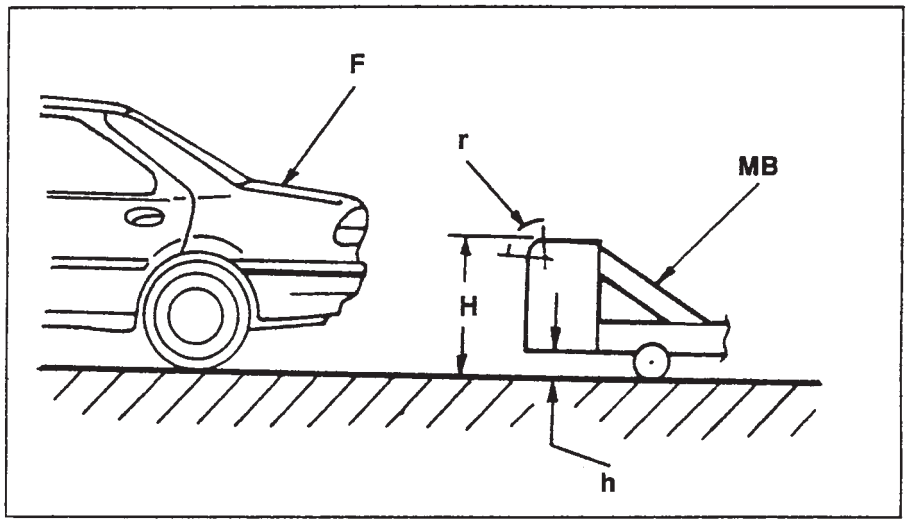


Key:

U	=	Offset 40%
B	=	Overall width of subject car
V_F	=	15.0kmh + 1.0kmh
R	=	150mm constant radius
F	=	Subject car

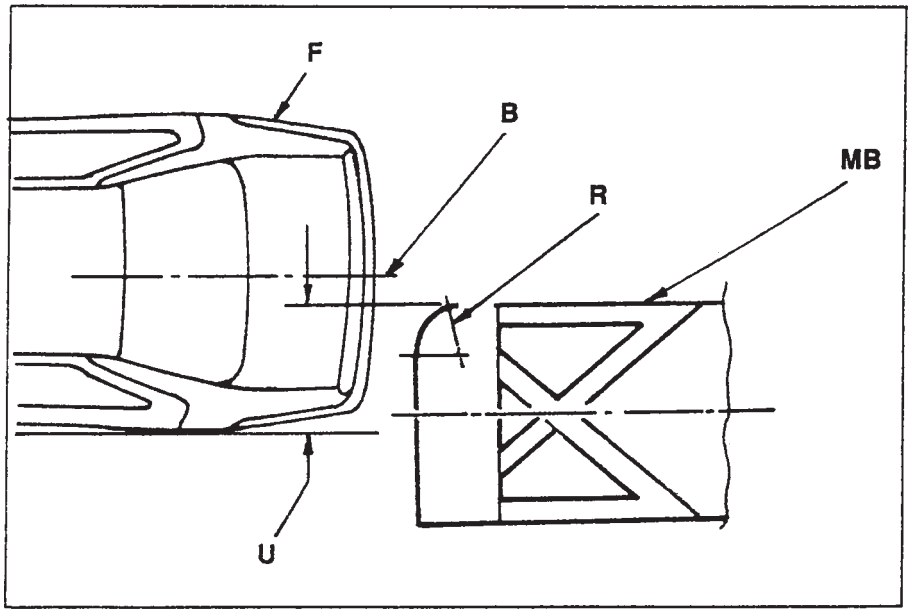
STANDARD INSURANCE FRONT IMPACT

Target Vehicle Mass: Net weight +75kg for driver and equivalent with full fuel tank.



Key:

MB	=	Mobile barrier
M_{MB}	=	1000kg mass
H	=	700mm barrier height
h	=	200mm barrier ground clearance
F	=	target car
r	=	50mm constant radius

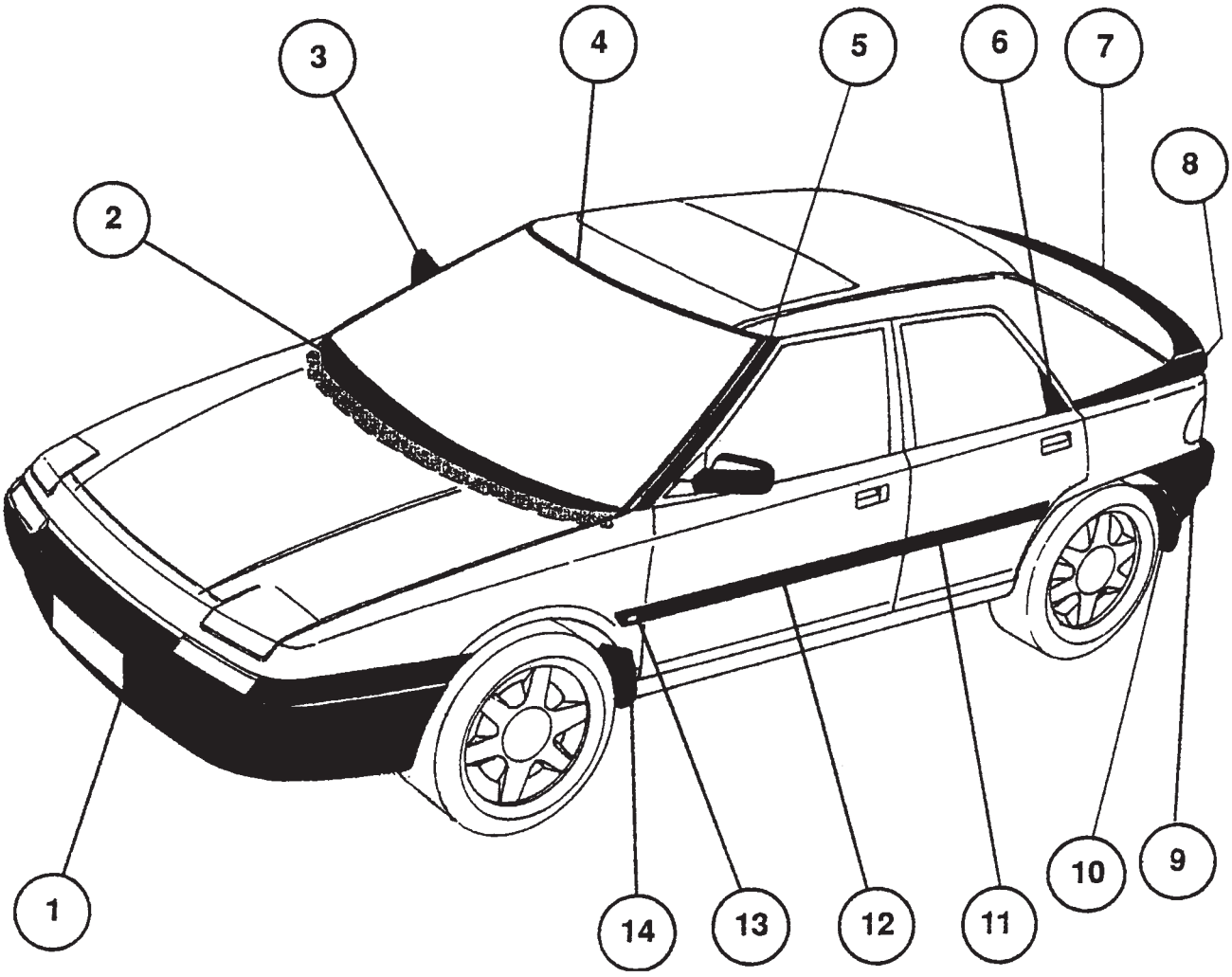


Key:

U	=	Offset 40%
B	=	Centre line of target car
V_{MB}	=	15.0kmh + 1.0kmh
V_F	=	0kmh (handbrake off)
R	=	150mm constant radius
F	=	Target car

THE IDENTIFICATION OF PLASTIC TRIM

PLASTIC EXTERIOR TRIM



1	Front Bumper (PPR)	8	Tailgate Spoiler End Section RH and LH (PUR)
2	Cowl Intake Grille (PVC/PAB)	9	Rear Bumper (PPR)
3	Door Mirror Casing RH and LH (PAB)	10	Rear Mudflap RH and LH (PEV)
4	Front Screen Moulding (PVC)	11	Rear Door Waist Moulding RH and LH (PPR)
5	'A' Post Upper Moulding RH and LH (PCT/PBT)	12	Front Door Waist Moulding RH and LH (PPR)
6	Rear Door Corner Capping RH and LH (PAB)	13	Front Wing Waist Moulding RH and LH (PPR)
7	Tailgate Spoiler (PUR)	14	Front Mudflap RH and LH (PEV)

Key:
***PPR** = Polypropylene*
***PBT** = Polybutylene Terephtalate*
***PAB** = Polyamide*
***PCT** = Polycarbonate*
***PVC** = Polyvinylchloride*
***PEV** = Polyethylene*
***PUR** = Polyurethane*

THE IDENTIFICATION OF SPECIAL STEELS

SPECIAL STEELS

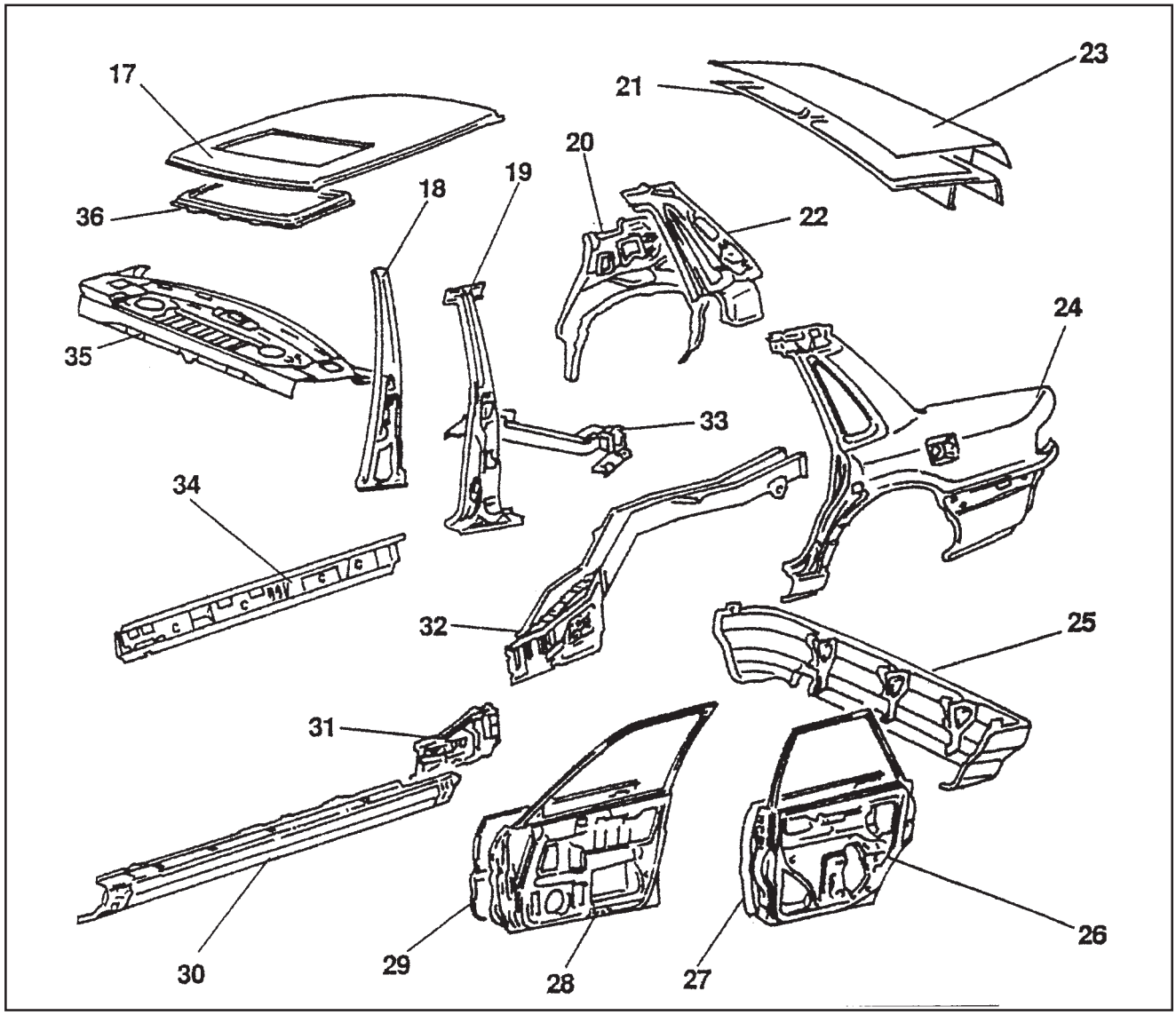


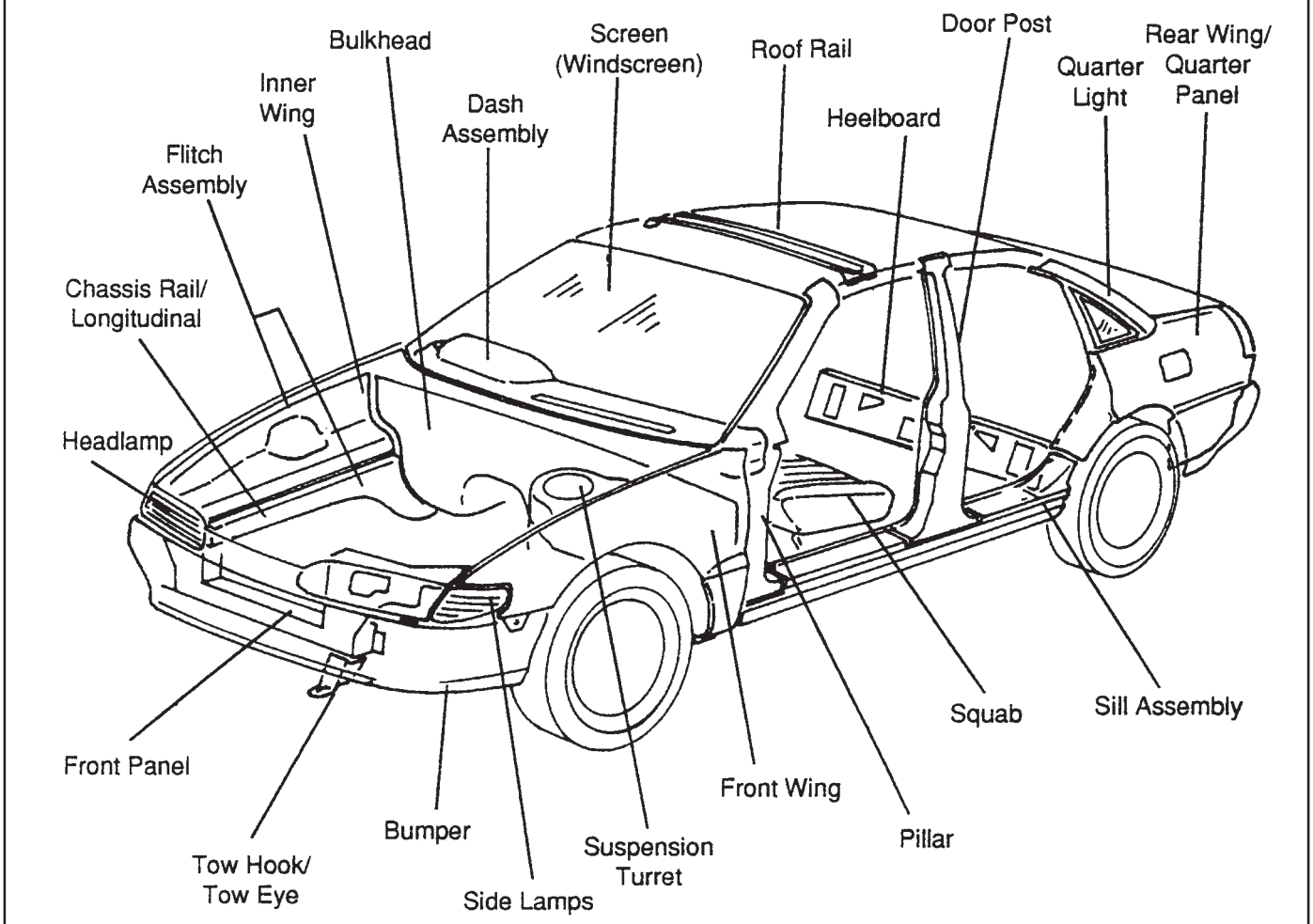
Fig. Ref.	Description	Code	Fig. Ref.	Description	Code
17	Roof Panel	C	27	Rear Doorskin RH/LH	C
18	'B' Post Closing Panel RH/LH	A	28	Front Door Frame RH/LH	D
19	Outer 'B' Post RH/LH	A	29	Front Doorskin RH/LH	C
20	Inner Rear Wheelarch RH/LH	F	30	Sill Panel RH/LH	C
21	Boor Lid Frame	D	31	Inner Sill Rear Extension RH/LH	C
22	Rear Inner Wing RH/LH	A	32	Rear Chassis Leg RH/LH	C
23	Boot Lid Skin	B	33	Rear Suspension Crossmember	C
24	Rear Wing RH/LH	F	34	Inner Sill RH/LH	C
25	Rear Bumper Panel	C	35	Rear Parcel Shelf Panel	A
26	Rear Door Frame RH/LH	D	36	Sunroof Frame	E

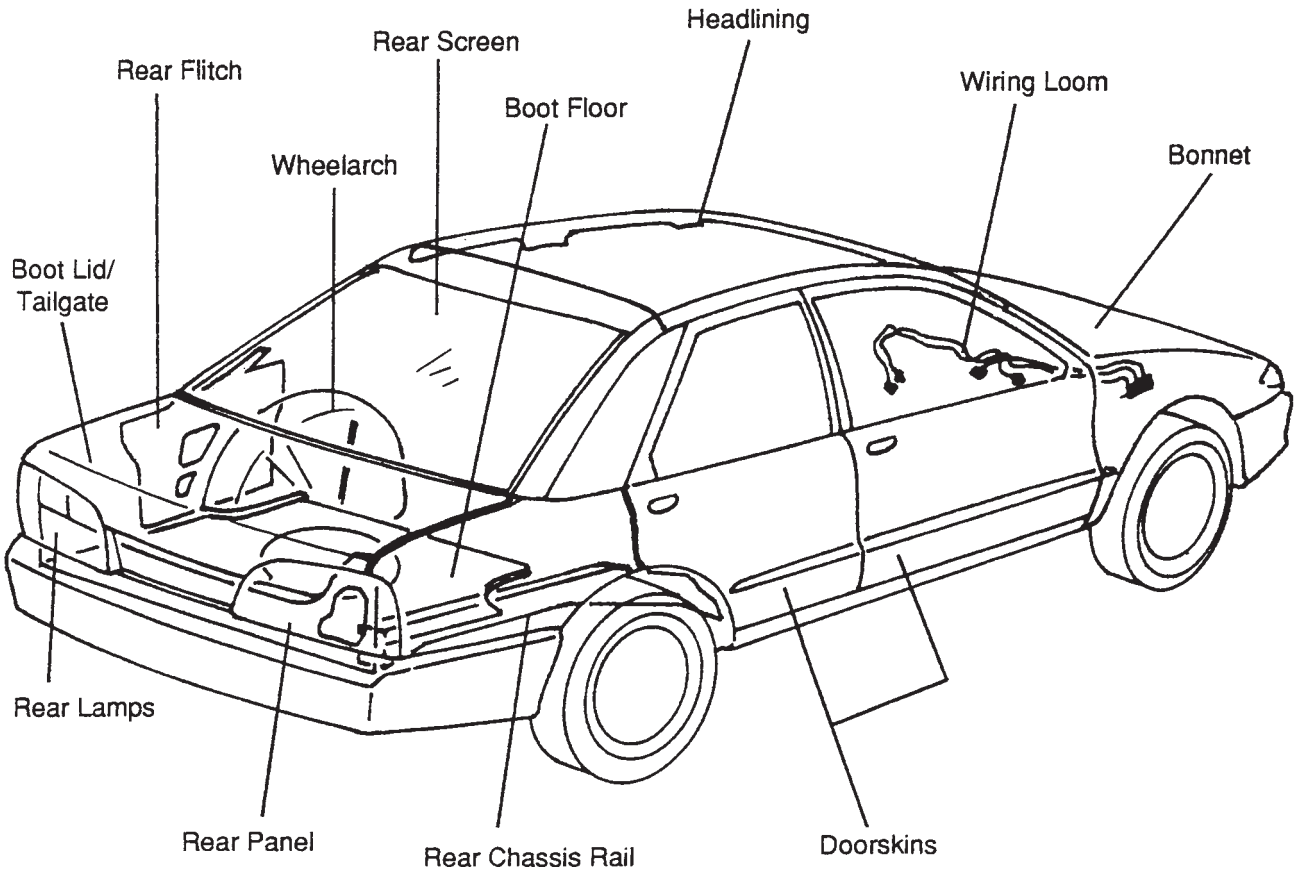
Code:

A: Phosphorus-enriched HSS part to Manufacturer Specification SPRC35.
B: Phosphorus-enriched HSS and galvanised steel part to Manufacturer Specification SGAC35R.
C: Galvanised steel part to Manufacturer Specification SGACC.
D: Galvanised steel part to Manufacturer Specification SGACE.
E: Galvanised steel part to Manufacturer Specification SGAHC.
F: Electrogalvanised, zinc-nickel coated teel part to Manufacturer Specification SENCE.

GLOSSARY OF TERMS

GLOSSARY OF TERMS





GLOSSARY OF TERMS

	UK	AUSTRALIA
1	Bonnet	Bonnet
2	Boot	Boot
3	Boot Floor	Boot Floor
4	Boot Lid	Boot Lid
5	Bulkhead	Firewall
6	Bumper	Bumper
7	Chassis Rail/Longitudinal	Front Chassis Rail
8	Dash Assembly	Dash Assembly
9	Door Post	"B" or Centre Pillar
10	Doorskins	Doorskins
11	Fitch Assembly	Rail & Skirt
12	Front Panel	Front Panel
13	Front Wing	Front Guard
14	Headlamp	Headlamp
15	Headlining	Headlining
16	Heelboard	Heelboard
17	Inner Wing	Front Skirt
18	Kerb Weight	Kerb Weight
19	Pillar	"A" or Front Pillar
20	Quarter Light	Quarter Light
21	Quarter Panel	Quarter Panel
22	Rear Chassis Rail	Rear Chassis Rail
23	Rear Flitch	Rear Quarter Panel Inner
24	Rear Lamps	Tail Lamps
25	Rear Panel	Back or Rear Panel
26	Rear Screen	Rear Screen
27	Rear Wing	Rear Quarter Panel
28	Roof Rail	Roof Rail/Roof Side Frame
29	Screen (Windscreen)	Windscreen
30	Side Lamps	Side Lamps
31	Sill Assembly	Sill Panel
32	Squab	Squab
33	Suspension Turret	Strut Tower
34	Tailgate	Tailgate
35	Tow Hook/Tow Eye	Tow Hook
36	Wheel Arch	Rear Wheel House/Arch
37	Wiring Loom	Wiring Loom

GLOSSARY OF TERMS

	UK	FRANCE
1	Bonnet	Capot
2	Boot	Coffre
3	Boot Floor	Plancher arrière
4	Boot Lid	Couvercle de coffre
5	Bulkhead	Tablier
6	Bumper	Bouclier ou Pare-chocs
7	Chassis Rail/Longitudinal	Longeron avant
8	Dash Assembly	Planche de bord
9	Door Post	Pied milieu
10	Doorskins	Panneaux de porte
11	Fitch Assembly	Demi bloc avant
12	Front Panel	Face avant
13	Front Wing	Aile avant
14	Headlamp	Phare
15	Headlining	Bandeau de pavillon
16	Heelboard	Traverse arrière
17	Inner Wing	Doublure d'aile
18	Kerb Weight	Poids à vide
19	Pillar	Pied avant
20	Quarter Light	Custode
21	Quarter Panel	Aile arrière
22	Rear Chassis Rail	Longeron arrière
23	Rear Flitch	Doublure d'aile arrière
24	Rear Lamps	Feu arrière
25	Rear Panel	Jupe arrière
26	Rear Screen	Lunette arrière
27	Rear Wing	Aile arrière
28	Roof Rail	Traverse de pavillon
29	Screen (Windscreen)	Pare-brise
30	Side Lamps	Feu avant clignotant
31	Sill Assembly	Bas de caisse
32	Squab	Séllerie
33	Suspension Turret	Caisson de Mac-Pherson
34	Tailgate	Hayon arrière
35	Tow Hook/Tow Eye	Crochet de remorquage
36	Wheel Arch	Passage de roue
37	Wiring Loom	Faisceau électrique

GLOSSARY OF TERMS

	UK	GERMANY
1	Bonnet	Motorhaube
2	Boot	Kofferraum
3	Boot Floor	Kofferraumboden
4	Boot Lid	Kofferraumdeckel
5	Bulkhead	Stirnwand
6	Bumper	Stoßfänger
7	Chassis Rail/Longitudinal	Rahmenlängsträger
8	Dash Assembly	Armaturenbrett
9	Door Post	Türsäule (B-Säule)
10	Doorskins	Türblech
11	Fitch Assembly	Radhaus
12	Front Panel	Frontblech
13	Front Wing	Kotflügel vorne
14	Headlamp	Scheinwerfer
15	Headlining	Himmel
16	Heelboard	Querträger innen hinten
17	Inner Wing	Radhaus hinten
18	Kerb Weight	Leergewicht
19	Pillar	Pfosten/Säule
20	Quarter Light	Dachsäule
21	Quarter Panel	Seitenwand
22	Rear Chassis Rail	Längsträger hinten
23	Rear Flitch	Kofferraumverkleidung
24	Rear Lamps	Rücklicht
25	Rear Panel	Heckabschlußblech
26	Rear Screen	Heckscheide
27	Rear Wing	Kotflügel hinten
28	Roof Rail	Dachrahmen
29	Screen (Windscreen)	Windschutzscheibe
30	Side Lamps	Seitenlicht/Blinker seitlich
31	Sill Assembly	Schweller
32	Squab	Sitzpolster
33	Suspension Turret	Federbeinaufnahme
34	Tailgate	Heckklappe
35	Tow Hook/Tow Eye	Abschlepphaken
36	Wheel Arch	Radhaus hinten
37	Wiring Loom	Kabelstrang

GLOSSARY OF TERMS

	UK	ITALY
1	Bonnet	Cofano motore
2	Boot	Coperchio/Cofano
3	Boot Floor	Coperchio ruota di scorta
4	Boot Lid	Coperchio bagagliaio/Portellone
5	Bulkhead	Parete cruscotto
6	Bumper	Paraurti
7	Chassis Rail/Longitudinal	Longherone
8	Dash Assembly	Plancia completa
9	Door Post	Montante centrale
10	Doorskins	Pannelli esterni porte
11	Fitch Assembly	GFianchetto vano motore completo
12	Front Panel	Rivestimento anteriore/traversa anteriore
13	Front Wing	Parafango anteriore
14	Headlamp	Proiettore/Faro
15	Headlining	Rivestimento interno padiglione
16	Heelboard	Paratia sottosedile posteriore
17	Inner Wing	Passaruota/Fianchetto
18	Kerb Weight	Peso in ordine di marcia
19	Pillar	Montant anteriore
20	Quarter Light	Vetro fisso Laterale posteriore
21	Quarter Panel	Pannello esterno fiancata posteriore
22	Rear Chassis Rail	Longherone pavimento posteriore
23	Rear Flitch	Ossatura fiancata posteriore
24	Rear Lamps	Fanale posteriore
25	Rear Panel	Rivestimento posteriore/Traversa posteriore
26	Rear Screen	Cristallo lunotto
27	Rear Wing	Parafango posteriore
28	Roof Rail	Centina tetto
29	Screen (Windscreen)	Cristallo parabrezza
30	Side Lamps	Fanale ripetitore laterale
31	Sill Assembly	Longherone sottoporta completo
32	Squab	Schienale
33	Suspension Turret	Duoma
34	Tailgate	Parafango posteriore
35	Tow Hook/Tow Eye	Gancio di traino
36	Wheel Arch	Passaruota
37	Wiring Loom	Cablaggio elettrico

GLOSSARY OF TERMS

	UK	SPAIN
1	Bonnet	Capó
2	Boot	Maletero
3	Boot Floor	Piso maletero
4	Boot Lid	Capó maletero
5	Bulkhead	Chapa salpicadero
6	Bumper	Paragolpes
7	Chassis Rail/Longitudinal	Larguero delantero
8	Dash Assembly	Cuadro de mandos
9	Door Post	Pilar central
10	Doorskins	Panel de puerta
11	Fitch Assembly	Conjunto larguero y pase de rueda
12	Front Panel	Frente
13	Front Wing	Aleta delantera
14	Headlamp	Faro
15	Headlining	Montante lateral de techo
16	Heelboard	Traviesa posterior habitàculo
17	Inner Wing	Pase de rueda
18	Kerb Weight	Peso en orden de marcha
19	Pillar	Pilar delantero
20	Quarter Light	Custodia
21	Quarter Panel	Aleta trasera
22	Rear Chassis Rail	Larguero trasero
23	Rear Flitch	Cierre de aleta trasera
24	Rear Lamps	Pilotos traseros
25	Rear Panel	Faldón
26	Rear Screen	Luneta trasera
27	Rear Wing	Aleta trasera
28	Roof Rail	Cercha de techo
29	Screen (Windscreen)	Parabrisas
30	Side Lamps	Intermitentes
31	Sill Assembly	Estribo
32	Squab	Asiento
33	Suspension Turret	Torreta de suspensión
34	Tailgate	Porton
35	Tow Hook/Tow Eye	Gancho de remolque
36	Wheel Arch	Pase de rueda
37	Wiring Loom	Cableado

GLOSSARY OF TERMS

	UK	USA
1	Bonnet	Hood
2	Boot	Trunk
3	Boot Floor	Trunk Floor
4	Boot Lid	Deck Lid
5	Bulkhead	Firewall/Dash Panel
6	Bumper	Bumper
7	Chassis Rail/Longitudinal	Lower Front Rail
8	Dash Assembly	Instrument Panel
9	Door Post	Hinge/Lock Pillar
10	Doorskins	Door Outer Panel
11	Fitch Assembly	Apron Assembly
12	Front Panel	Radiator Core Support
13	Front Wing	Front Fender
14	Headlamp	Headlamp
15	Headlining	Headliner
16	Heelboard	Rear Floor Pan Kickup
17	Inner Wing	Inner Fender
18	Kerb Weight	Curb Weight
19	Pillar	Pillar
20	Quarter Light	Quarter Glass
21	Quarter Panel	Quarter Panel
22	Rear Chassis Rail	Rear Rail
23	Rear Flitch	Wheelhouse/Quarter Inner Panel
24	Rear Lamps	Tail Lamps
25	Rear Panel	Rear Body Panel
26	Rear Screen	Rear Window
27	Rear Wing	Quarter Panel - car / Side Panel - truck
28	Roof Rail	Roof Header
29	Screen (Windscreen)	Windshield
30	Side Lamps	Side Marker Lamp
31	Sill Assembly	Inner & Outer Rocker Panel
32	Squab	Seat Cushion
33	Suspension Turret	Strut Tower
34	Tailgate	Tailgate/Liftgate
35	Tow Hook/Tow Eye	Tow Hook
36	Wheel Arch	Wheel House
37	Wiring Loom	Wiring Harness