DESIGN AND REPAIRABILITY GUIDE

2025

RCAR

FOREWORD

The RCAR, founded in 1972, is an international organization devoted to harmonising and enhancing the work of all the insurance company research centres throughout the world.

More than five decades of research activity by the more than 20 RCAR centres have produced a vast knowledge on how accidents occur, what their human and material consequences are and how to repair cars.

The aim of this guide is to make the knowledge gathered by these research available to manufacturers, designers and technicians involved in the production of cars so that car production and car repair are easier and cheaper while, always maintaining the highest levels of safety in vehicles.

This New Design Guide is a complete updating of the previous one. The REPAIRABILITY Working Group has removed the obsolete points and added new ones so that the new content is in line with the latest technologies.

Now the guide includes remarks about new materials incorporated into modern cars; new cars powered by gas, electricity, or hybrids; ADAS (Advanced Driving Assistance Systems) and the ultrasonic sensors, cameras, lidars and radars that play a key role in their operation.

Over more than one hundred points, most with photographic illustration, the guide suggests how to improve design, spare part delivery, and other important topics that influence the reparability of cars.

Since first publication in 2008, the Design Guide has been an important reference document for car manufacturers when designing their new models.

The contribution of the Guide to car design is of the utmost importance for manufacturers, insurance companies and consumers because, if cars are less costly to repair, insurance premiums will be lower, the cost of ownership of the car cheaper and, therefore, cars will be more competitive in the market.

The RCAR REPAIRABILITY Working Group, over almost two years of sustained effort, has produced work of the highest standard.

I would like to give warm thanks to all the centres that have contributed to the DESIGN AND REPAIRABILITY GUIDE 2024 for the enthusiasm, effort, and the expertise they have poured into this guide.

Finally, I would like to remark that, to maintain its usefulness and its relevance, the DESIGN AND REPAIRABILITY GUIDE 2024 must be a living document, capable of assimilating all the advances that cars and repair methods will incorporate in the future.

Therefore, I urge all the RCAR research centres to contribute to the continuous updating of the guide, and all manufacturers to consult the guide when designing cars to incorporate repairability in their specifications.

Francisco Javier Alfonso Peña, Chairman,
RCAR REPAIRABILITY Working Group

INTRODUCTION

This Guide, produced by the RCAR research centres, is intended to convey the perspectives and concerns of car repairers to technicians involved in car design. In other words, the aim of this document is to make it possible for those involved in designing cars in the present to take into account the repairs which those cars which are being designed now may require years later.

For facility of consultation, this document is divided into two main chapters: No. 1 contains the recommendations applicable to all kinds of cars and No. 2 focuses on features characteristic of only some types of cars.

Chapter 1 is organized by topics that will have a great influence on collision repair that designers must decide on in designing a new vehicle:

- The types of material used in the construction of the car.
- Mechanical and electrical parts that are very often involved in road accidents Paint details, which influence the majority of the collision repairs.
- Details about the panels most frequently affected in crashes and finally.
- ADAS sensors, which play a fundamental role in the safety of the vehicle and its passengers, and, consequently, which must be repaired and calibrated so as to guarantee their perfect operation.

Chapter 2, in contrast, is organized by type of car, and highlights special characteristics that only affect one of the types of a car:

- Electrics.
- Hybrids.
- Gas powered.
- Body on frame, such as small trucks or pick-ups.

The intention of the guide is to be informative and user-friendly. To achieve this, many points show "poor" and "good" examples abundantly illustrated by graphics and photographs. Some of them have short introductions to further facilitate comprehension.

All the RCAR centres involved in the development of this Guide intend it to serve as a useful bridge linking insurers and repairers with designers and manufacturers with the overall goal of placing better cars in the hands of consumers who are their common customers.

INDEX

1. ALL KINDS OF CARS

Basic requirements

- Repair methods should be available at vehicle launch.
- Guidance should be available on the materials used in body construction, including recommendations for part replacement or repair, where not already covered within a repair method.
- Guidance should be available for the specification of any tools or equipment used within the body repair process.
- Service panels should be available for all common accident repair scenarios.
- Service panels and parts should be made available at vehicle launch and should remain readily available for at least 10 years after the end of production of the car.
- Service panels should replicate the condition of the part of the vehicle they are replacing, i.e., have the same welds; adhesive; brackets; re-enforcements; studs/fixings, where these do not hinder the replacement process.
- Where one or more of the above criteria is not available, the VM should supply a mechanism to confirm or reject a repair proposal.

1.1. TYPES OF MATERIAL

There are several materials used to make our cars, the main factors for material selection, especially for the body include thermal, chemical, or mechanical, environmental resistance, durability, ease of assembly and manufacturing. There is a significant effort that goes into know the types of materials used by manufacturers on each model and variant. This is because the ELV (End of Life Vehicle) requirements govern the amount of recyclability and reuse of materials used.

A car made from the most efficient materials will help in fuel consumption while still provide the necessary safety features. There is a lot of planning, design, and science put into developing a car, and there are different types of materials used to design a car, and these materials determine the durability, design, and sometimes the speed of the vehicle.

The most common materials used in a car are:

Steel

It is the most common, go-to material for body structure and outer panel design due to its strength, formability, well known process of welding and maintainability. It has a good life with proper treatment and coatings. There are different types of steel in modern cars. Therefore, they help you remain safe on the road since it is a metal that is responsible for the heavyweight and support of the cars.

With the increased focus on safety, the application now requires more impact absorbing but strong enough materials to withstand vehicle dynamic stresses. This makes the HSS/UHSS options so viable since achieving similar performance using traditional materials will result in increase in weight.

Plastic

Plastics used in car manufacturing are petroleum by-products (gas and oil). Plastics are challengers to steel because of their prominence in car manufacturing. They are malleable and still strong enough to hold the structure in shape.

Plastics constitute almost half of the total car parts, being the main component in manufacturing the dashboard, door handles, pipes, and air vents. The durability, versatility, and lightweight characteristics of plastics make them the ideal materials for different parts.

Aluminium

It is lighter (by almost 40% to steel), corrosion resistant, malleable, easily machinable and has good thermal/electrical conductivity. Also, the material can be used as load bearing when extruded. Manufacturers started using aluminium for making lightweight yet stronger shells quite recently for mainstream cars. The problem with aluminium other than cost is the joining process, it required special welding process as it has very good electrical conductivity. Also, the NVH and the absorption properties were completely different to that of steel.

1.1.1. STEEL

Introduction

Steel is the predominant material used in motor vehicle body and chassis construction. The following lists some of its characteristics:

- Plentiful, cheap, and recyclable.
- Malleable, ductile, and durable - easy to shape into body panels.
- Easy to weld steel to steel.
- Strong and hard and can be alloyed with other metals where Higher Strength or Advanced Higher Strength is required for specific purposes.

The requirement to reduce vehicle emissions demands the need to reduce the weight of the motor vehicle body and chassis, whilst maintaining the requirements for safety.

Higher Strength and Advanced Higher Strength Steels are used in areas where there is a requirement for the vehicle structure to dissipate or absorb impact energy for passenger safety, or where it is required to protect components such as the fuel tank, fuel cell or High Voltage battery.

1.1.1.1. SHIPPING DAMAGE TO SERVICE PARTS

Inspection criteria

The packaging of service parts must be sufficient to avoid any damage to the surface or the shape during shipping in either case.

Reason

When service parts arrive damaged and deformed to the repairer, repair times and then repair cost increase.

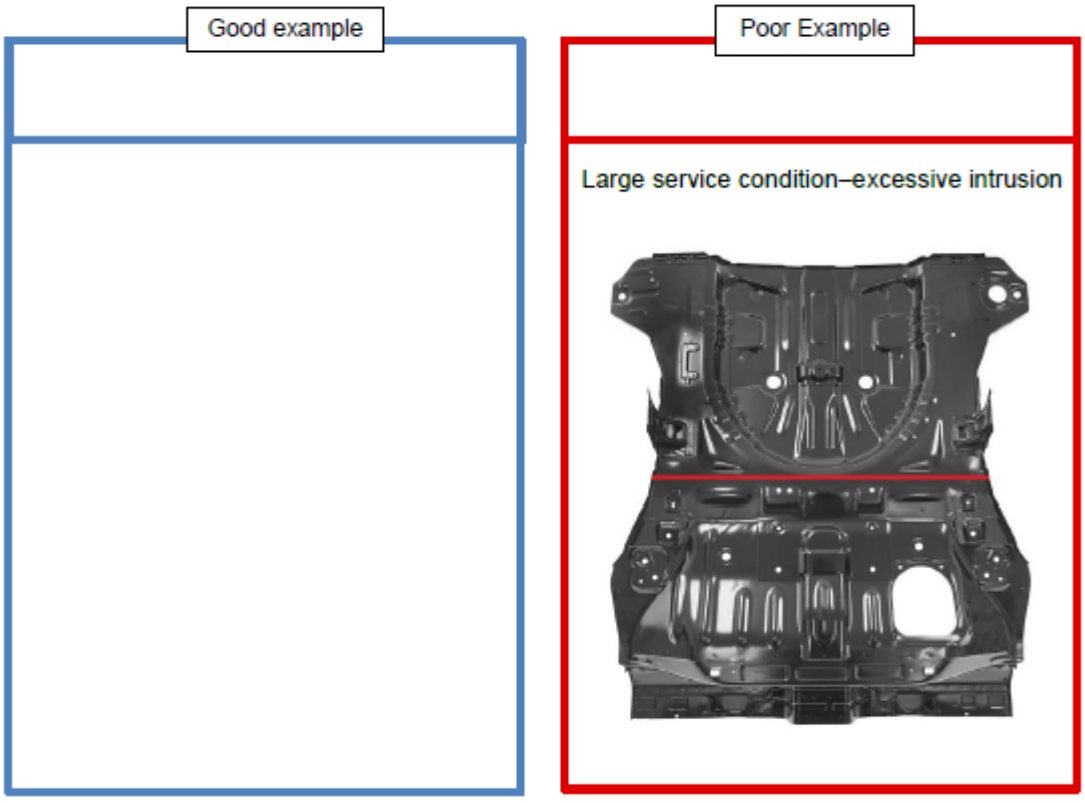
1.1.1.2. STEEL - SERVICE PANEL CONDITION

Inspection criteria

- Service panels to be relevant to common accident damage scenarios.
- Service panel sections available, where appropriate, to avoid unnecessary cost, transportation & storage issues, and less intrusive fitment.
- Service panel to be relevant to the available repair method.
- Service panel to be available at vehicle launch.
- Service panel to be fully assembled and joined as it would be on the vehicle and to include any necessary brackets, studs/fixings, reinforcements, and additional components.

Reason

- An inappropriately large service assembly can cause issues with transportation and storage as well as unnecessarily increasing its cost.
- An unavailable service panel may delay the repair process and, in some instances, render a repair to the vehicle non cost effective, leading to a total loss situation. This is not good from a cost, customer, or environmental perspective.
- A service panel that is not appropriate to the accident damage, or to the available repair method, or is not fully joined, may add confusion for the repairer and result in the vehicle being repaired incorrectly.



1.1.1.3. MULTI-PANEL NODES

Inspection criteria

Consider the panel overlap affect for panels that are frequently damaged and require replacement:

- Provide suitable sectioning points for commonly damaged panels.
- Avoid placing non frequently damaged panels over frequently damaged ones.
- Provide repair information to identify where inner, hidden, reinforcement panels are close to the outer panel.

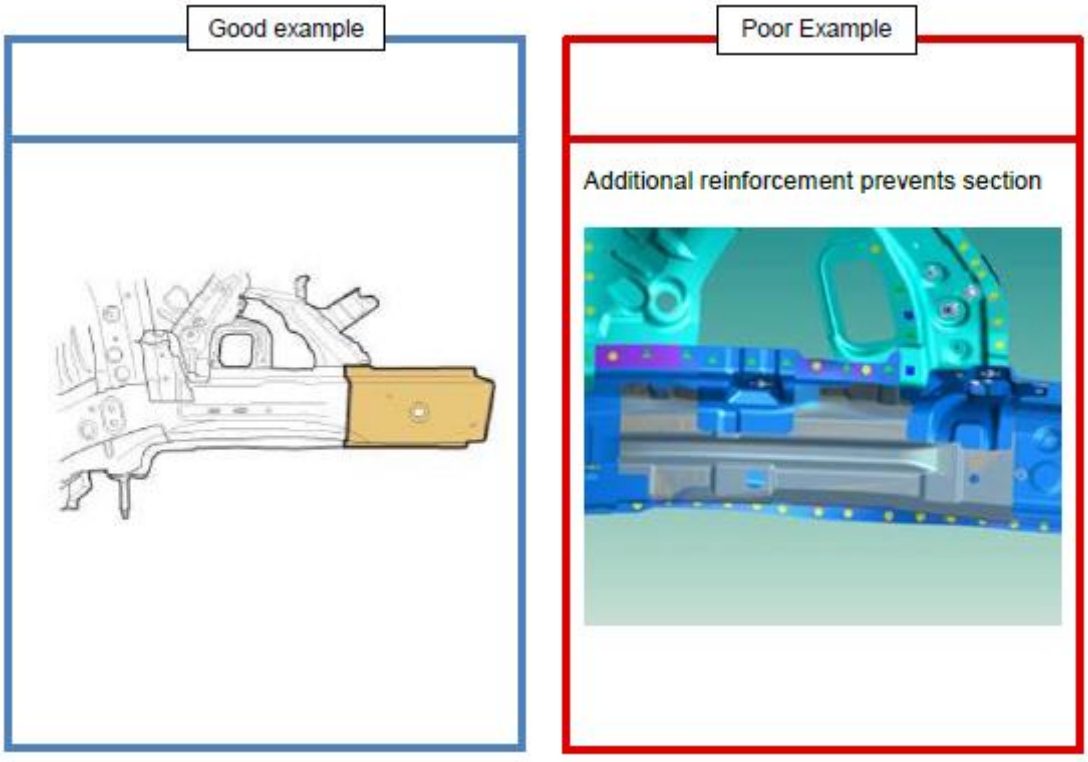
Reason

When two or more body panels are assembled in such a way that they are in proximity, or overlap each other, it can cause issues with their replacement in repair.

It can be difficult to separate or section the panels, due to their proximity with each other, without causing damage.

It can be impossible to remove the damaged panel, without the need to remove adjacent undamaged panels, which leads to a more intrusive repair, (including additional MET items that may require removal such as engines, facias, etc.

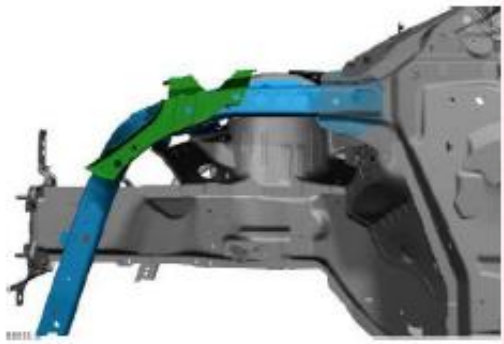
Same model with hybrid version repair limited by extra reinforcement.



Good example

Lamp panel section (partial repalcement) that removes the need to remove rear quarter panel.

Poor Example



Intrusive requirement to remove A Pillar outer section

1.1.1.4. USE OF ULTRA HIGH STRENGTH STEELS (UHSS)

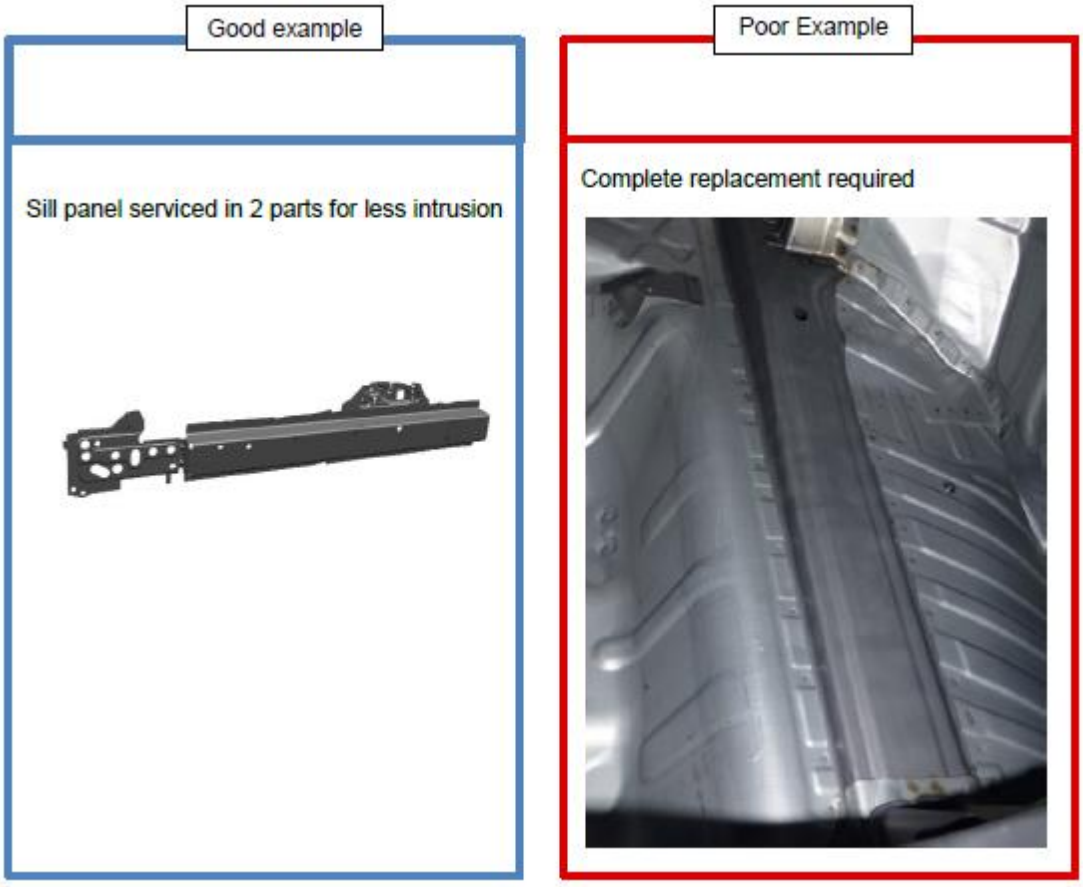
Inspection criteria

Provision for efficient repair in areas of high damage exposure should be made to enable practical and safe repair globally.

Reason

For areas such as front or rear-side members, where they have suffered localized damage, there should be provision to replace only the damaged area rather than having to replace the complete assembly.
OR
There should be provision to enable a repair section to be carried out rather than having to replace a complete assembly. This will reduce the intrusiveness of the actual repair and the associated vehicle strip.
OR
For areas such as rear side-members, where UHSS is applied in areas frequently exposed to crash damage, natural joins as part of a sectional design should be made, with repair procedures that do not require the entire assembly to be replaced.

Repair information for diagnosing body damage



1.1.2. ALUMINIUM

Introduction

Aluminium is an alternative to steel in motor vehicle body and chassis construction. The following lists some of its characteristics:

- Light weight.
- Has good corrosion resistance.
- Is soft, malleable, ductile, and conductive.
- 100% recyclable.
- Good energy absorption.

The requirement to reduce vehicle emissions demands the need to reduce the weight of the motor vehicle body and chassis, whilst maintaining the requirements for safety.

If you compare a similar aluminium body panel to a steel one, the aluminium panel will show a weight reduction due to its lower density. However, to obtain the same strength and/or rigidity, there needs to be more aluminium material, the panel has to be specifically shaped, or an additional reinforcing material applied.

With the correct knowledge and tools, aluminium panels can be repaired and replaced easily.

1.1.2.1. THE USE OF ALUMINIUM

Inspection criteria

Aluminium body panels should have the same efficient repair replacement scope as steel body panels, with procedures and service panels available for short sections where appropriate.

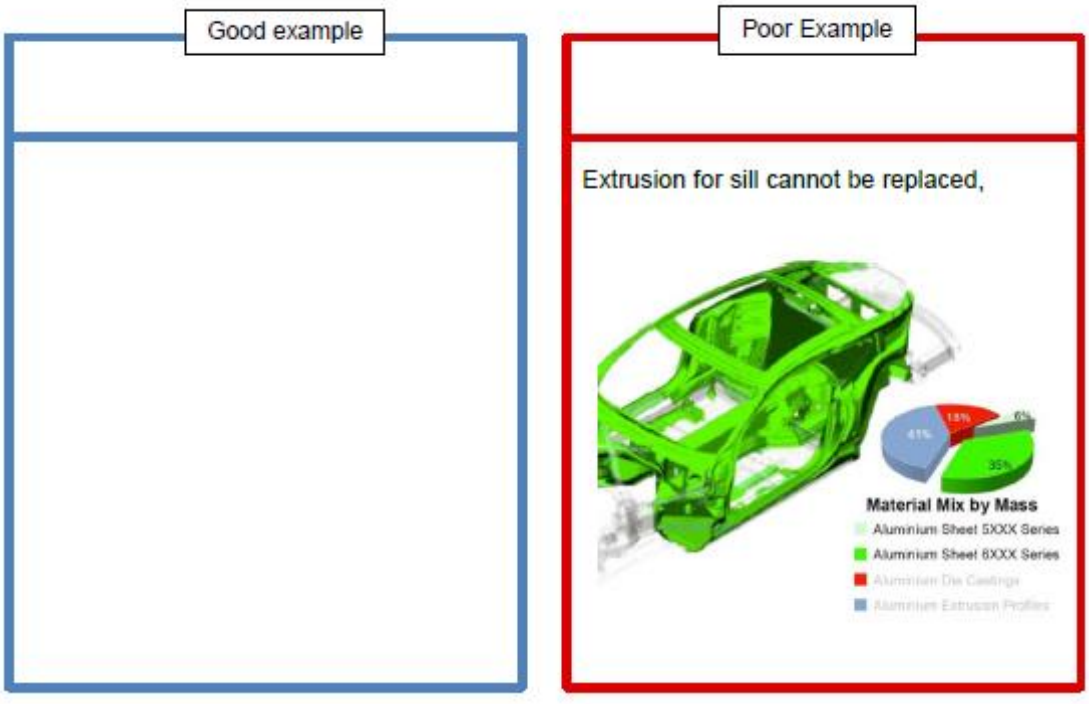
- Repairs to vehicles containing aluminium are no more complex than equivalent vehicles containing steel. However, where steel and aluminium meet, either in construction or repair, the cross contamination between the two materials must be managed.
- In repair workshops, it is necessary to separate vehicles, constructed of the differing materials and the tools used for the repair of either material must not be mixed.
- Aluminium extrusions are more susceptible to creasing and aluminium castings are more susceptible to cracking, when compared with steel.

Reason

Where aluminium is utilized within the structure (side sills, front or rear chassis legs), procedures for replacement should not be too intrusive, with natural joins that are considered so as not to require too much mechanical/trim strip or removal of other panels for access.

- Information available to show locations and types of aluminium used within the vehicle.
- Repair methods available for the replacement of aluminium body panels.
- Repair guidance available to confirm the do`s and don’ts for aluminium repair,
- including Non-Destructive Testing procedures for crack testing cast aluminium components.
- Repair workshops to have dedicated aluminium only work areas/bays and dedicated aluminium-only tool kits. It will also be necessary to provide dedicated, aluminium specific, extraction systems.

Application of aluminium poorly considered can make a car irreparable.



1.1.2.2. WELDING CASTINGS

Inspection criteria

Castings can sustain damage, and repair of castings is typically prohibited. Therefore, replacement procedures must be enabled with cost-efficient service conditions, and replacement procedures that are not needlessly intrusive and do not require special tools beyond those **Reason**able to expect from a bodyshop. adjacent panel removal should be avoided.

Reason

- A process for Non-Destructive Crack Testing of castings to be made available.
- A clear inspection and replacement criteria to be provided by the vehicle manufacturer, particularly for cases where the casting is not visibly damaged.
- Replacement of castings should be achievable using commonly available tools and skills

1.1.2.3. REPAIR OF ALUMINIUM

Inspection criteria

Clear information must be provided regarding tools and equipment requirements, and parameters for allowing cosmetic repair of non-structural components

Reason

Aluminium can be costly, and surface panels are exposed to damage. It is reasonable to recognize that the customer will expect panels can be safely and efficiently repaired.

Example of positive OEM repair strategy for aluminium

Good example

Poor Example

1.1.3. PLASTICS

Introduction

Plastics are used extensively in the motor vehicle. They are used for internal and external trim parts and coverings as well as for external cosmetic body panels and non-structural body panels. The following lists some of its characteristics:

- Light weight
- Has good corrosion resistance.
- Can resist minor impact damage.
- Can be cheaper than an equivalent metal part/component.
- 100% recyclable
- Good energy absorption

The requirement to reduce vehicle emissions demands the need to reduce the weight of the motor vehicle body and chassis, whilst maintaining the requirements for safety.
Plastics can also be used for reinforcing structural steel and aluminium body and chassis panels.

1.1.3.1. SPARE PARTS PACKAGING

Inspection criteria

Do not pack service parts with low-quality materials. As an alternative, always use high quality packing materials.

Reason

Packing spare parts with low-quality packaging should be avoided, as they may be damaged during shipment, resulting in additional repair costs.

1.1.3.2. PLASTICS - SERVICE PANEL CONDITION

Inspection criteria

- Service panels to be relevant to common accident damage scenarios.
- Service panel sections available, where appropriate, to avoid unnecessary cost, transportation & storage issues, and less intrusive fitment.
- Service panel to be relevant to the available repair method.
- Service panel to be available at vehicle launch.
- Service panel to be fully assembled and joined as it would be on the vehicle and to include any necessary brackets, studs/fixings, reinforcements, and additional components.

Reason

- An inappropriately large service assembly can cause issues with transportation and storage as well as unnecessarily increasing its cost.
- An unavailable service panel may delay the repair process and, in some instances, render a repair to the vehicle non cost effective, leading to a total loss situation. This is not good from a cost, customer, or environmental perspective.
- A service panel that is not appropriate to the accident damage, or to the available repair method, or is not fully joined, may add confusion for the repairer and result in the vehicle being repaired incorrectly.

1.1.3.3. COMPOSITES- LOCATION OF COMPOSITE MATERIALS

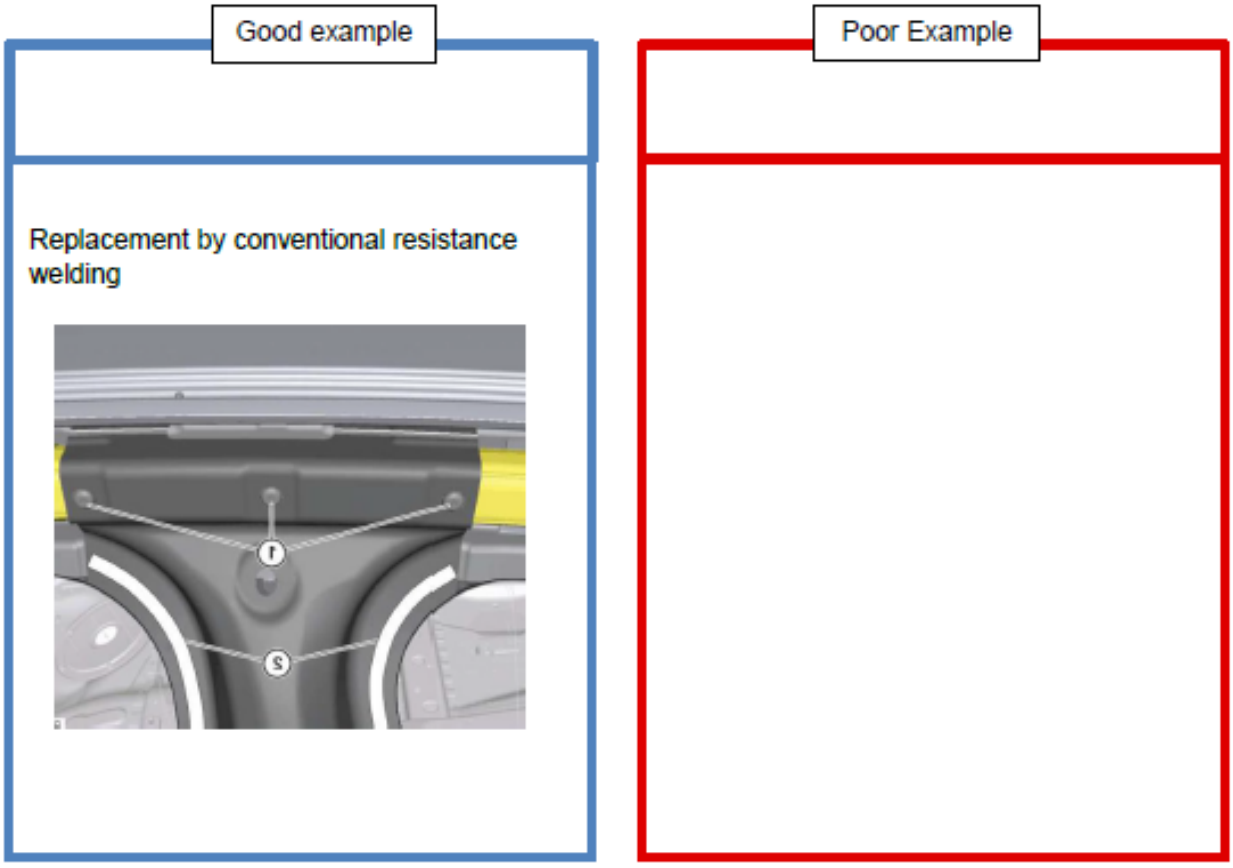
Inspection criteria

- Composite materials should be located and engineered to be accessible for damage inspection and for efficient non-intrusive replacement, without the requirement of unique and expensive special tool requirements.

Reason

- Consideration should be given to quick and clear inspection and damage diagnosis of composite panels, and service panels and diagnosis and replacement procedures for safe and efficient repair/replacement must be available where structural integrity cannot be verified.
- Guidance to be provided by the vehicle manufacturer to identify where the load forces dictate panel replacement.
- Replacement of composite panels should be commensurate with steel body panels.

Good CFRP application for replacement



1.1.3.4. PLASTICS - REPAIR

Inspection criteria

Plastics should be labelled to clearly identify material to repair, and clear guidance provided of permissible and prohibited repairs.

Reason

Plastics are common to all vehicles, and expectation is that these can be repaired. This should be supported wherever possible by material information, but areas of non-repair must be clearly identified to prevent repair in error.

Identification of plastics for repair

Good example

It is possible to repair the following damage:

- Slight deformations without visible cracks in the paint.
  Visible cracks reach the component and it is not possible to permanently rectify the damage> again become visible on the paintwork after a certain period of time.
- Slight damage, e.g. scrapes, if the component underneath does not become visible.
- Cracks, holes up to 2.5 centimetre in length.
  Cracks must **not** reach the edge of the component.

Attention!

The following components **cannot** be repaired:

- Components that are not painted as standard.
  Unable to restore grained surface.
- Fuel tank, fluid tank (e.g. window washer system, brake fluid, coolant expansion tank, etc.)

Poor Example

1.2. MECHANICAL, ELECTRICAL & TRIM

Repair of a vehicle is not just restricted to body panels. When an impact has occurred, the amount of secondary damage to other parts can cost as much, if not more than the repair of the panels.

Mechanical stands for all the parts that are related to the power train, primary protection, steering, braking, glazing and fuel system.

Electrical covers all the wiring and auxiliaries feeding into or connected to the electrical loom, for example HVAC, motors for windscreen wipers and windows, electric looms, airbags, restraint systems, ECUs, lighting, entertainment systems and batteries.

Trim is all the parts that are used to give the interior its looks, touch and functionality and they usually go hand in hand with the electrical items. Apart from providing for comfort, seats are also part of the occupant safety system, with integrated airbags and active head restraints.

Most electrical controls are fitted into, or are part of trim panels, for example switches, heatingcontrols and airbags. Trim panels are also used for noise reduction and thermal insulation of the interior.

Although the list is not exhaustive, below are some of the most common examples found on cars.

1.2.1. FUEL TANK REMOVAL (FILLER NECK PIPE)

Inspection criteria

The fuel filler neck should be able to be removed individually instead of together with the fuel tank.

Reason

When the filler neck pipe and fuel tank are individual parts, removal and installation of the fuel tank is not necessary to repair the rear quarter panel, rear side member, etc., which reduces man-hours.

Good Example

Damage

The quarter panel and rear side member were damaged and needed to be repaired.

During repair

Removal of the fuel tank was not necessary as the fuel neck is separate from the fuel tank.

Poor Example

Damage

The rear side member and wheel housing were damaged and needed to be repaired.

During repair

Removal of the fuel tank was necessary as the fuel neck is part of the fuel tank.

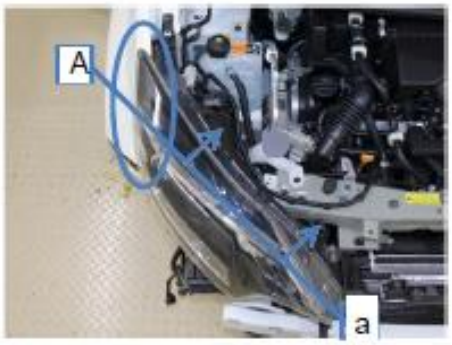
1.2.2. LIGHTING CLUSTERS (HEADLIGHTS)

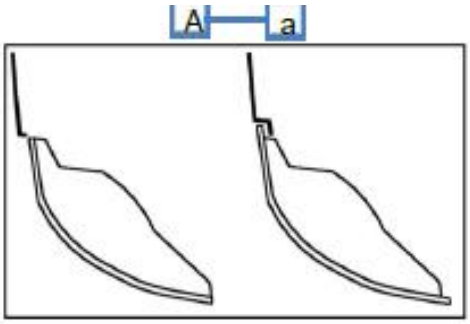
Inspection criteria

The headlight and front fender should be detached easily in a collision so that damage to the front fender does not occur.

Reason

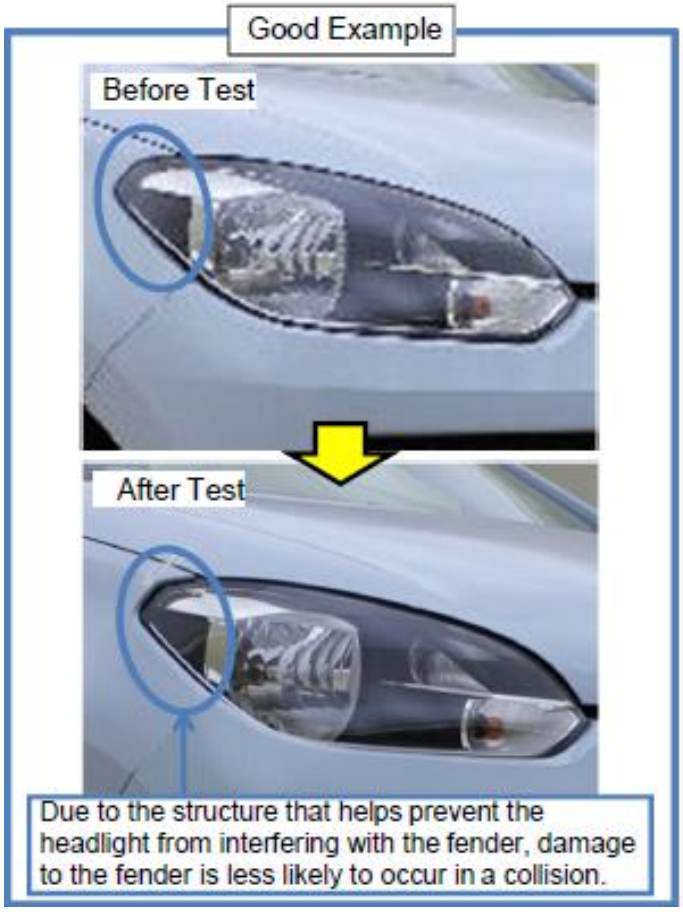
If the headlight unit and the fender are not detached easily, damage to the fender is likely to occur when the headlight is pushed in.

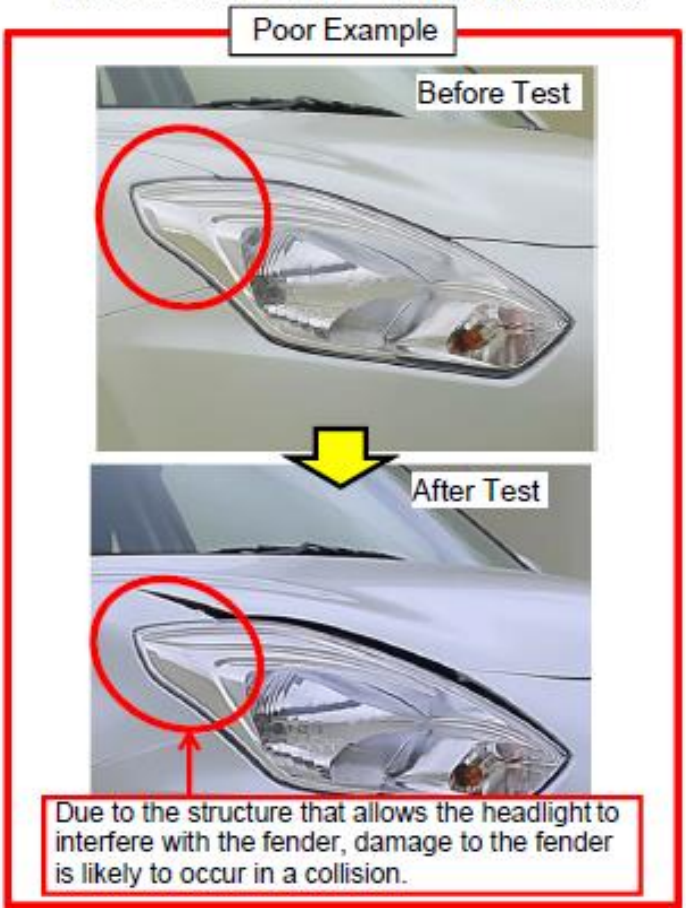




Example of a shape where the headlight is less likely to interfere with the fender.

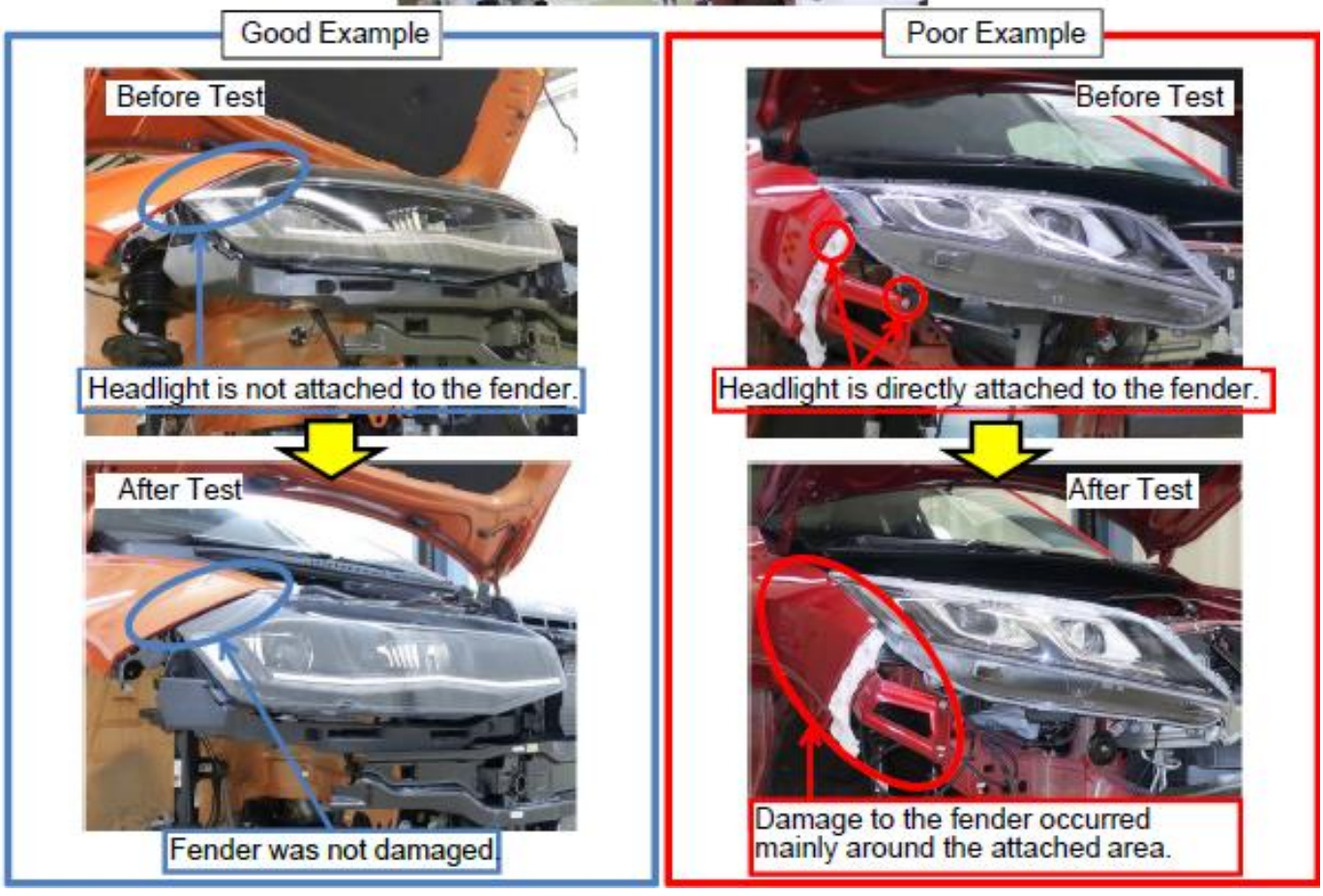
Example of a shape where the headlight is likely to interfere with the fender.





LIGHTING CLUSTERS (HEADLIGHTS)

Example of a structure where the headlight is directly attached to the fender.



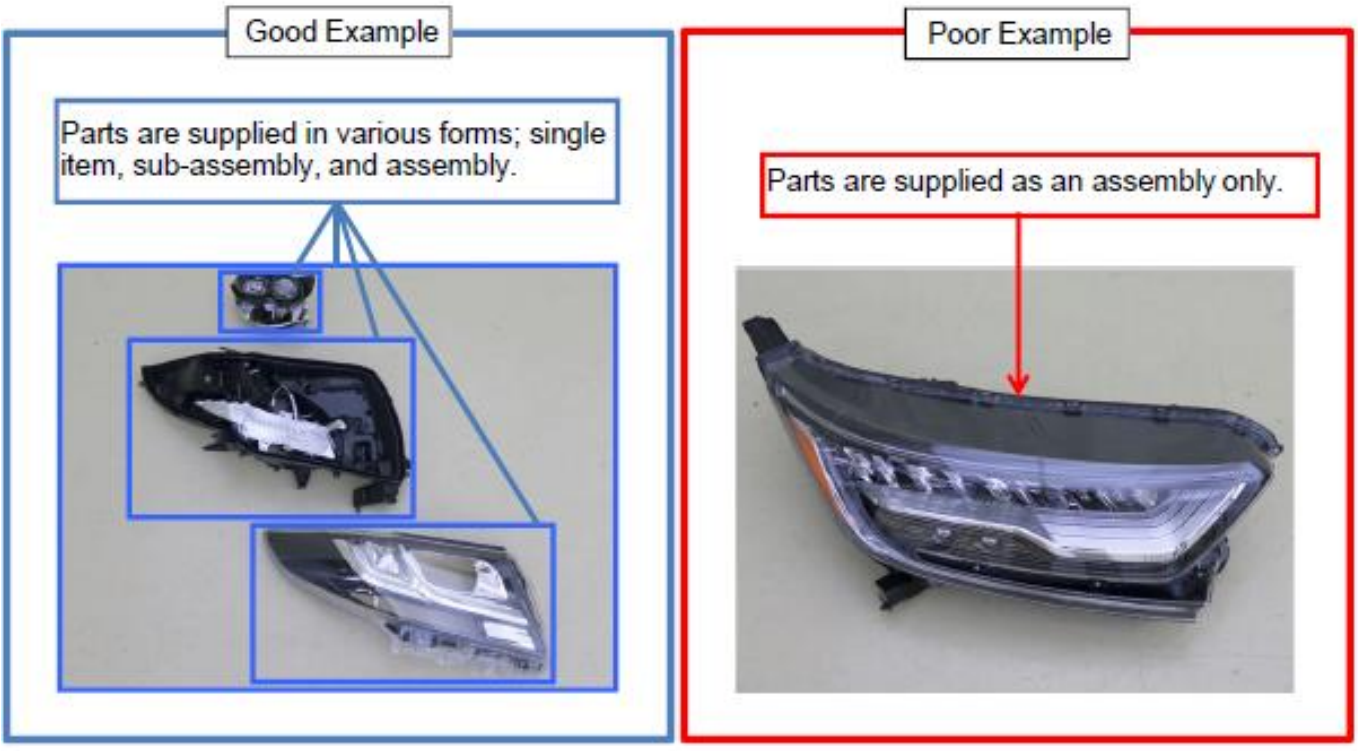
LIGHTING CLUSTERS (HEADLIGHTS)

Inspection criteria

Expensive headlights such as LEDs must be disassemblable and the lens, housing, controller unit, etc. should be supplied individually.

Reason

LED headlights are expensive. When the headlight components are not supplied individually, if the bracket or lens be damaged, the assembly needs to be replaced.



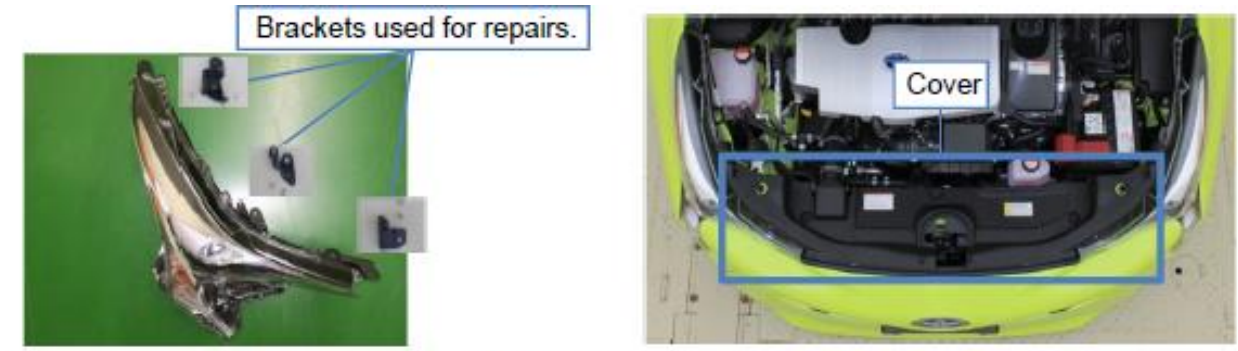
LIGHTING CLUSTERS (HEADLIGHTS)

Inspection criteria

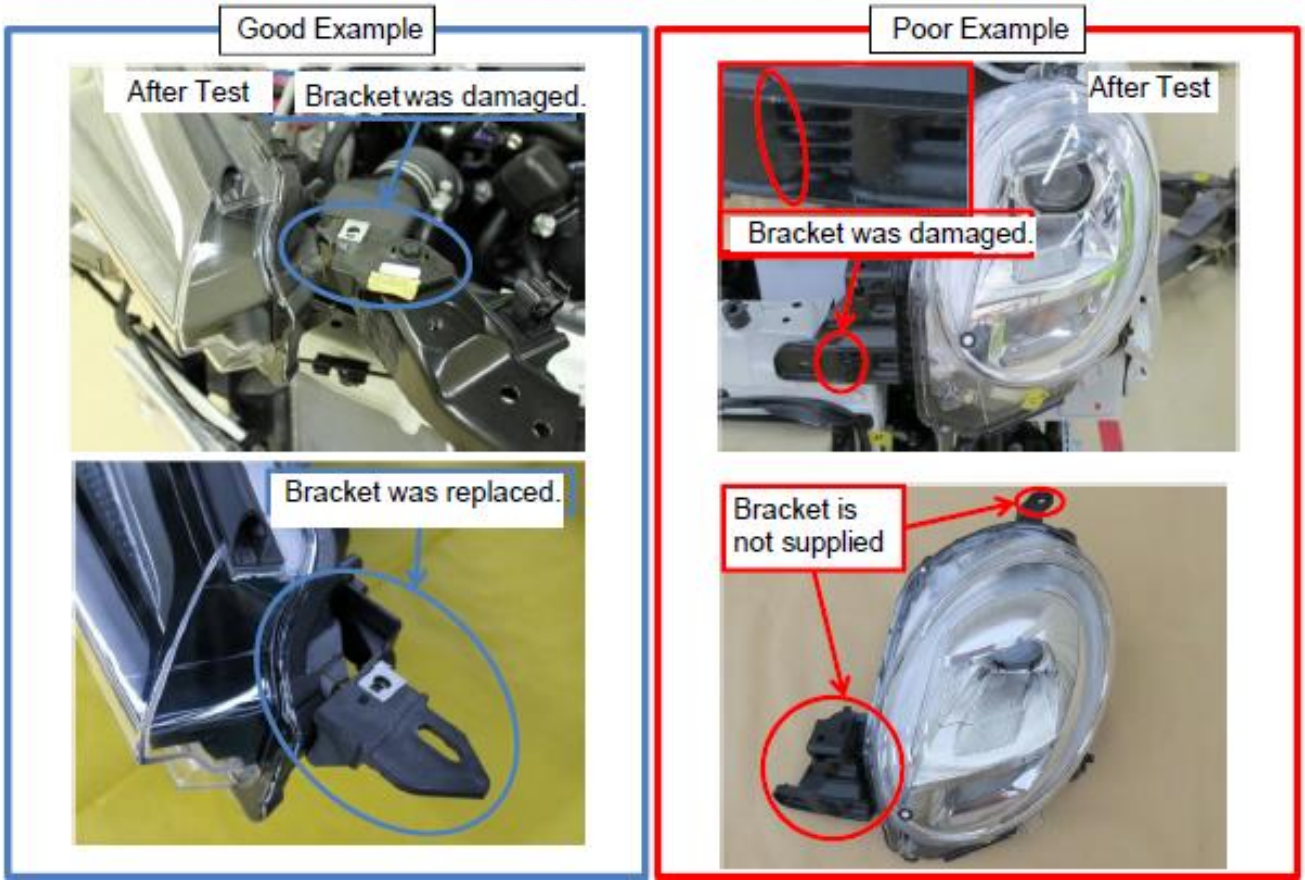
Brackets used for headlight repairs should be supplied individually and covered to hide the marks from repairs.

Reason

When brackets used for headlight repairs are supplied individually, it is not necessary to replace the headlight assembly or unit when the bracket is damaged, which reduces the repair cost.
Also, if the bracket is covered, the marks from repairs are hidden, which promotes replacement of the bracket.



Example where brackets used for headlight repairs can be supplied individually and are covered.



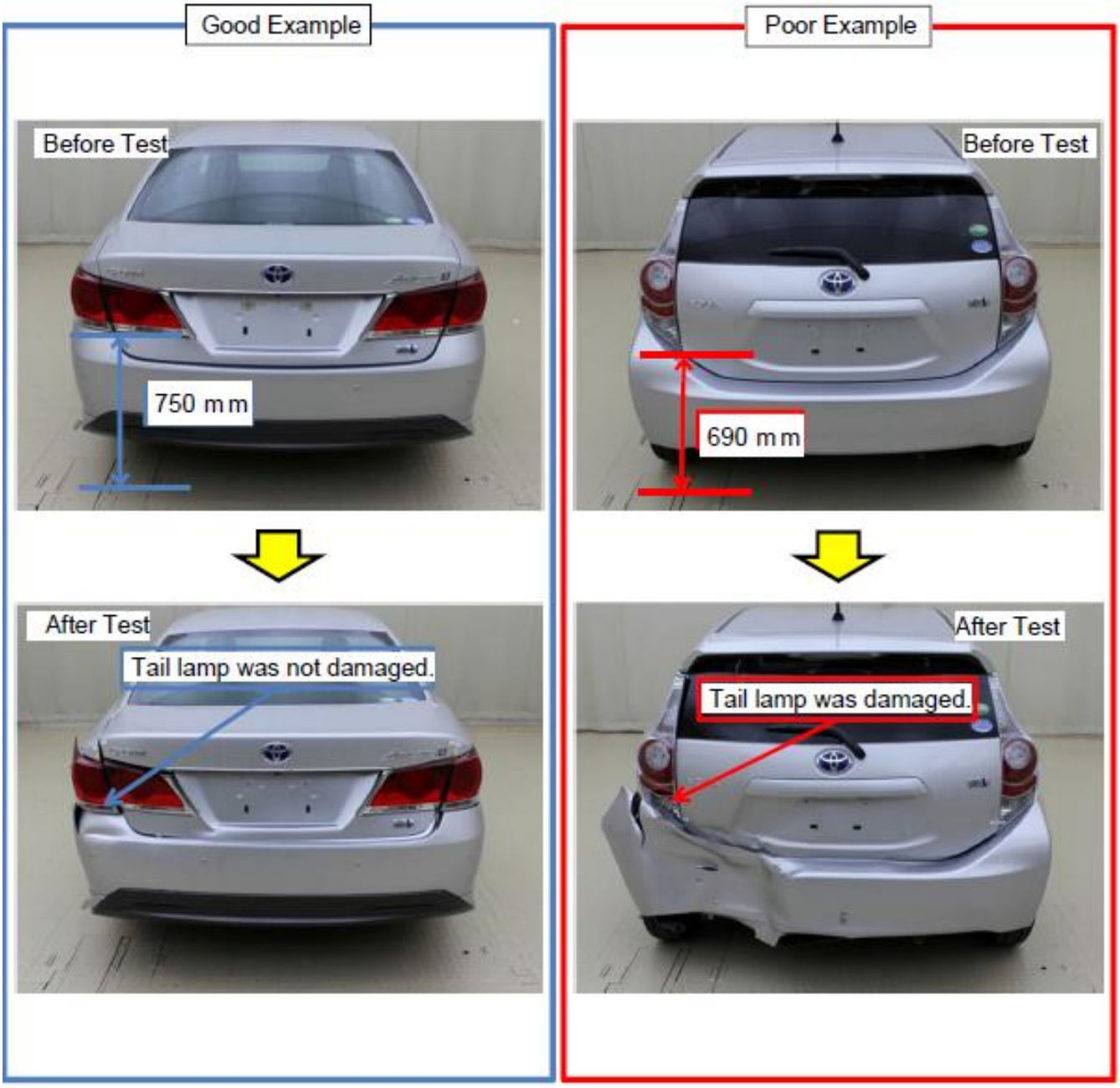
LIGHTING CLUSTERS (TAIL LAMP)

Inspection criteria

The bottom end of the tail lamp should be higher than the barrier (705 mm).

Reason

When the bottom end of the tail lamp is higher than 705 mm, damage to the tail lamp is less likely to occur.



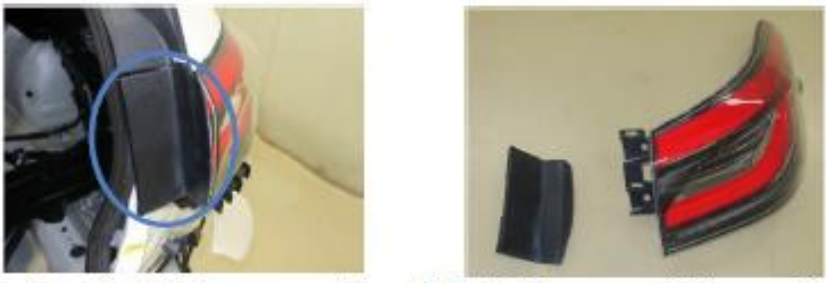
LIGHTING CLUSTERS (TAIL LAMP)

Inspection criteria

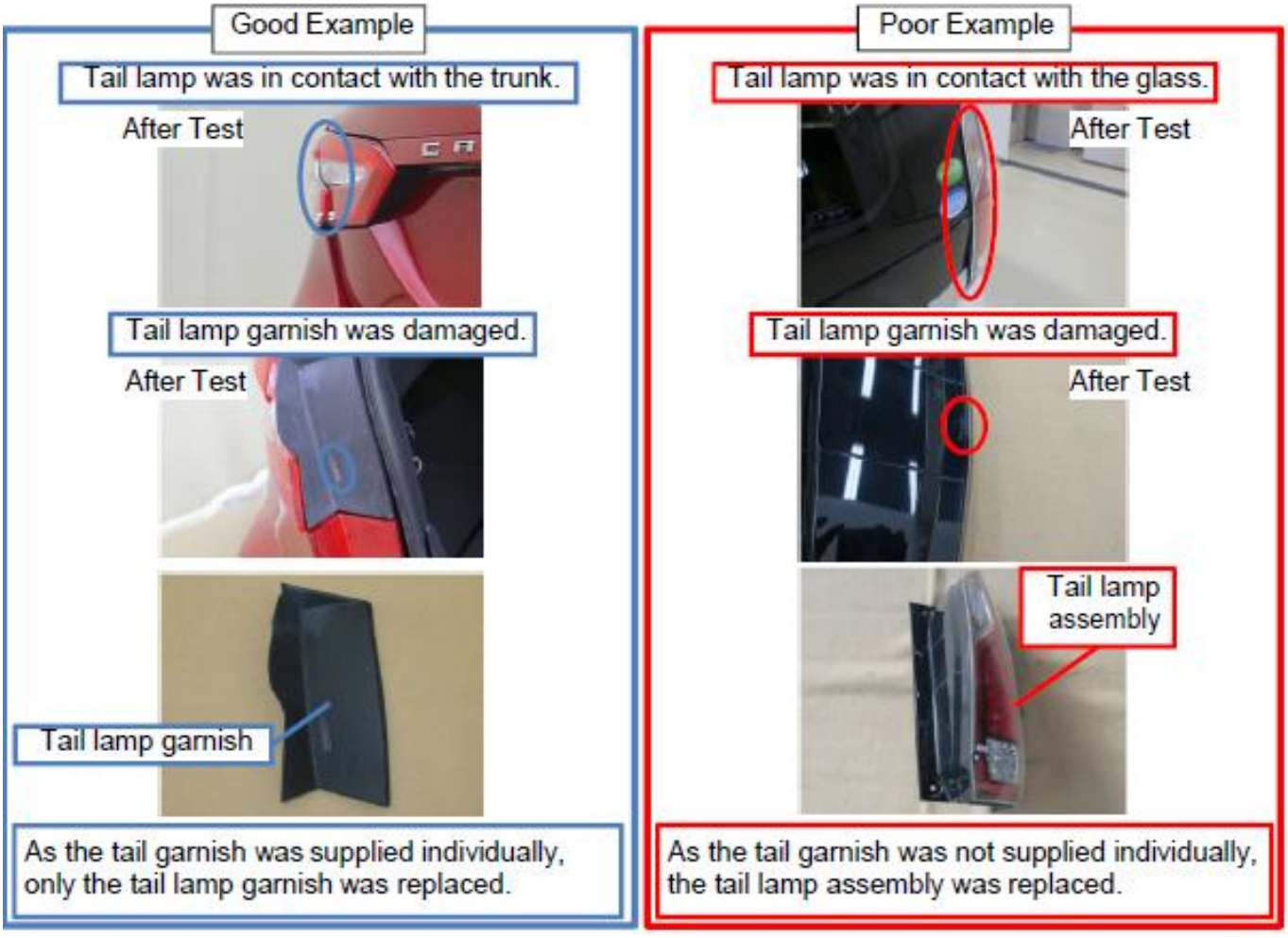
There should be a tail lamp garnish between the rear door and the tail lamp, and the tail lamp garnish should be supplied individually.

Reason

When there is a tail lamp garnish between the tailgate and the tail lamp and the tail lamp garnish is supplied individually, if the tail lamp garnish is damaged, it is not necessary to replace the tail lamp assembly or the unit, which reduces the repair cost.



Example where there is a tail lamp garnish and the tail lamp garnish is supplied individually.



1.2.3. AVAILABILITY OF ELECTRICAL CONNECTORS

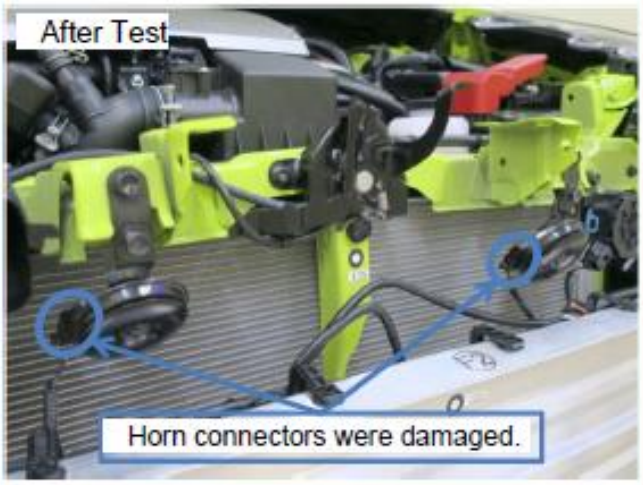
Inspection criteria

Connectors in the area where damage is likely to occur should be supplied individually.

Reason

When connectors in the area where damage is likely to occur are supplied individually, if the connector is damaged, it is not necessary to replace the harness assembly, which reduces man-hours and parts cost.

Good Example

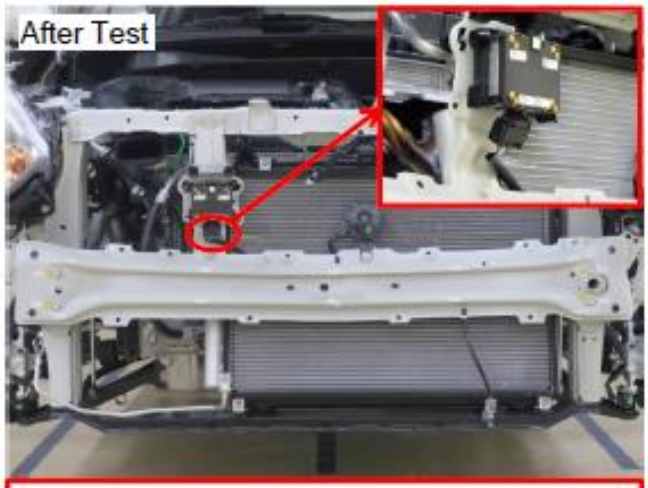


Part name	High-pitched horn assembly
Connector No.	A3
Connector part No.	90980-10619
Connector color	Black
Specification	

Part name	Low-pitched horn assembly
Connector No.	A1
Connector part No.	90980-10619
Connector color	Black
Specification	

Only the clips had to be replaced as the replacement harness clip and connector clips are supplied individually.

Poor Example



The auto brake controller connector was damaged.

The main harness assembly had to be replaced as the auto brake controller connector was not supplied individually.

AVAILABILITY OF ELECTRICAL CONNECTORS

Inspection criteria

Harness clips, harness bands, and connector clips in the area where damage is likely to occur should be listed as an individual part in the parts catalogue.

Reason

When harness clips, harness bands, and connector clips in the area where damage is likely to occur are supplied individually, if the harness clip, harness band, or connector clip is damaged, it is not necessary to replace the harness assembly, which reduces man-hours and parts cost.

Good Example

The harness clip and connector clip on the rear bumper cover were damaged.

Parts

Only the clips had to be replaced as the replacement harness clip and connector clips are supplied individually.

Poor Example

The harness clip on the side of the side member was damaged.

Only the harness clip was damaged, but the harness assembly had to be replaced as the harness clip is not supplied individually.

1.2.4. AIRBAG AND PRETENSIONER (AIRBAG)

Inspection criteria

The front and side airbag sensors should be reusable if they are not damaged in the collision.

Reason

When airbag sensors are reusable, the cost of repair of the collision damages is smaller.

1.2.4.1. AIRBAG AND PRETENSIONER CAUSING PROTRUSION IN TRIM PANELS AND SEATS (BREAKING OF CONTROLS ON THE WHEEL)

Inspection criteria

The driver's airbag must be a unit independent from the rest of the elements that are mounted on the steering wheel.

Reason

Driver airbag units that include additional system switches are much more expensive than independent airbag units. When a driver's airbag has been activated, it must not cause any damage to the other components of the steering wheel.

1.2.4.2. AIRBAG AND PRETENSIONER CAUSING PROTRUSION IN TRIM PANELS AND SEATS (PASSENGER AIRBAG - WINDSHIELD BREAK)

Inspection criteria

Passenger airbag location in the dashboard and its orientation angle must prevent damages in the windscreen when it deploys.

Reason

The passenger airbag in its deployment should not break the windscreen, because this increases repair costs very much.

Good example

Poor Example

1.2.4.3. AIRBAG AND PRETENSIONER CAUSING PROTRUSION IN TRIM PANELS AND SEATS (PASSENGER AIRBAG - BREAKAGE OF THE DASHBOARD DECK)

Inspection criteria

The passenger airbag mounted on the dashboard must have a separate unit from the dashboard.

Reason

The passenger airbag in its deployment should not break the cover of the dashboard to avoid an increment of the collision repair cost due to the replacement of this expensive part.

Good example

Deployment of airbag does not affect dashboard

Poor Example

Deployment of airbag destroys dashboard

1.2.4.4. AIRBAG AND PRETENSIONER CAUSING PROTRUSION IN TRIM PANELS AND SEATS (SIDE AIRBAG - UPHOLSTERING AND SEAT RACKING OF SEAT BACKREST)

Inspection criteria

The side airbag mounted on the backrest of the driver and the passenger seats must be a separate unit from the seat backrest.

Reason

To avoid damages in the seats when these airbags deploy and so avoiding increments in repair costs.

Good example

The side airbag module must be replaceable from the rest of the seat backrest.

Poor Example

The lateral airbag breaks in its activation the padding and the upholstery of the backrest of the seat, this generates high repair costs

1.2.4.5. AIRBAG AND PRETENSIONER CAUSING PROTRUSION IN TRIM PANELS AND SEATS (CURTAIN AIRBAG - ROOF TIE BREAKAGE)

Inspection criteria

The curtain airbag must not damage either the roof trim or the upper trim of pillars A, B and C.

Reason

Interior trims and especially roof trim is very expensive and need a lot of time to be replaced.

1.2.4.6. AIRBAG AND PRETENSIONER CAUSING PROTRUSION IN TRIM PANELS AND SEATS (KNEE AIRBAG - BREAKING OF DASHBOARDS)

Inspection criteria

The knee airbag must be a unit independent of the rest of the dashboard trim under the steering wheel, and it should be dismounted without affecting steering wheel bar covers.

Reason

The activation of the knee airbag must not break or damage the trim of the dashboard under the steering wheel to prevent repair costs to increase unnecessarily.

1.2.4.7. AIRBAG AND PRETENSIONER (AIRBAG)

Inspection criteria

Airbag should not deploy in low-speed collision, like 15 Km/h RCAR crash-test.

Reason

Deployment of airbags in low-speed collisions increments unnecessarily repair costs and could cause personal injuries.

Good example

Airbag did not deploy at 15 km/h crash test

Poor example

Airbag deployed at 15 km/h crash test

AIRBAG AND PRETENSIONER (AIRBAG)

Inspection criteria

Airbag ECU should be reusable.

Reason

Reusing ECUs reduce repair costs.

Good example

Reprogrammable airbag ECU

Poor example

Airbag ECU NOT Reprogrammable

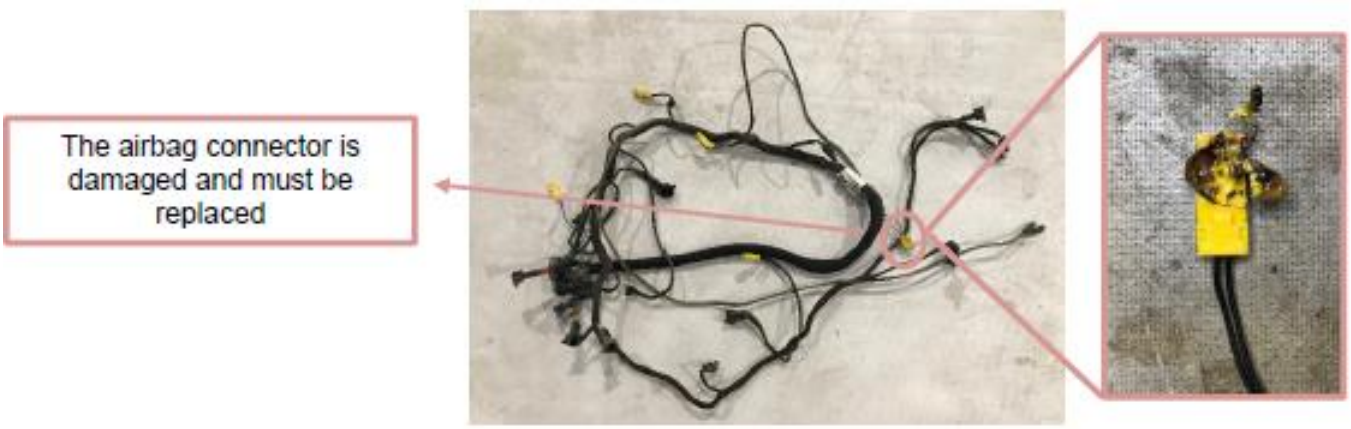
1.2.4.8. AIRBAG AND PRETENSIONER (AIRBAG WIRE HARNESS)

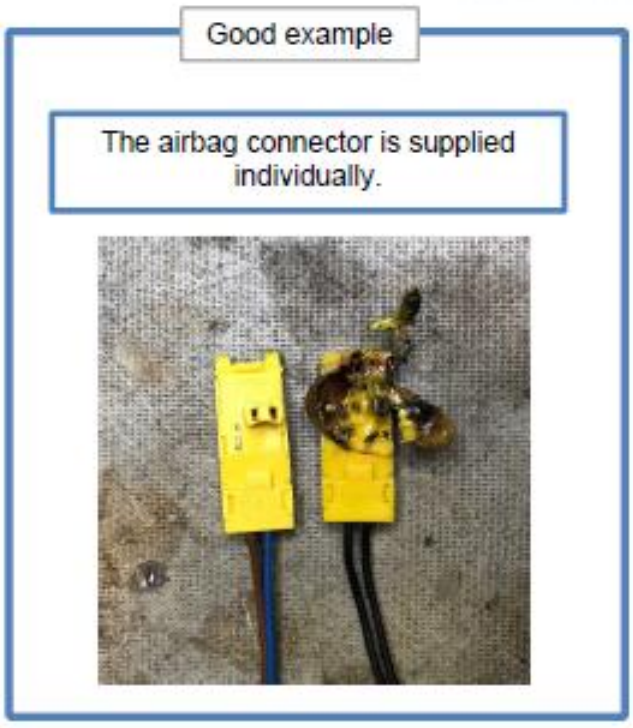
Inspection criteria

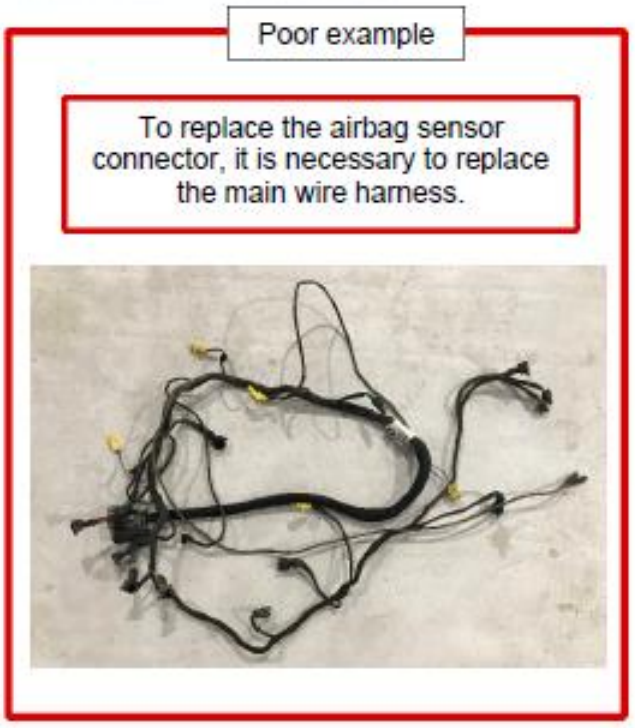
The wire harness of the airbag system should be supplied in different sections so that only the damaged section must be replaced.

Reason

The activation of airbags frequently affects some part of the wiring (e.g., connectors). If it is necessary to buy and, in some case, to replace the complete wire harness, repair costs increase very much.







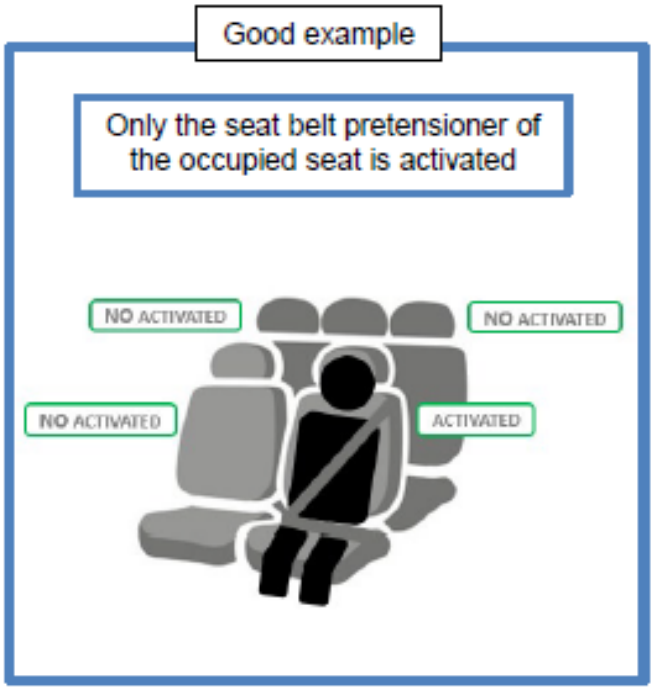
1.2.4.9. AIRBAG AND PRETENSIONER (SEAT-BELT PRETENSIONERS)

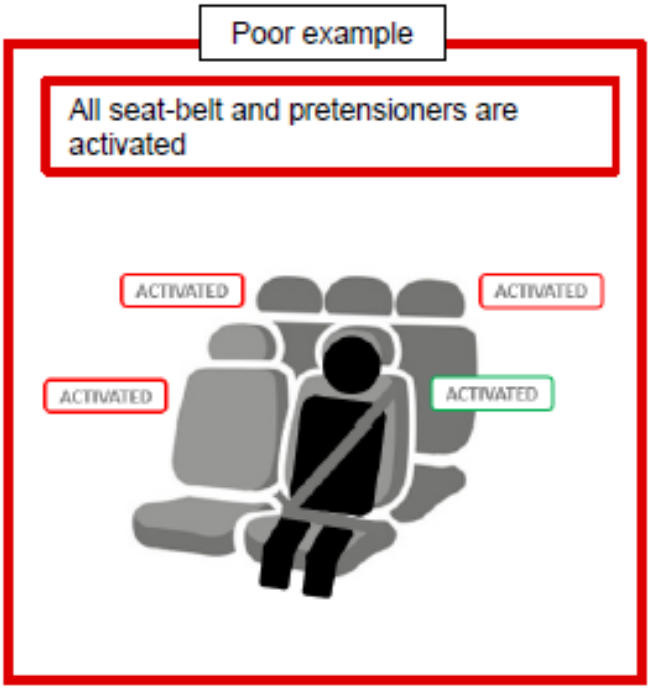
Inspection criteria

The seatbelt pretensioners should not be activated when the seat is not used, or the seatbelt is not fastened.

Reason

When the vehicle has an accident, it is not necessary to activate the seat belt pretensioners of the seats that not occupied, because nobody needs its protection. On the contrary, its activation would only have consequently an increment in repair costs.





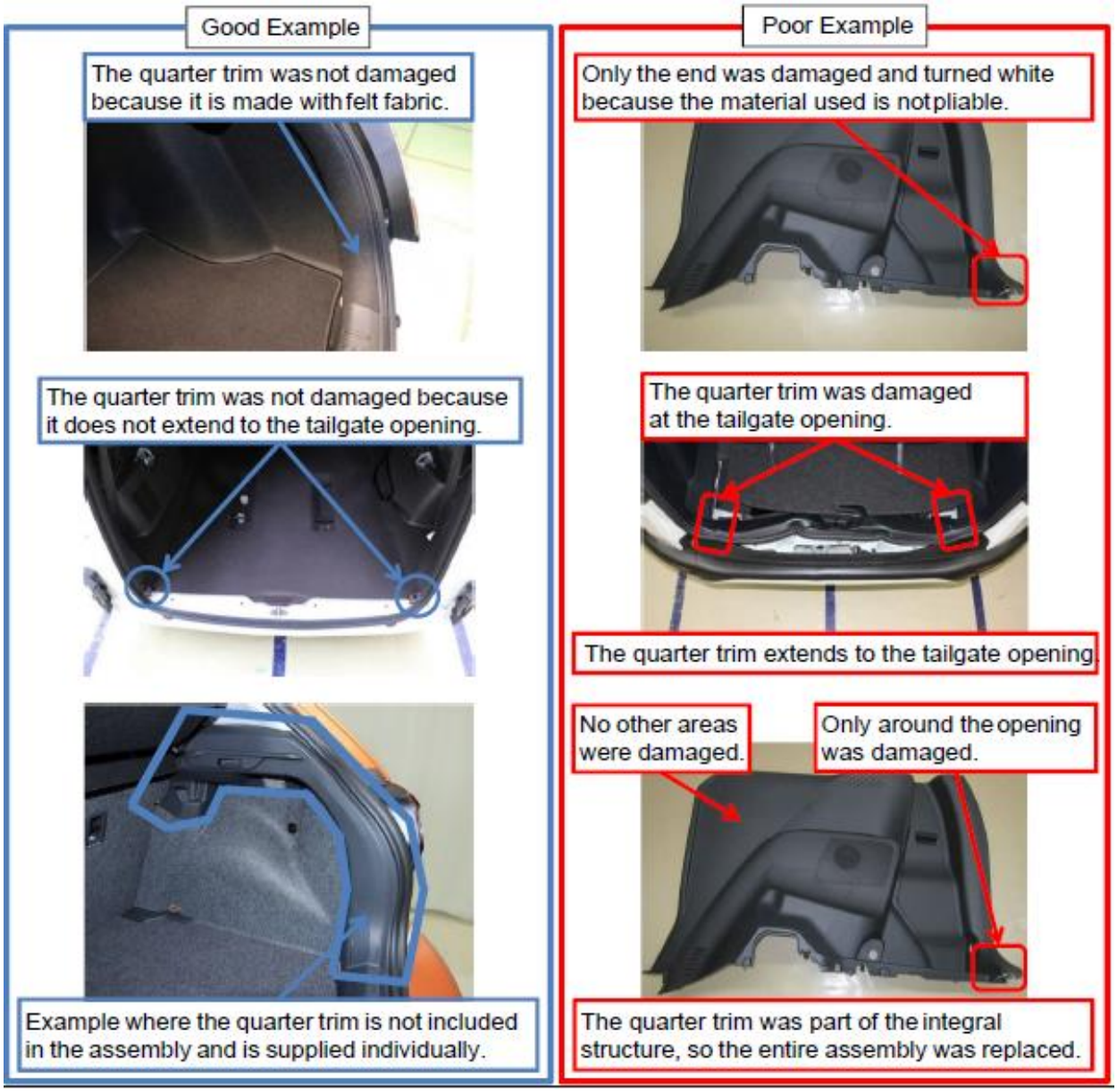
1.2.5. QUARTER TRIM

Inspection criteria

The quarter trim should be made of felt fabric so that white marks caused by damage do not stand out. When the quarter trim is made of a material other than felt fabric, the quarter trim should not extend to the tailgate opening. If it extends to the tailgate opening, that portion should be supplied separately.

Reason

When the quarter trim is made of felt fabric, white marks caused by damage do not stand out, which makes the quarter trim more reusable.
When the quarter trim does not extend to the tailgate opening, damage to the quarter trim is less likely to occur when the rear panel is damaged.
When the tailgate opening portion of the quarter trim is supplied separately, if the tailgate opening portion of the quarter trim is damaged, it is not necessary to replace the quarter trim assembly, which reduces the repair cost.



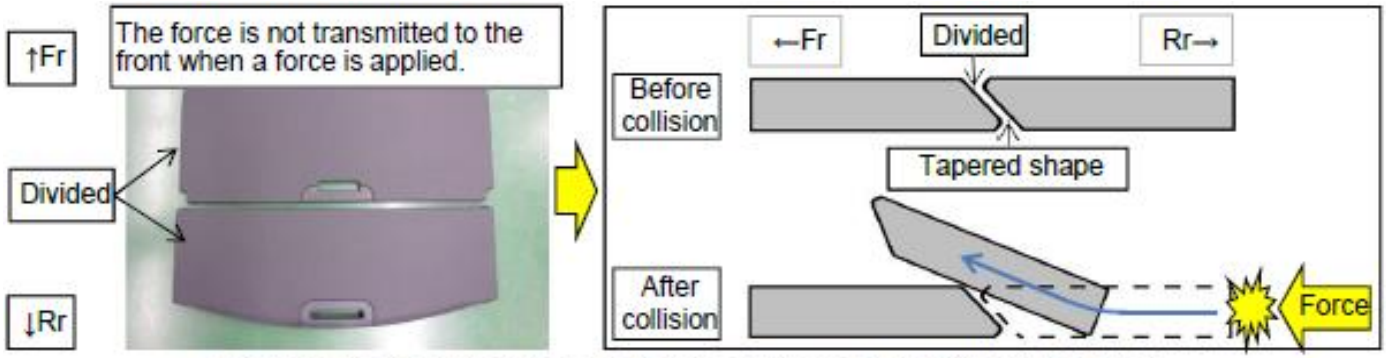
1.2.6. FLOORBOARD TRIM

Inspection criteria

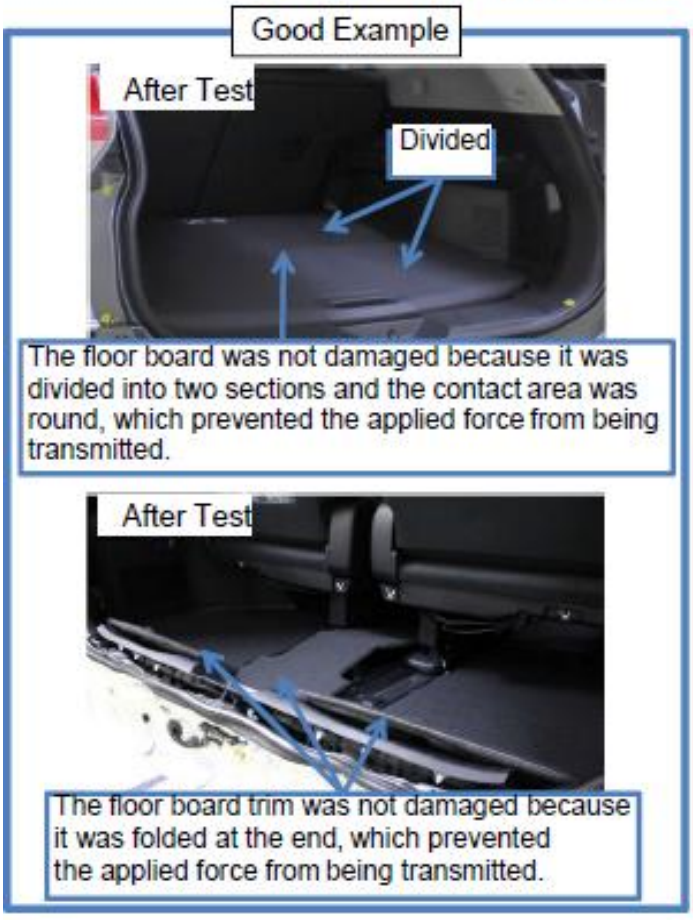
The floorboard trim should be divided into front and rear sections so that applied force is not easily transmitted at the mating section.

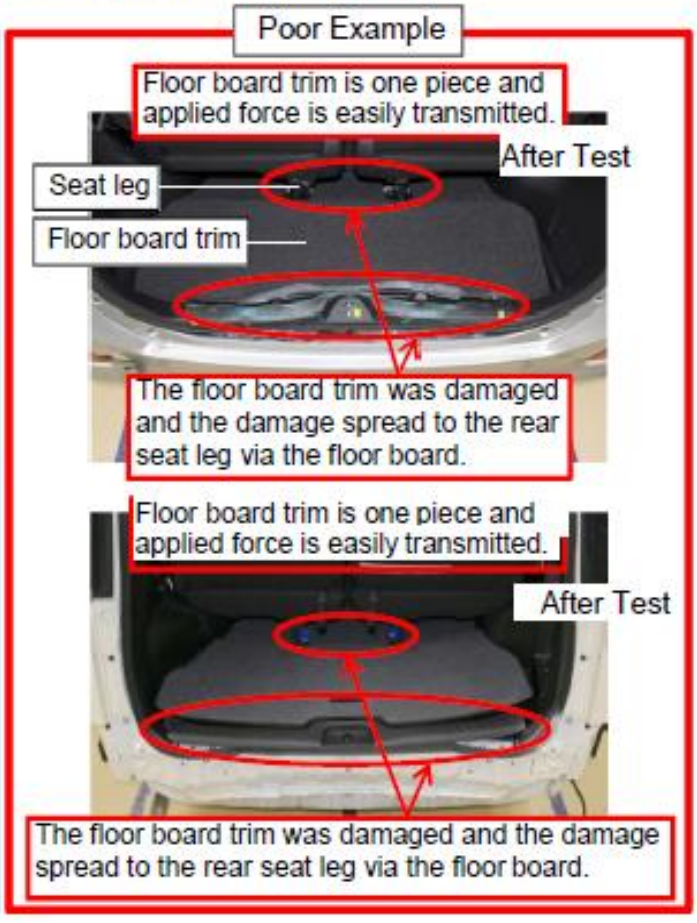
Reason

When the floorboard trim is divided into front and rear sections so that applied force is not easily transmitted at the mating section, damage is less likely to spread to the rear seat and front trim via the floorboard trim.



Example of a structure where the floor board trim is divided into front and rear sections so that applied force is not easily transmitted at the mating section.





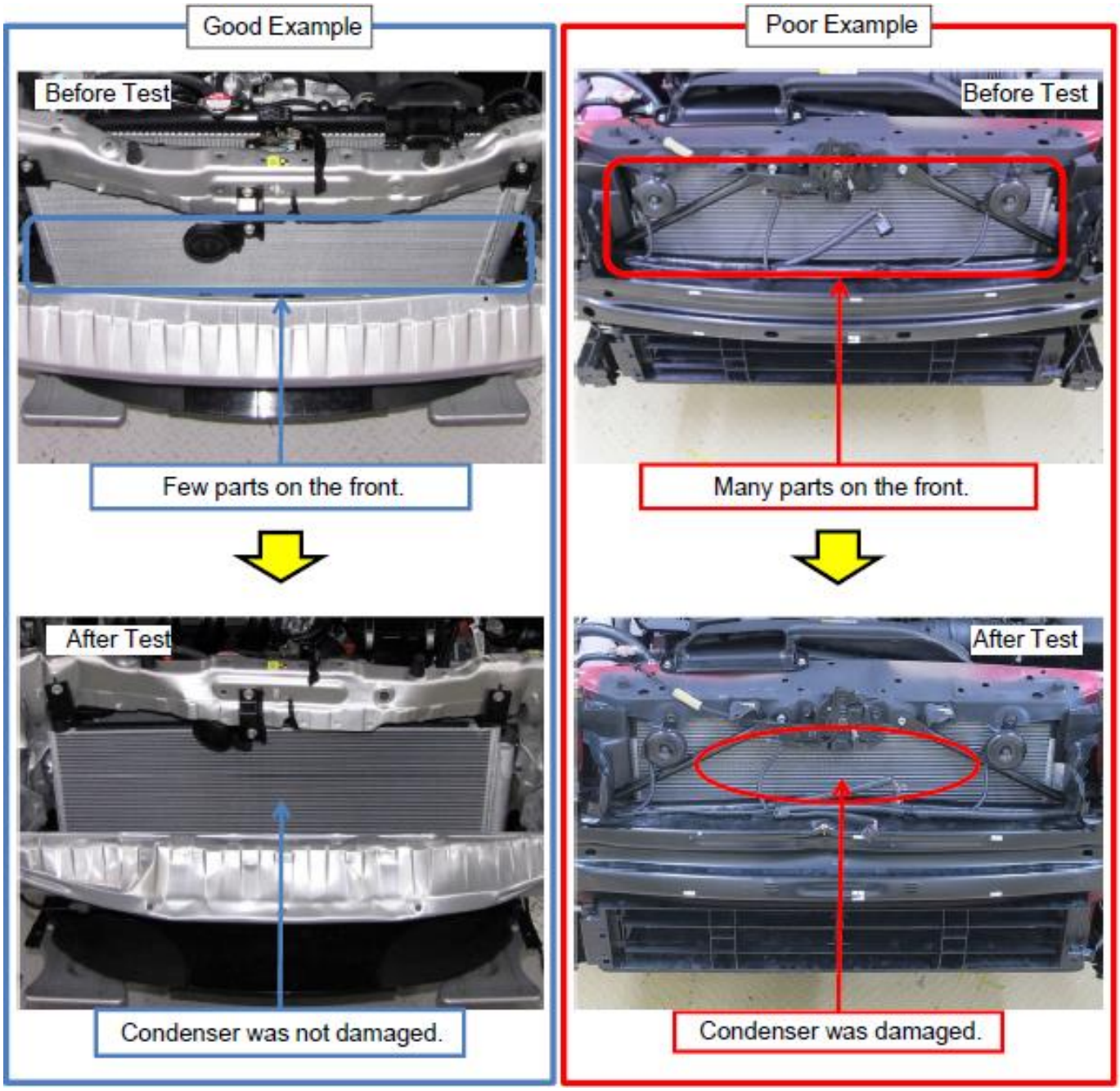
1.2.7. AIR CONDITIONER CONDENSER

Inspection criteria

The air conditioner condenser should not have parts on the front of the condenser to avoid penetration.

Reason

When there are no parts such as horn, stay, etc. on the front of the condenser, damage to the condenser is less likely to occur in a collision.



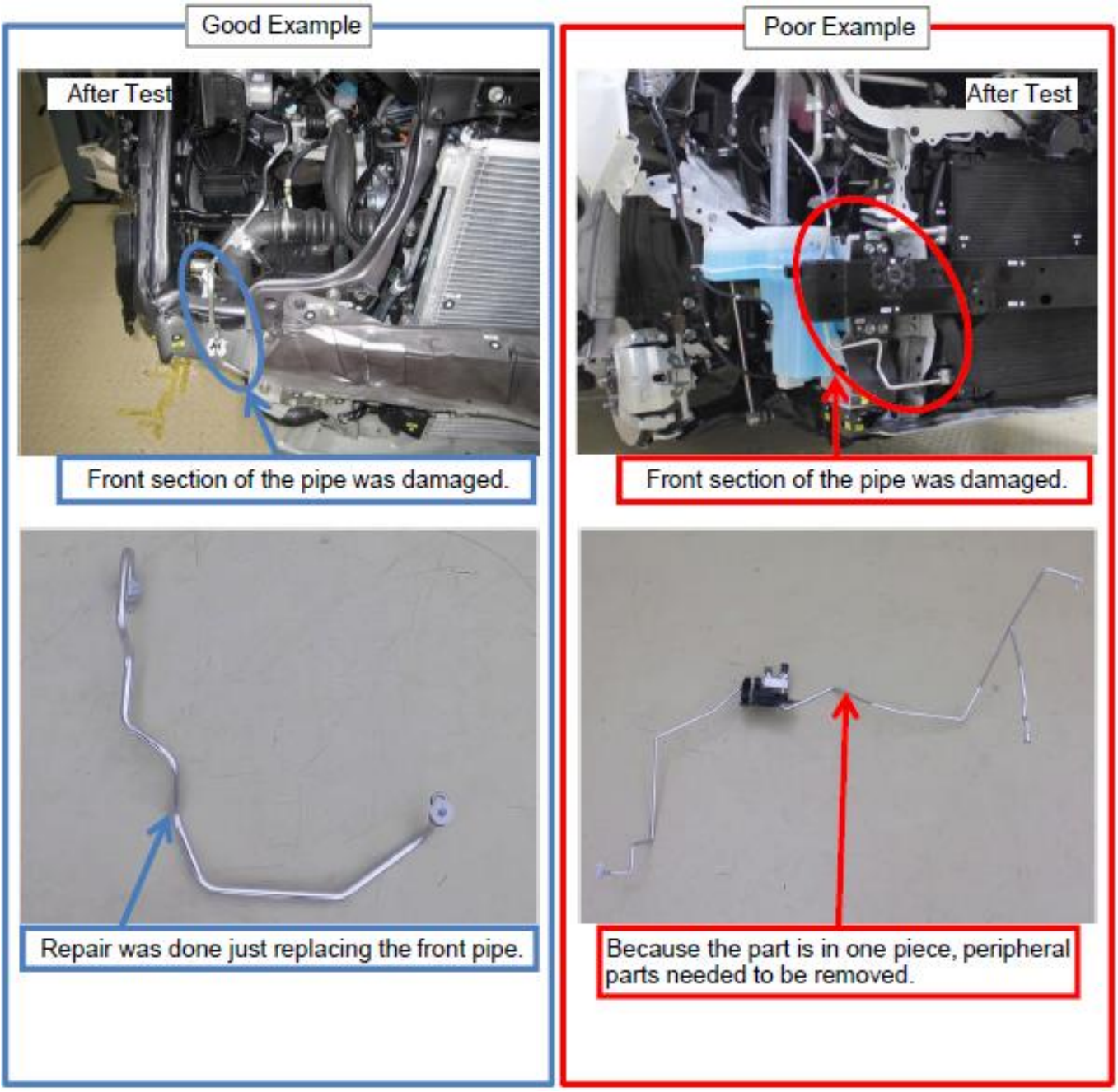
1.2.8. AC CONDENSER PIPE AND OTHER PIPES

Inspection criteria

Pipes including the air conditioner condenser pipe should be divided into front and rear sections and each section should be supplied individually.

Reason

When pipes including the air conditioner condenser pipe are divided into front and rear sections, only the damaged side needs to be replaced and removal of the engine and other peripheral parts are eliminated, which reduces the repair cost.



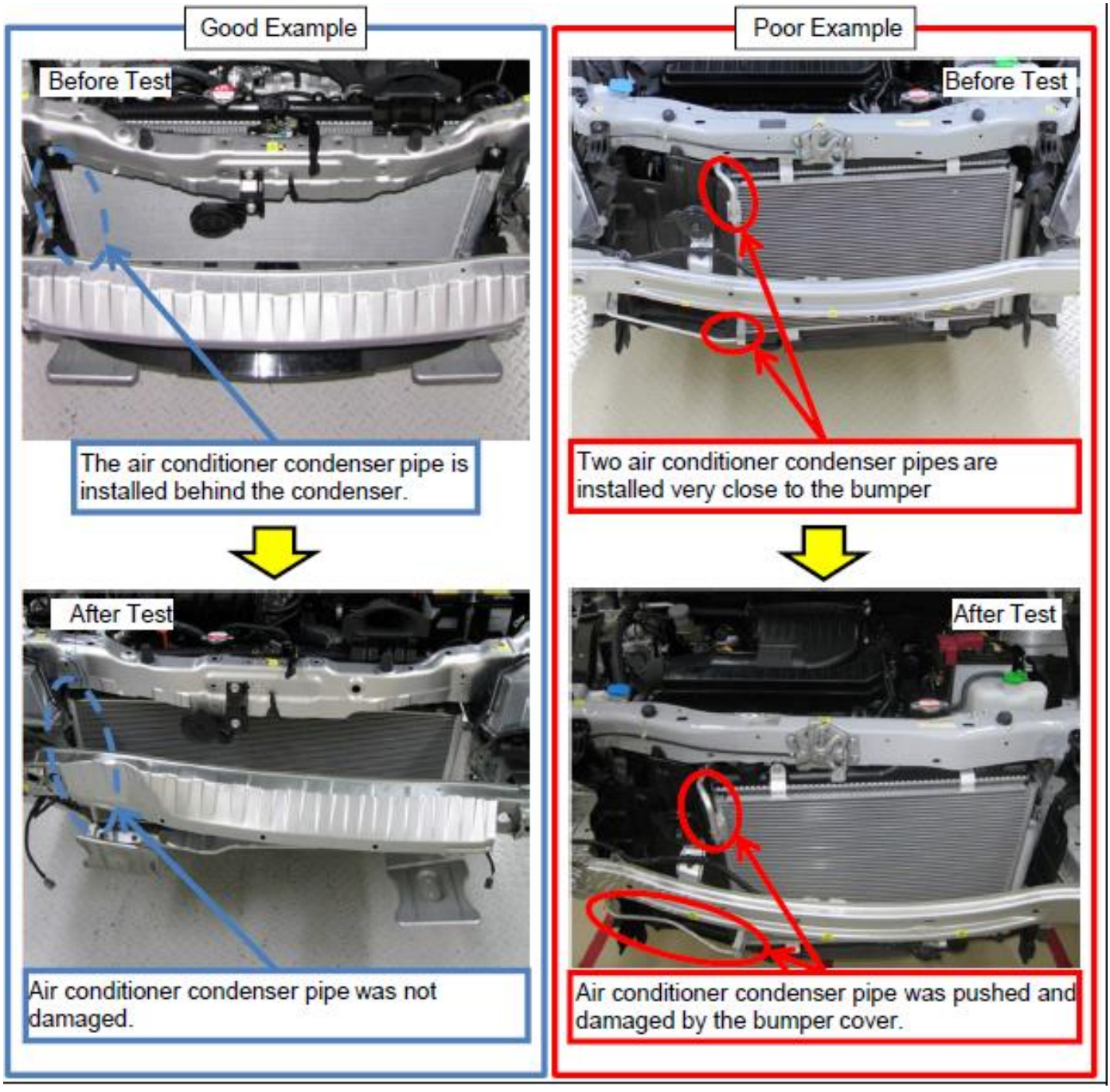
AC CONDENSER PIPE AND OTHER PIPES

Inspection criteria

Pipes including the air conditioner condenser pipe should be installed at a position where interference from peripheral parts can be avoided in a collision.

Reason

Pipes including the air conditioner condenser pipe are weak and prone to damage. Installing them at a position where interference from peripheral parts can be avoided helps prevent damage.



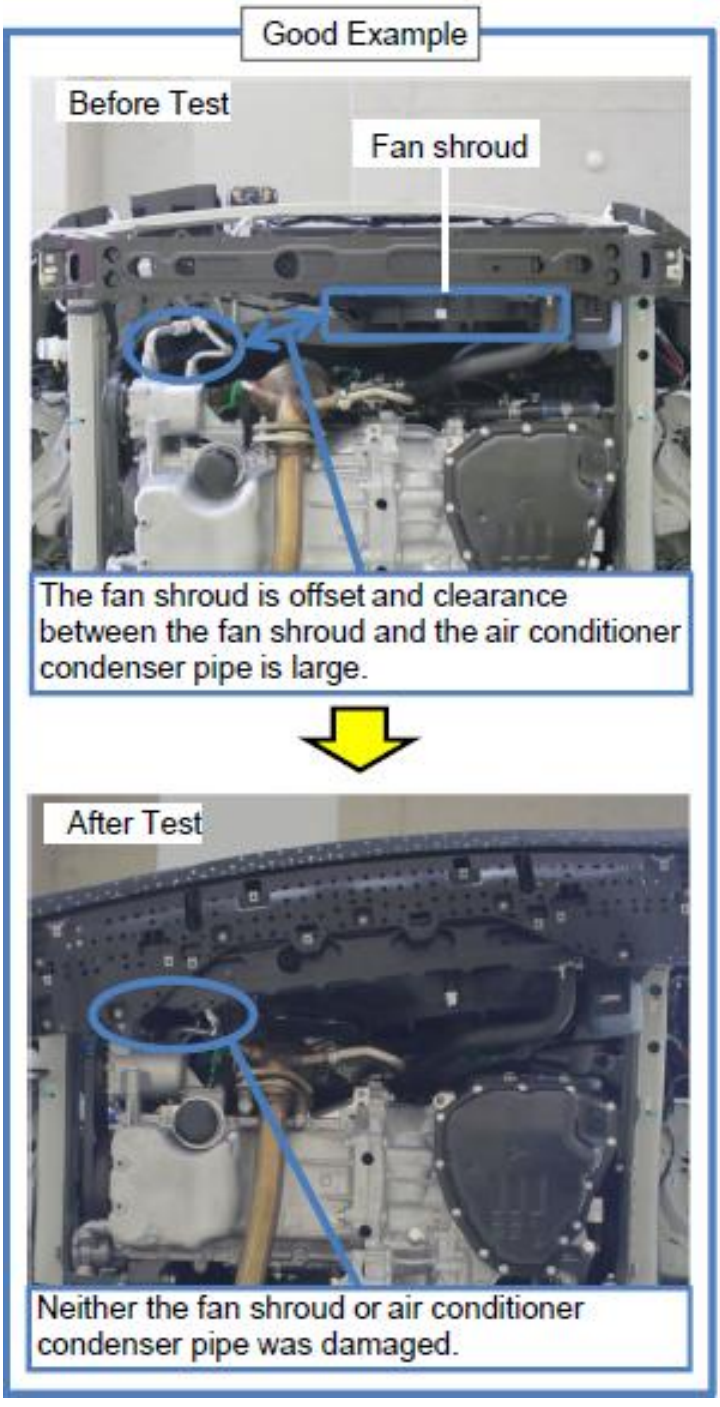
1.2.9. FAN SHROUD

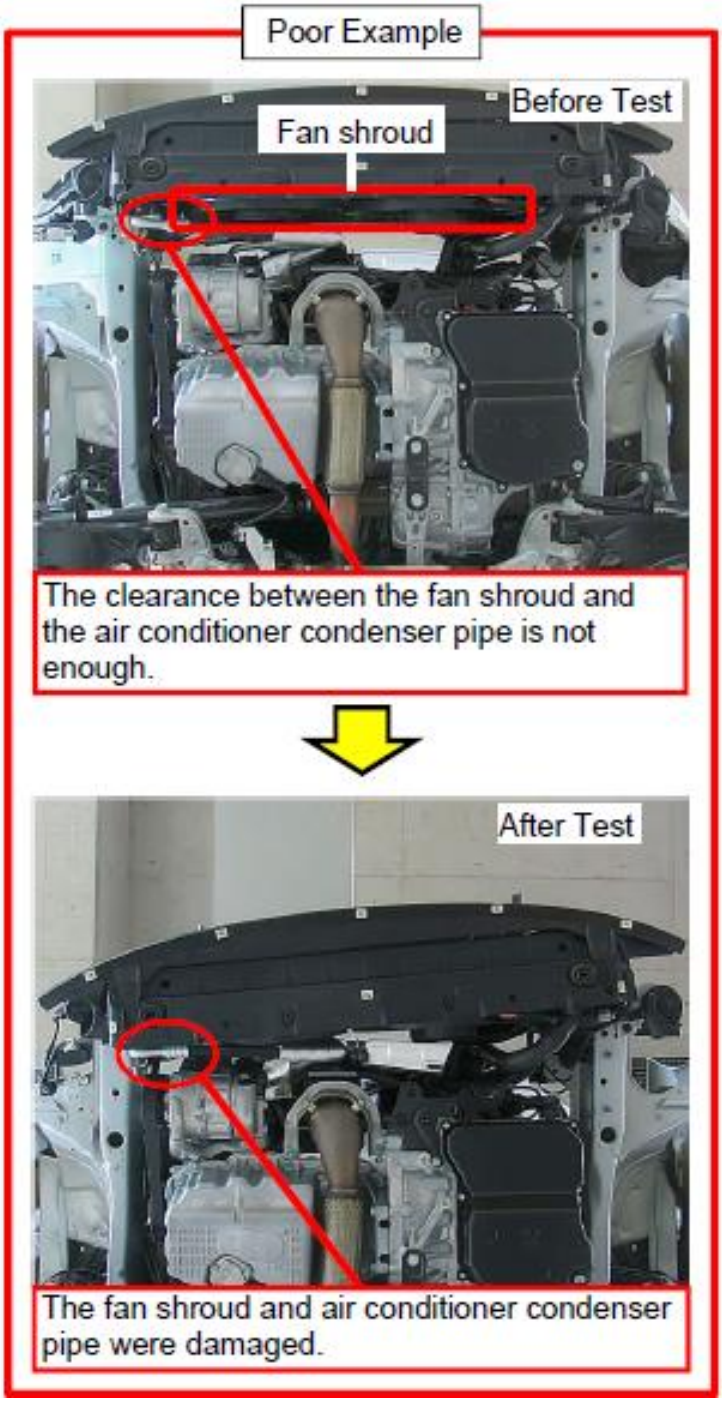
Inspection criteria

There should be clearance between the fan shroud and engine, auxiliary equipment, and pipes.

Reason

When there is clearance between the fan shroud and engine, auxiliary equipment, and pipes, damage to the fan shroud, radiator, auxiliary equipment, or pipes is less likely to occur.





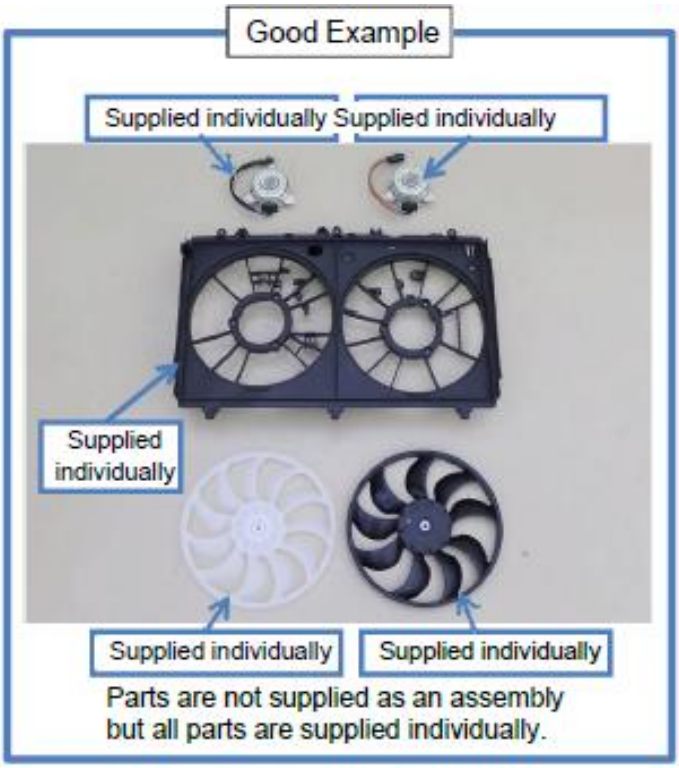
FAN SHROUD

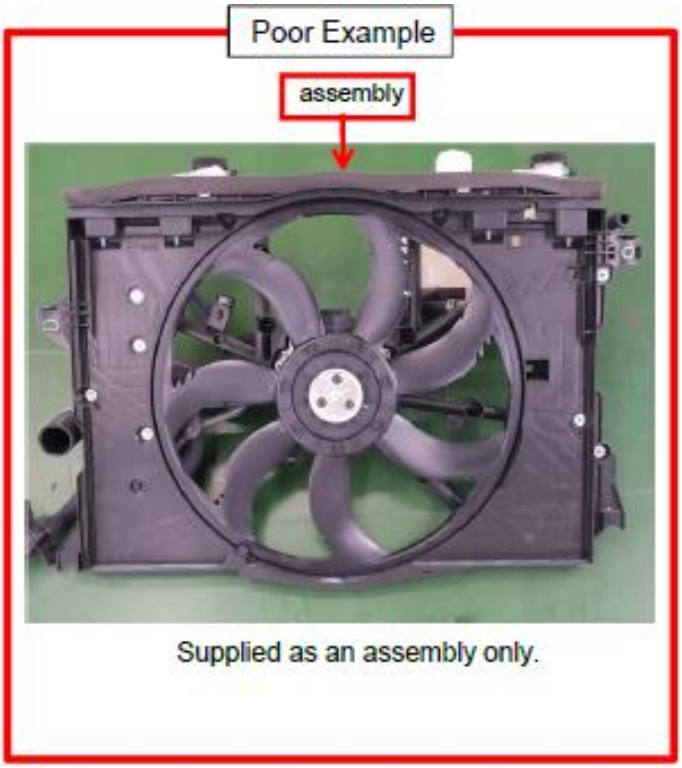
Inspection criteria

The parts for the fan shroud should be supplied as a sub-assembly or individually so that it can be replaced according to the degree of damage.

Reason

Damage to the fan shroud tends to be partial damage. When the parts are supplied as an assembly, sub-assembly, or individually, it can be replaced according to the degree of damage, which reduces the repair cost.





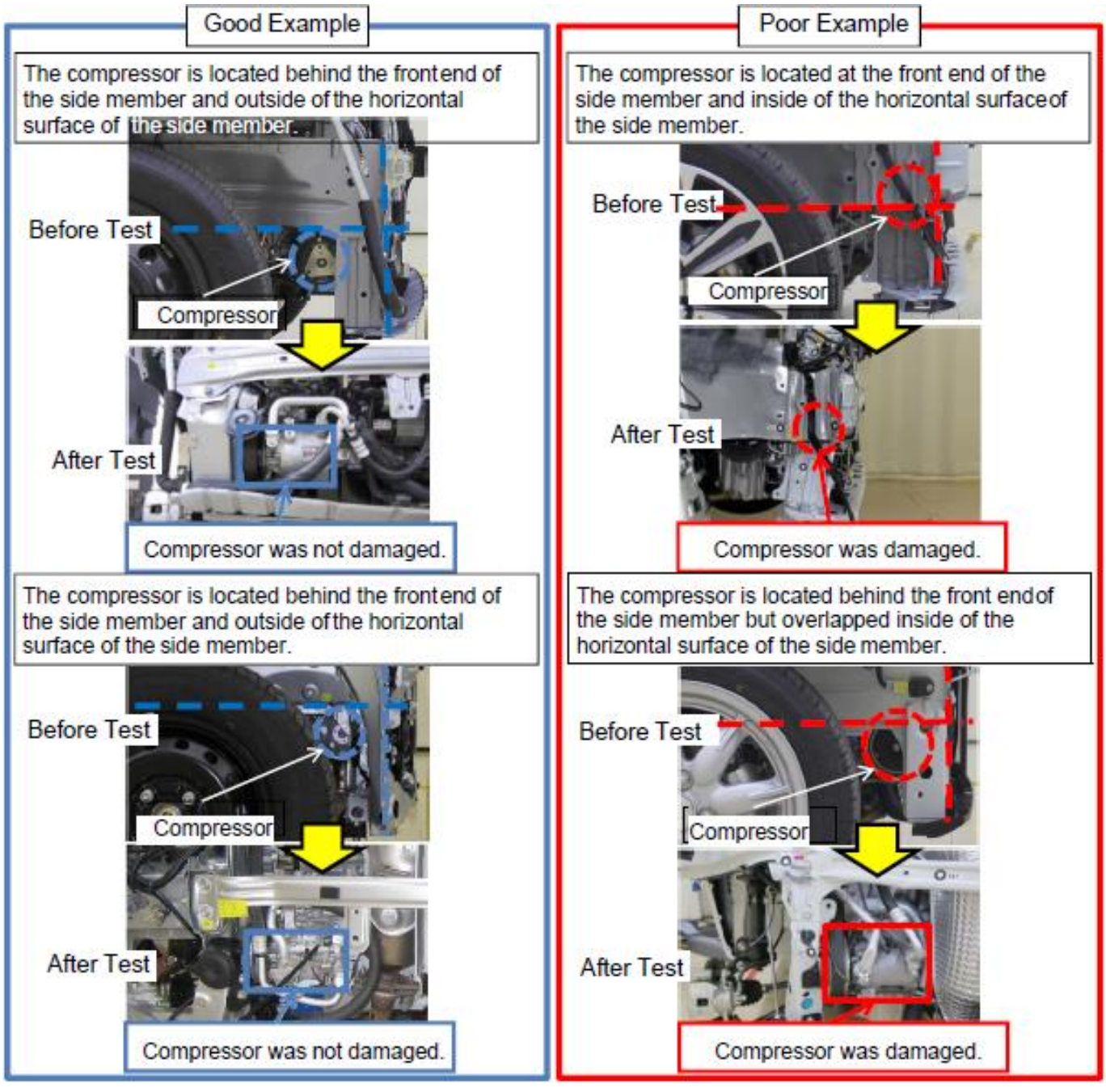
1.2.10. COMPRESSOR
(Applicable only to the compact car particular in Japan)

Inspection criteria

The compressor should be installed behind and below the lower end of the side member.

Reason

When the compressor is installed behind the front end of the side member avoiding the horizontal surface of the side member, risk of damaging the compressor is reduced when the side member is crushed or bent inward due to a collision.



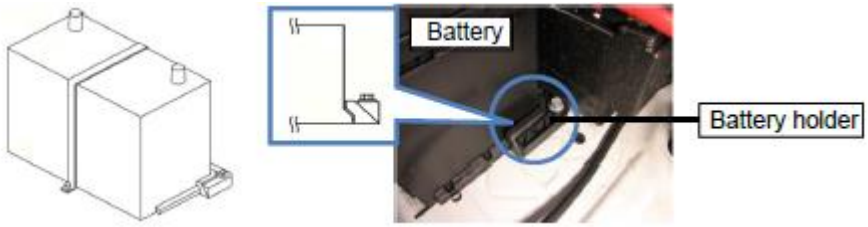
1.2.11. BATTERY

Inspection criteria

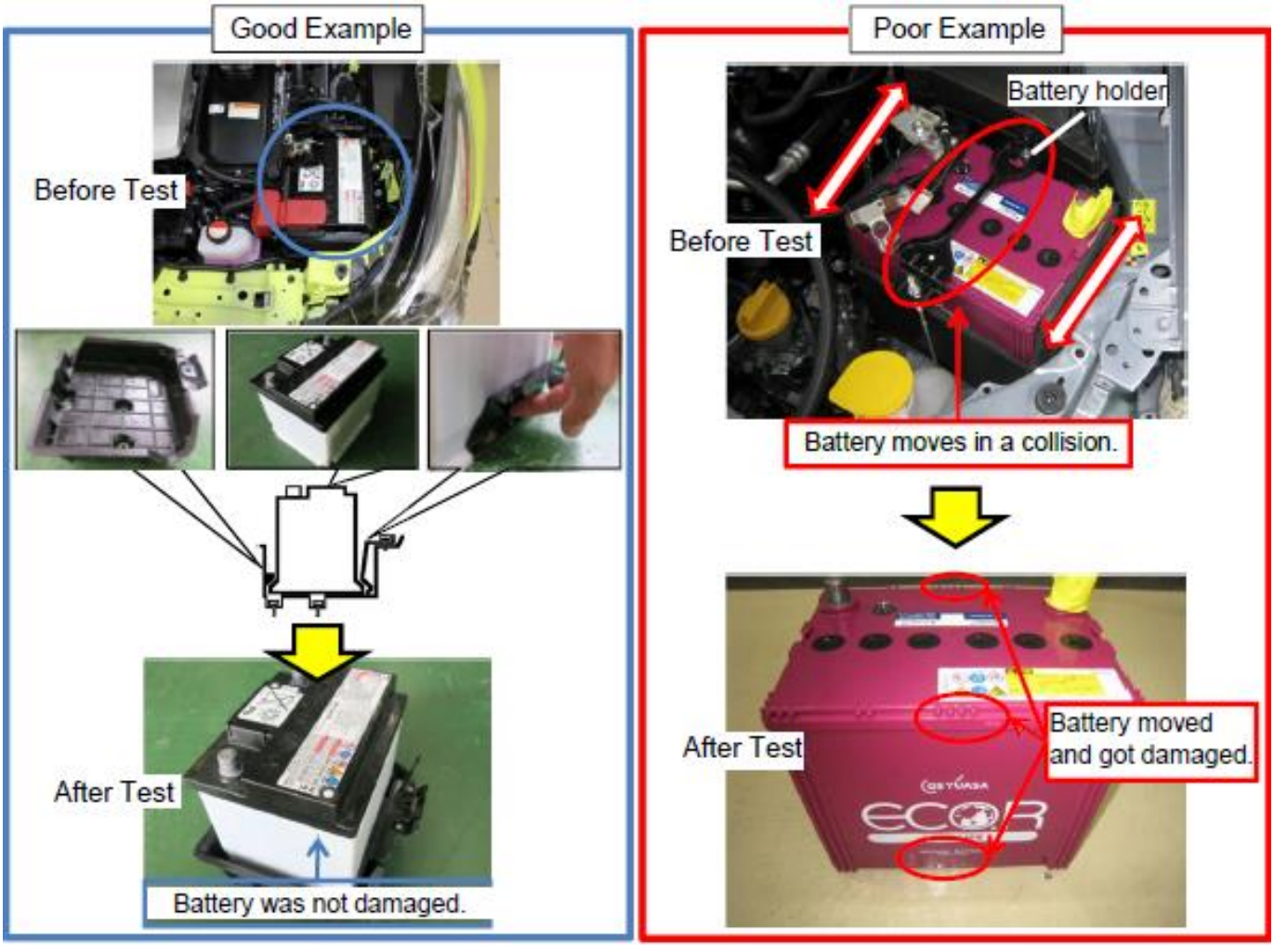
The battery should be secured in a way that it does not move on impact.

Reason

When the battery is secured in a way that it does not move on impact, damage to the battery caused by the battery holder or other part is less likely to occur because the battery does not move in a collision.



Example where the battery is secured in a way that it does not move on impact.



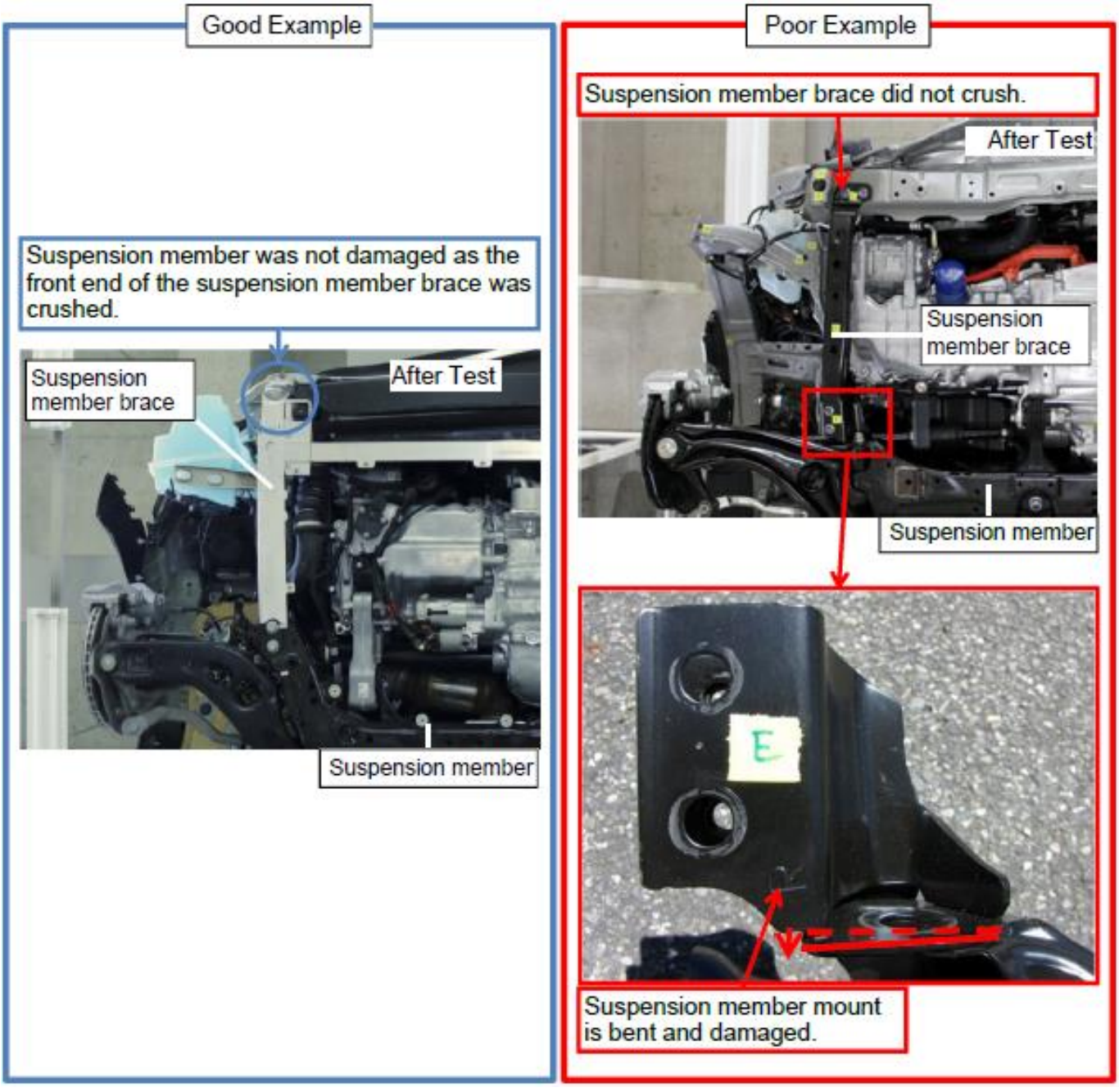
1.2.12. SUSPENSION MEMBER BRACE

Inspection criteria

The suspension member brace should be designed to break or crush in a minor collision so that the impact is not transmitted to the suspension member.

Reason

When the suspension member brace allows it to break in the middle or crush in a minor collision so that the impact is not transmitted to the suspension member, damage to the suspension member is less likely to occur.



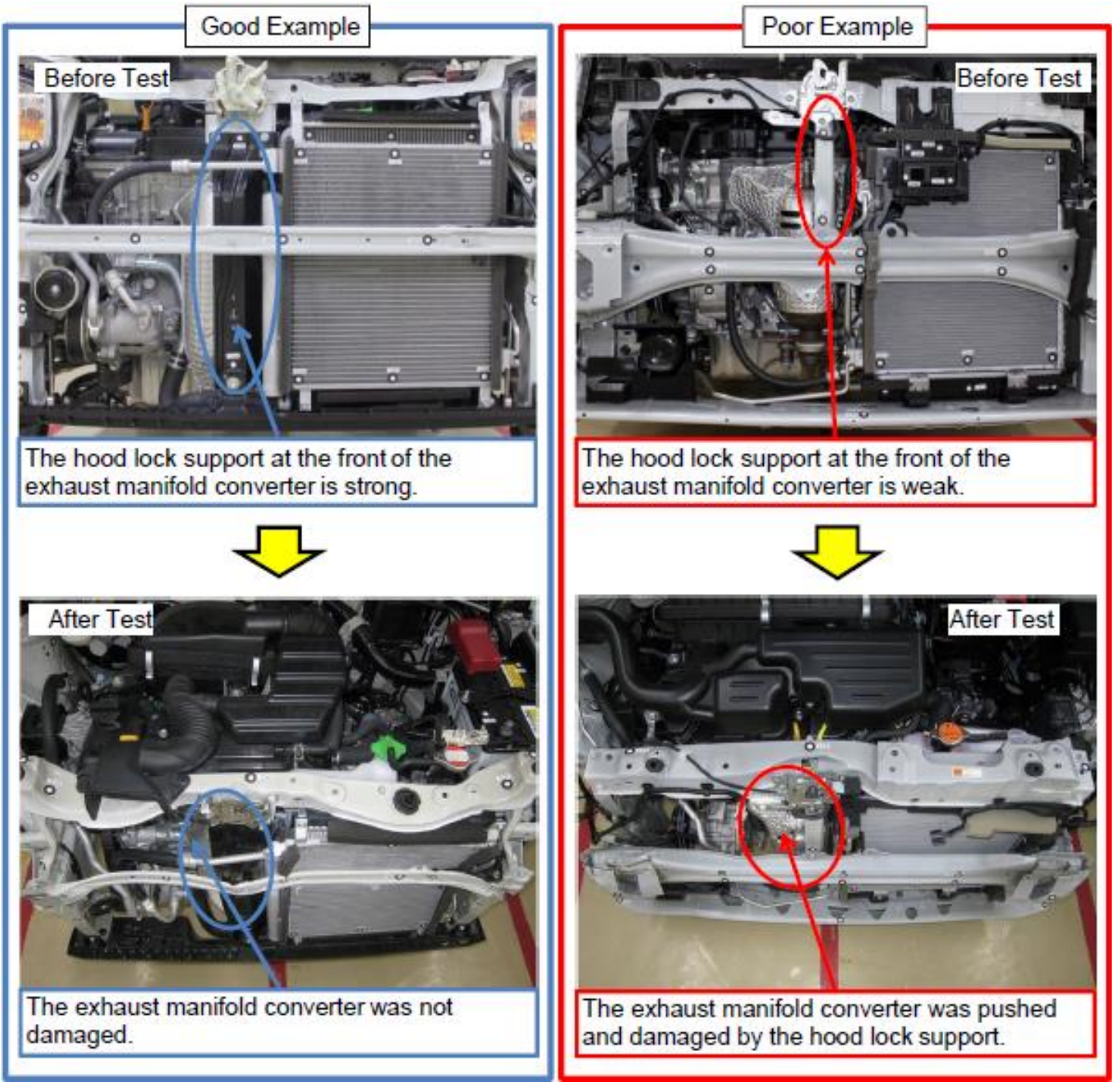
1.2.13. EXHAUST MANIFOLD CONVERTER (Applicable only to the mini vehicles particular in Japan)

Inspection criteria

The exhaust manifold converter should be protected with a protective cover to prevent damage from the front peripheral parts in a collision.

Reason

For the mini vehicles, when the exhaust manifold converter is protected with a rigid hood lock support or other means, damage to the exhaust manifold converter is less likely to occur even if the bumper reinforcement moves back.



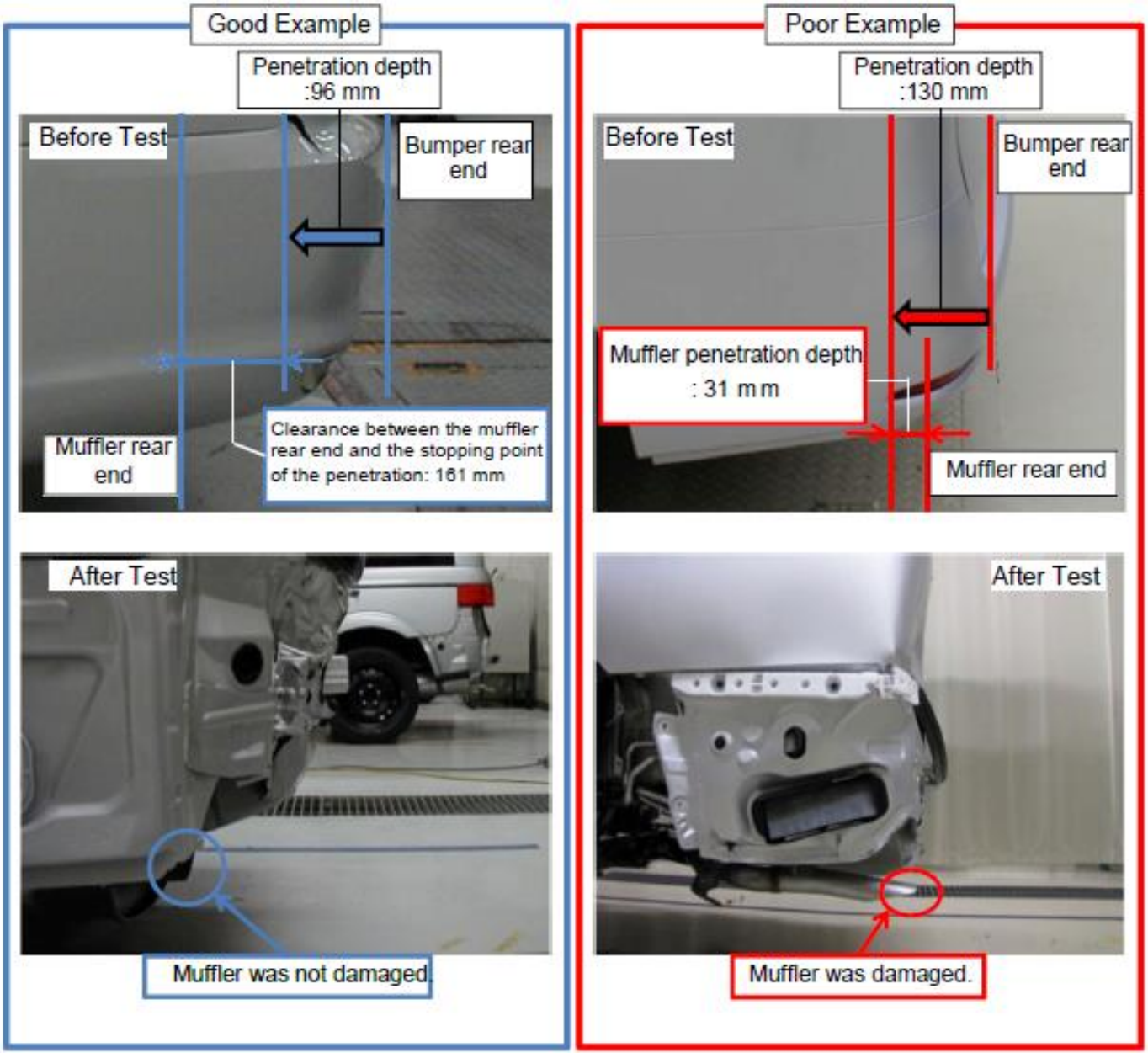
1.2.14. MUFFLER

Inspection criteria

The distance from the rear end of the bumper to the rear end of the muffler should be 60 mm or more than maximum penetration depth (RCAR test at 15 km/h).

Reason

When the distance from the rear end of the bumper to the rear end of the muffler is 60 mm or more than maximum penetration depth (RCAR test at 15 km/h), damage to the muffler is less likely to occur.



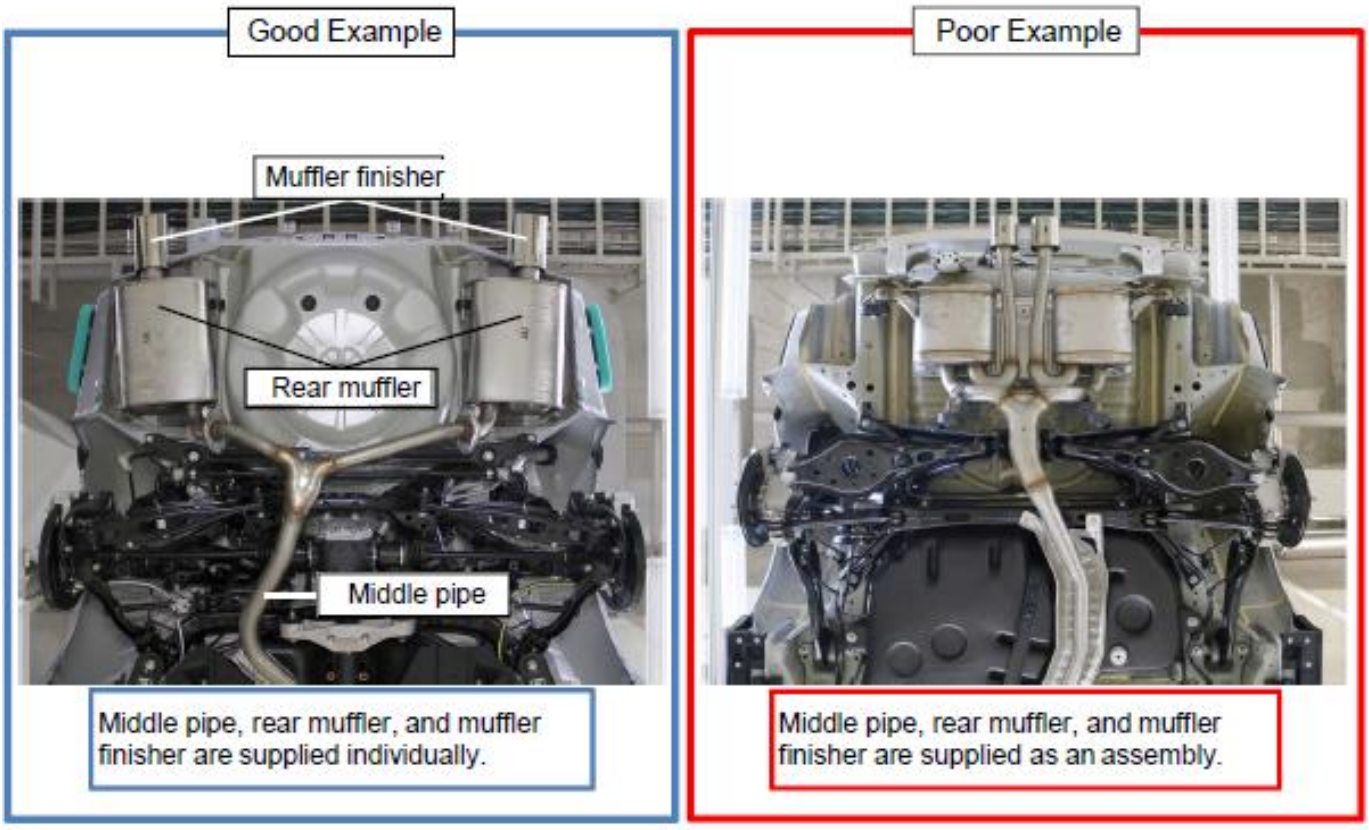
MUFFLER

Inspection criteria

The rear muffler should be supplied individually.
When the muffler finisher is used, it should be separable and supplied individually.

Reason

When the rear muffler is supplied individually, if the rear end of the rear muffler is damaged, only the damaged section needs to be replaced, which reduces the repair cost.
When the rear muffler finisher is supplied individually, if the muffler finisher is damaged, only the muffler finisher needs to be replaced, which reduces the repair cost.



1.3. PAINT

General Information

Paint is the finish of the vehicle but consists of more than just adding colour to a body shell.
It also contains all the base layers - the protective coatings and pre-treatments.
During manufacturing of a car, these are applied by automated systems, using paint robots and high bake ovens. Consideration should be given to the fact that the application and type of paint in a manufacturing environment is different to the method of application in repair and the therefor used paint materials.
In manufacture, paint is applied to an empty body shell, whilst in repair the vehicle contains all the trim parts, engine and running gear, which restricts the way paint can be applied and baked.

1.3.1. DIFFERENCES IN FINISH

Inspection criteria

Avoid visible and non-visible surfaces having different paint and finish treatments.

Reason

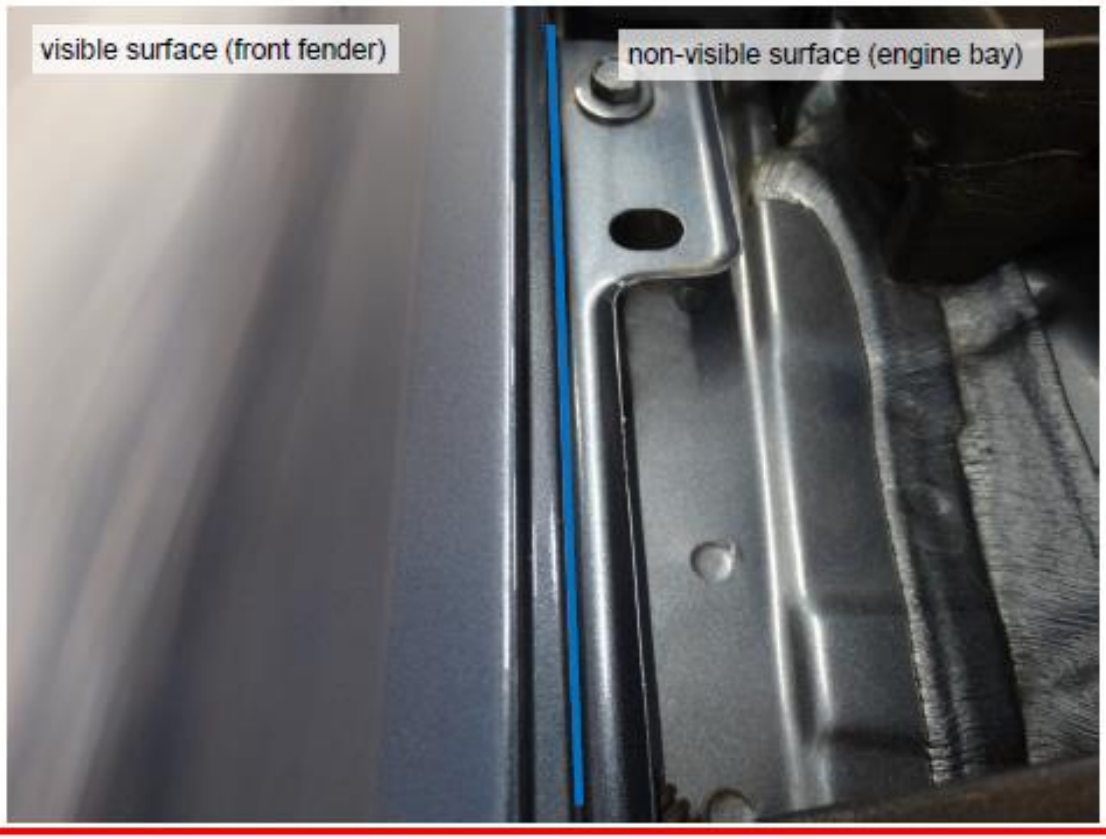
There may be differences in the colour and finish of the visible and non-visible surfaces (e.g., in engine bays).

This particularly shows when panels such as the hang-on panels at the front of the vehicle are covering both visible and non-visible areas, where the engine bay has only had a layer of base coat and a clear finish.

When the panel is replaced, it will be fully painted to the same quality as the visible surface. This will show as a difference between the new panel and the rest of the panels in that area and is, therefore, unacceptable as there will be clear evidence of repair.

Poor example:

Outer panel (front wing - left side) painted in different color compared to surface paint on the inner part (front wing mounting - right side).



1.3.2. READY-PAINTED SERVICE PARTS

Inspection criteria

Supply service parts in a base primer or untreated.

Reason

Service parts that are supplied painted to the body colour will show slight differences in colour.

Customers are more critical about colour differences after a repair than on first delivery when the vehicle is new.

This means that a re-spray is required to match the vehicle colour better, obviously incurring extra costs for repair.

1.3.3. REMOVAL AND FITTING OF DOOR HANDLES, MIRRORS…

Inspection criteria

Inserts should be detachable from the retaining panel, either as clip in/on or by means of screws without the removal of interior trim panels.

If a permanent fixing cannot be avoided, the plastic part should be surrounded by a soft rubber seal which can be lifted to assist masking the component.

Reason

When this is not the case, it means that masking is required whilst the retaining panel is painted, requiring extra time. Also, the quality will not be as good as when a panel can be sprayed without any inserts.

Poor example:

Two-piece rear bumper fascia spare part isn't delivered as two parts but heat-sealed and riveted which makes masking of the lower part (structured raw plastics) for painting the upper part very difficult.

Good example:

Glued-in side window with liftable seal - partially lifted with lifting tape.

1.3.4. DIFFERENT COLOURS ON THE SAME PANEL

Inspection criteria

Avoid the application of more than one colour on the same panel.

Reason

Two or more colours on the same panel are difficult to blend in and will always show evidence of repair.

Poor example:

Vehicle with two-tone painting (twice metallic paint) on different parts leads to increasing efforts for masking and defining the appropriate colours to avoid blending.

1.3.5. DIFFERENT PAINT COLOURS ON SERVICE PARTS

Inspection criteria

Use the same neutral colour for all service parts, ideally medium grey.

Reason

The quality of service condition parts will affect the quality of the paint job.

Cataphoretic painted sheet metal panels with its characteristic black colour need to be grounded and fillered before being painted. Therefore, coloured filler can be appropriate.

In contrast, on plastic spare parts the coloured grounding is at the same time the filler. Therefore, the colour of the grounding should be neutral to be used for all paint colours.

Otherwise, additional application of coloured filler is required, costing more in both time and materials.

1.3.6. CONSISTENCY OF SERVICE PANELS AND BODY SHELLS

Inspection criteria

All closure panels should be supplied with sealing to match that used in production.

Reason

This will remove any evidence of repair, improve the overall quality of repair and reduce the repair time.

1.3.7. PARTS WITH CONTINUOUS PROTECTION STRIP / EDGE / CRIMPING

Inspection criteria

In many cases, depending on the location and extent of the damage, it is not necessary to paint the complete body shell.

The option of painting only part of the component can still produce a quality finish.

Reason

Fitting a continuous protection strip / moulding / crimping / edge across the whole width of the panel will avoid colour match problems when painting only part of the door. This contributes to a high quality finish and also to cost savings.

The option to remove the exterior accessories on the panel, such as the handle, lock, moulding and mirror, without the need to remove the whole inner trim, will facilitate their removal for painting and avoid masking operations.

Poor example:

A protection strip that doesn't cover the whole width of the door panel does not allow painting of only a part of the door as zoning is not possible.

Good example:

A continuous crimping / edge across the the whole side panel enables either the top or bottom of the side panel to be painted separately.

A plastic cover on the side panel which ranges from the rear side window to the tail-lamp divides the side panel in two parts that can be painted separately.

1.3.8. SPECIAL PAINT COLOURS (MATT, STRUCTURED, SPECIAL PIGMENTS)

Inspection criteria

Use solid, metallic or pearl-effect paint colours without any other special pigments.

Reason

Special paint colours with matt varnish, structured finish, chrome effect paint or other special pigments like glass bubbles make it nearly impossible to paint only the damaged or renewed parts of a vehicle.

The formula for the needed paint colour cannot be determined that precise even with up-to-date electronic spectrophotometers to avoid extra costs for time and material if blending or painting the whole vehicle is needed.

1.3.9. PAINTING ON FOILED TRIM STRIPS AND ORNAMENTS

Inspection criteria

Avoid the inclusion of stickers and ornaments that are convert with the clear coat applied to the whole panel.

Reason

Foiled trim stickers and ornaments that are covered with clear coat together with the whole panel reduce the possibilities of repairing the damaged panel which results in additional costs.

Poor example:

Foiled ornaments on the base coat with additional matt clear coat on a door panel makes it necessary to paint the whole side of the car in case of a repair.

1.3.10. PAINTING OF OUTER PANEL SPARE PARTS WITH ADAS SENSORS MOUNTED BEHIND

Inspection criteria

Avoid the mounting of ADAS sensors behind outer panels that have to be painted or provide ready-painted spare parts or make sure that the repair and painting of such spare parts can be done with only the needed limitations (e.g. prohibition of wire mesh for plastics repair, well-defined area where application of putty is prohibited, well-defined area with limitation for paint thickness,).

Reason

In case of a repair being necessary, this requires specific paint application with limited thickness and includes the prohibition of any repair methodology. Thereby additional costs occur as new spare parts are needed even for damages that would be repairable if there wouldn't be an ADAS sensor behind.

Moreover, paint thickness cannot be measured non-destructive on three-dimensional bended plastic parts reliable which may result in extra costs if the final calibration of an ADAS sensor failed at the end of the repair.

Poor example:

A rear radar sensor (blue marking) mounted underneath the rear bumper fascia (photo with semipermeable overlay).

1.4. VEHICLE BODY PANELS

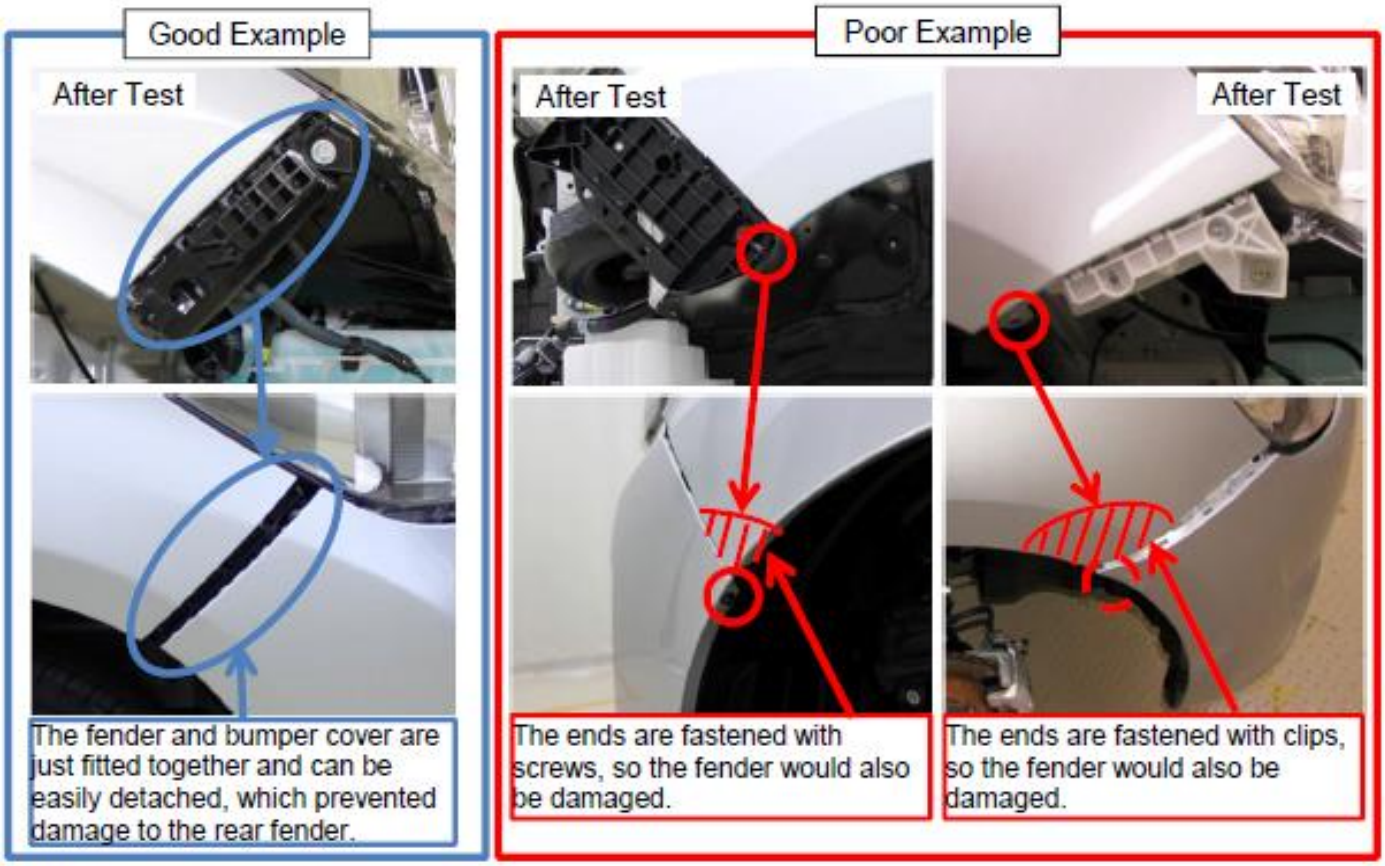
1.4.1. FRONT BUMPER COVER

Inspection criteria

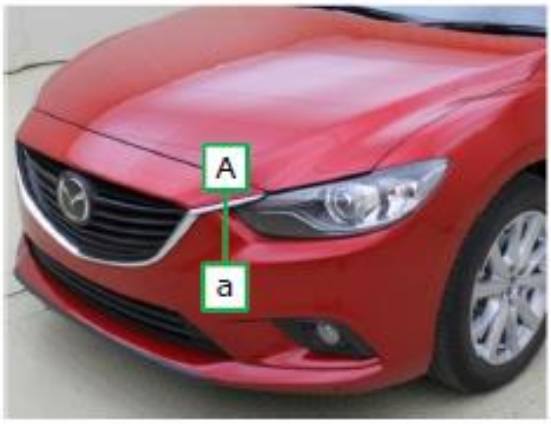
The front bumper cover (including radiator grille) mount should be easily detached in a collision to prevent damage from spreading to the headlight, fender, and other expensive peripheral parts.

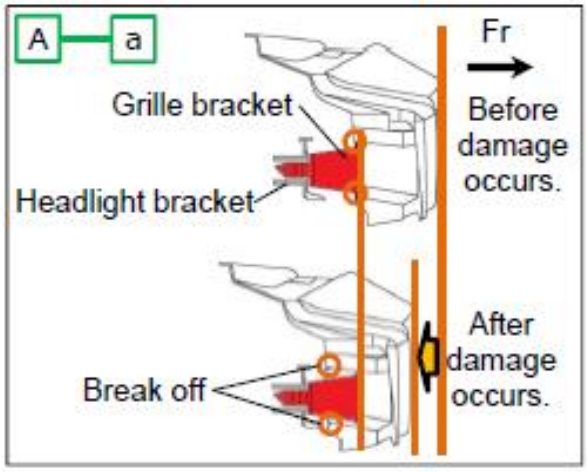
Reason

When the front bumper cover (including radiator grille) mount is easily detached, damage is less likely to spread to the headlight, fender, and other expensive peripheral components.

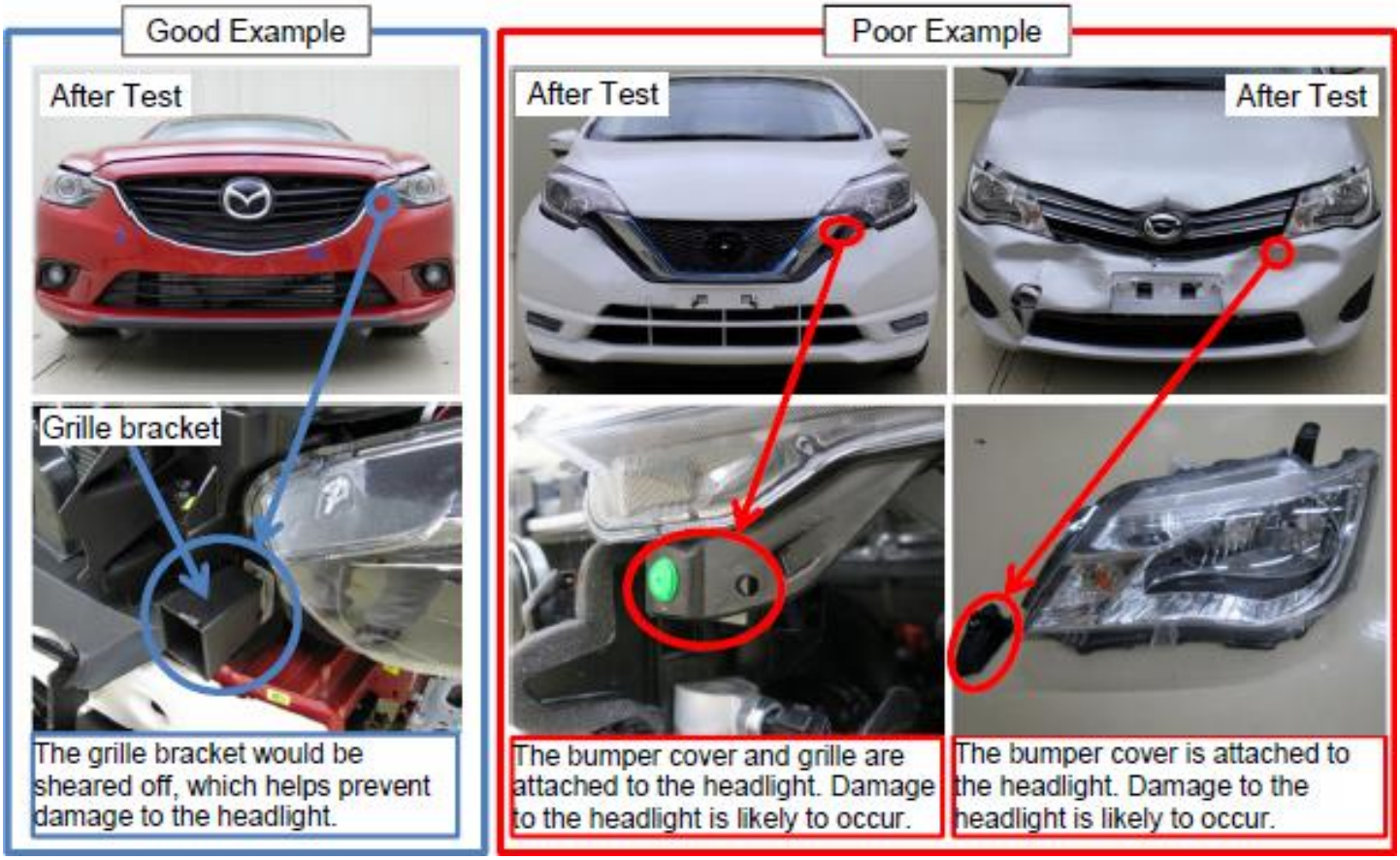


FRONT BUMPER COVER

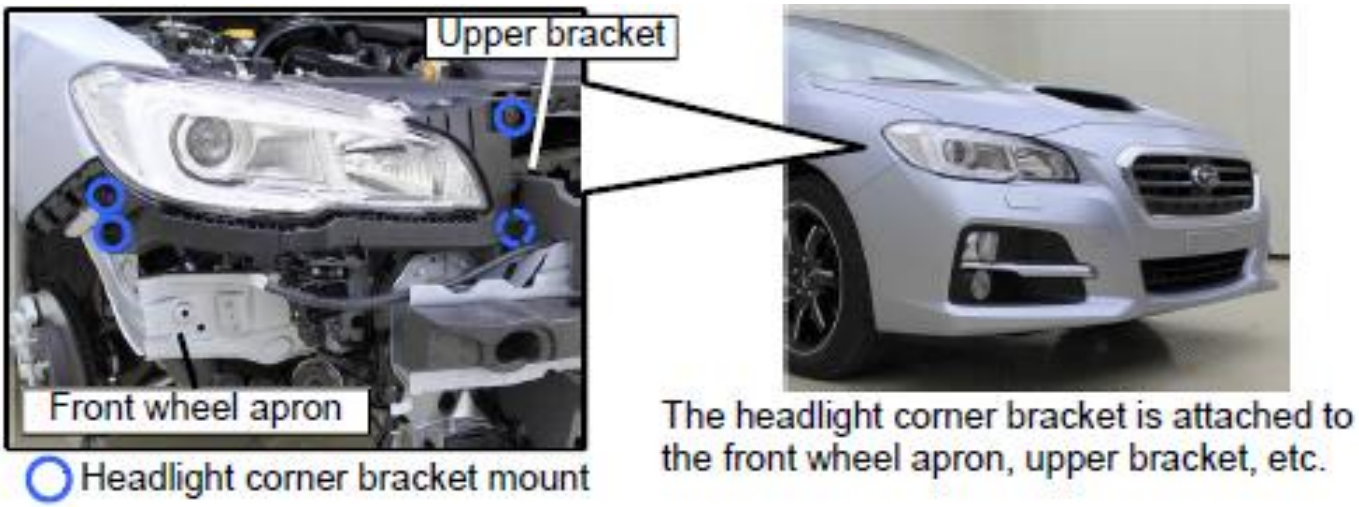




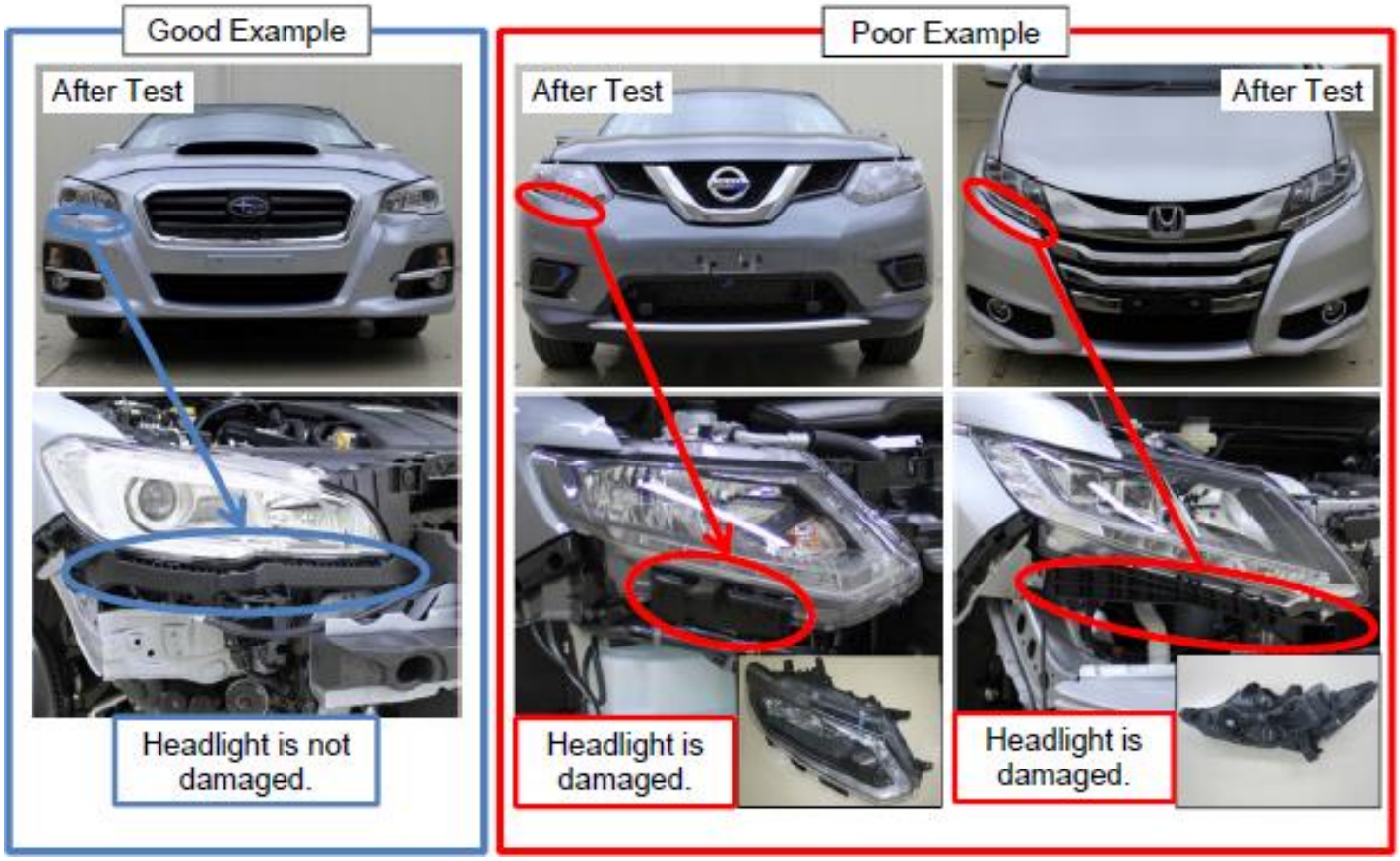
Example of a structure where the mating section of the radiator grille and headlight break off to prevent damage from spreading to the headlight.



FRONT BUMPER COVER



Example of a structure where the bumper cover is not directly attached to the headlight but attached to the headlight corner bracket, which helps prevent damage to the headlight.



1.4.2. FRONT BUMPER REINFORCEMENT

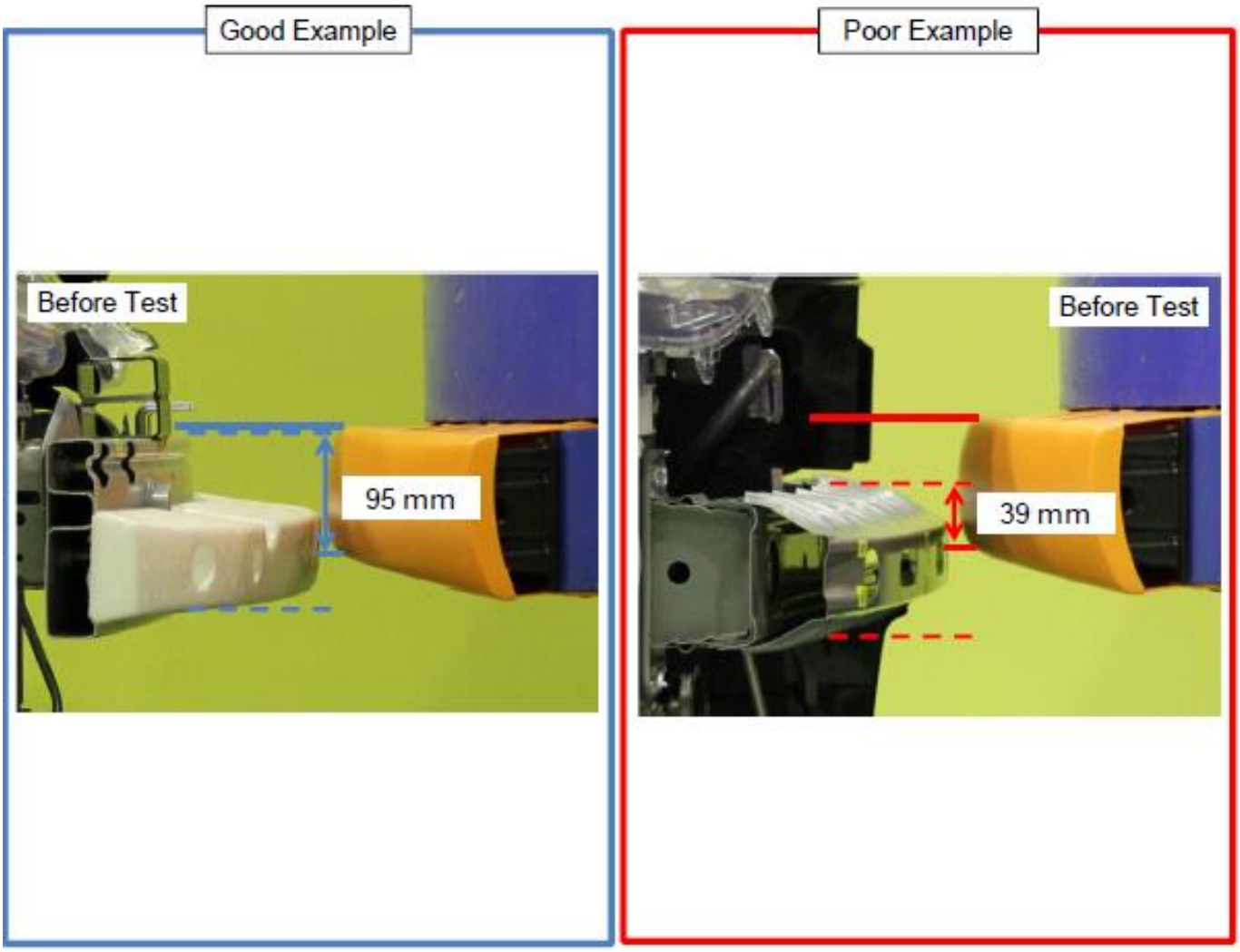
Inspection criteria

The front bumper reinforcement and the bumper barrier should have an engaging amount of 75 mm or more. If the engaging amount is less than that, a structure should be used that prevents underride.

Reason

When the front bumper reinforcement and the bumper barrier have an engaging amount of 75 mm or more, underride is less likely to occur and the penetration depth is reduced, which helps prevent damage to the headlight, fender, condenser, radiator, etc.

For measurement procedures, see "RCAR Bumper Test Procedures".



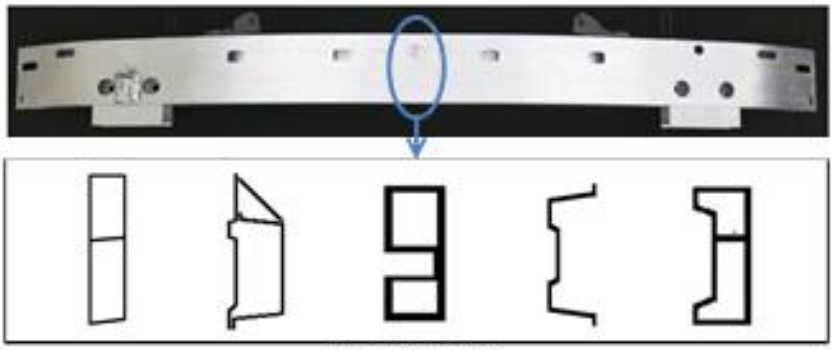
FRONT BUMPER REINFORCEMENT

Inspection criteria

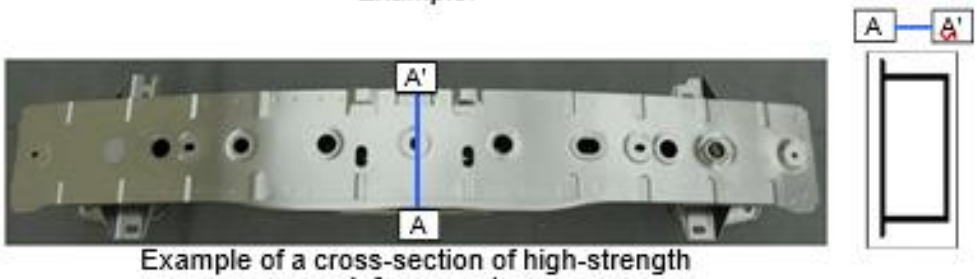
The front bumper reinforcement should use materials and shapes that provide sufficient strength and energy absorption capability suitable for the vehicle weight.

Reason

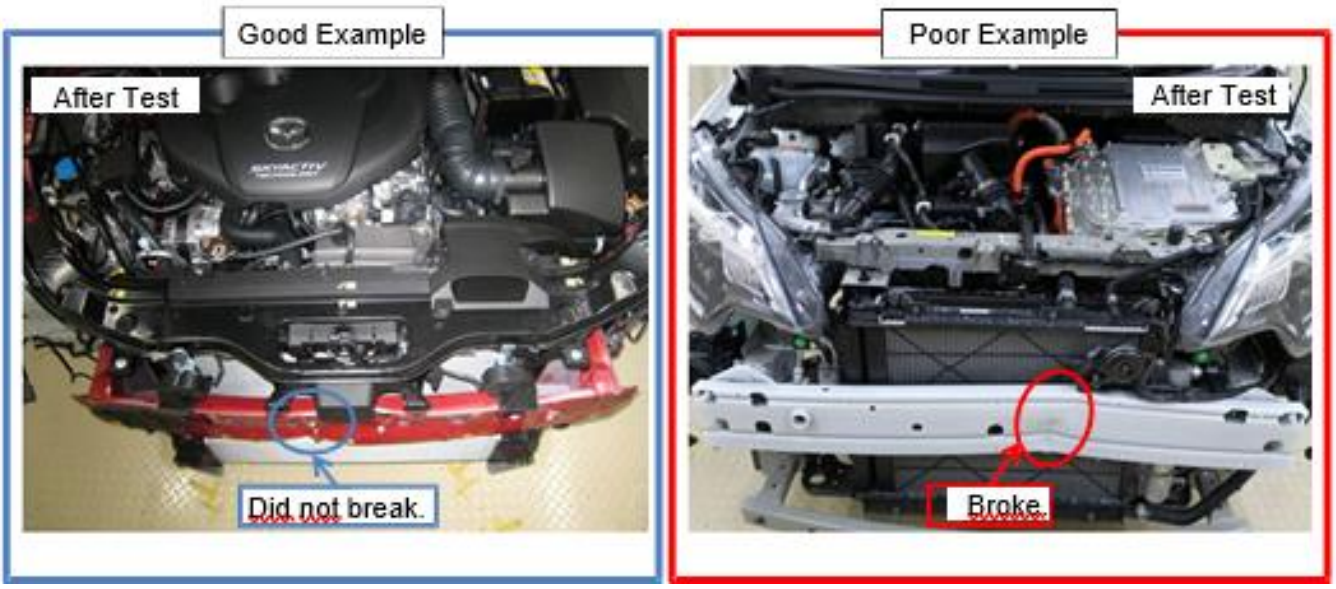
When the front bumper reinforcement uses materials and shapes that provide sufficient strength and energy absorption capability suitable for the vehicle weight, breaking and crushing are reduced, which helps prevent damage to the headlights, hood, fender, condenser, radiator, etc.



Cross-Section
Example.



Example of a cross-section of high-strength reinforcement.



FRONT BUMPER REINFORCEMENT

Inspection criteria

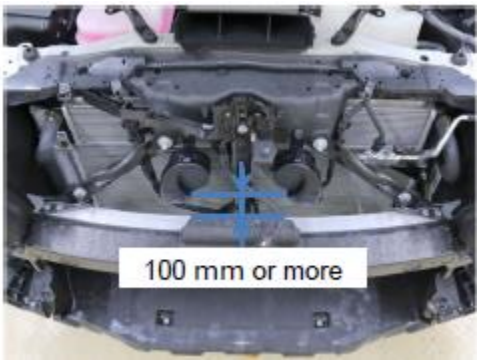
The clearance between the front bumper reinforcement and the parts aft of it should be 100 mm or more.

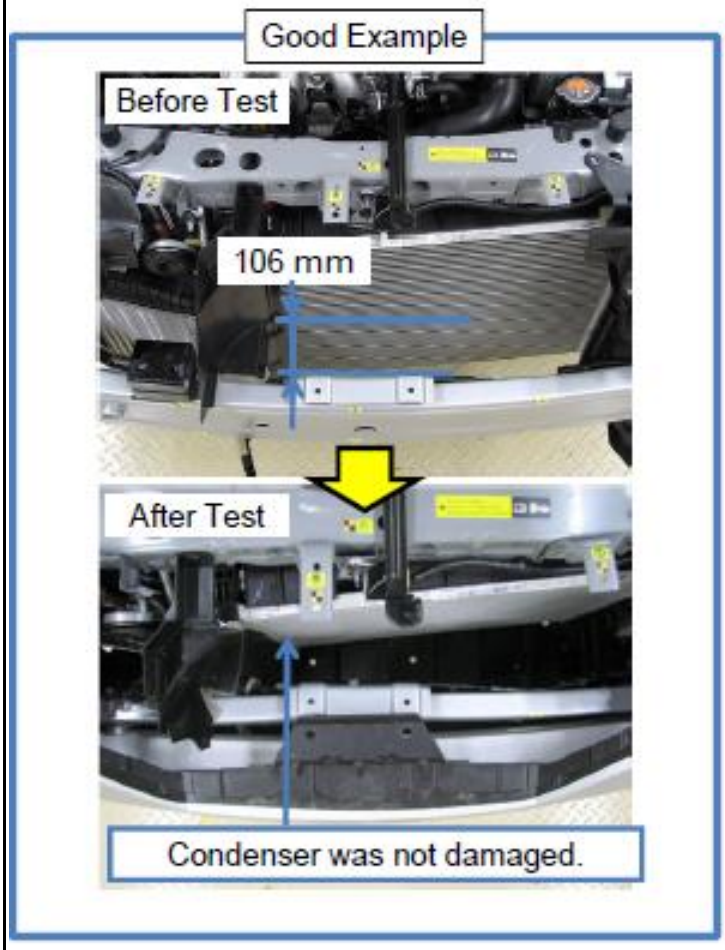
Reason

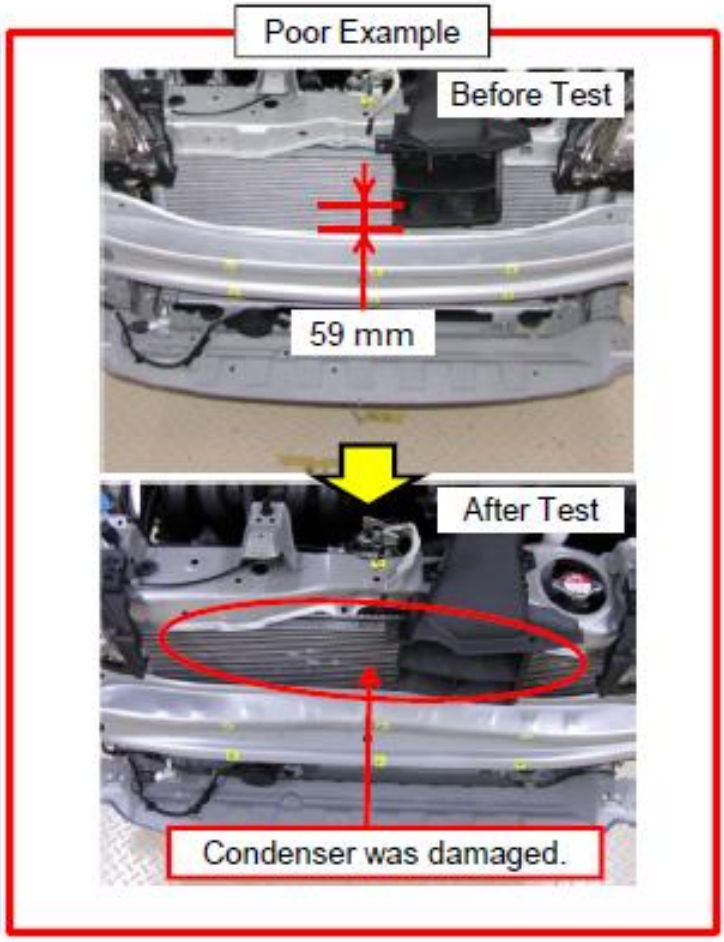
When the clearance between the front bumper reinforcement and the parts aft of it is 100 mm or more, damage to the condenser and radiator is less likely to occur if the reinforcement penetrates.

Clearances that prevent damage to the expensive condenser are:

- Clearance between the bumper reinforcement and condenser.
- Clearance between the bumper reinforcement and parts such as hood lock stay.
- Clearance between parts such as hood lock stay and condenser.







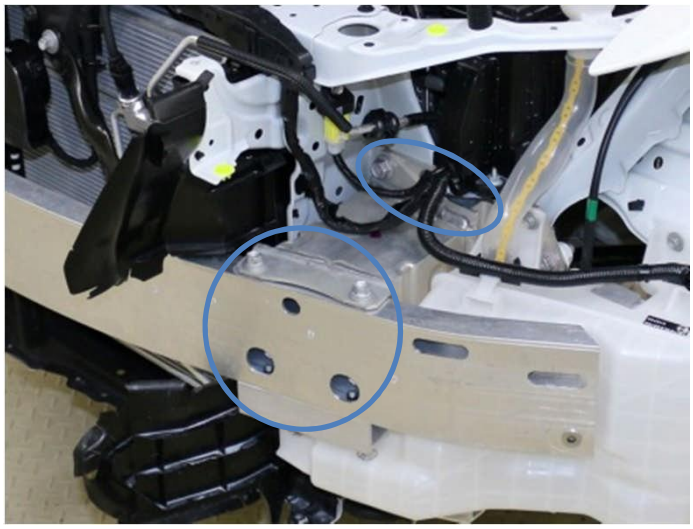
FRONT BUMPER REINFORCEMENT

Inspection criteria

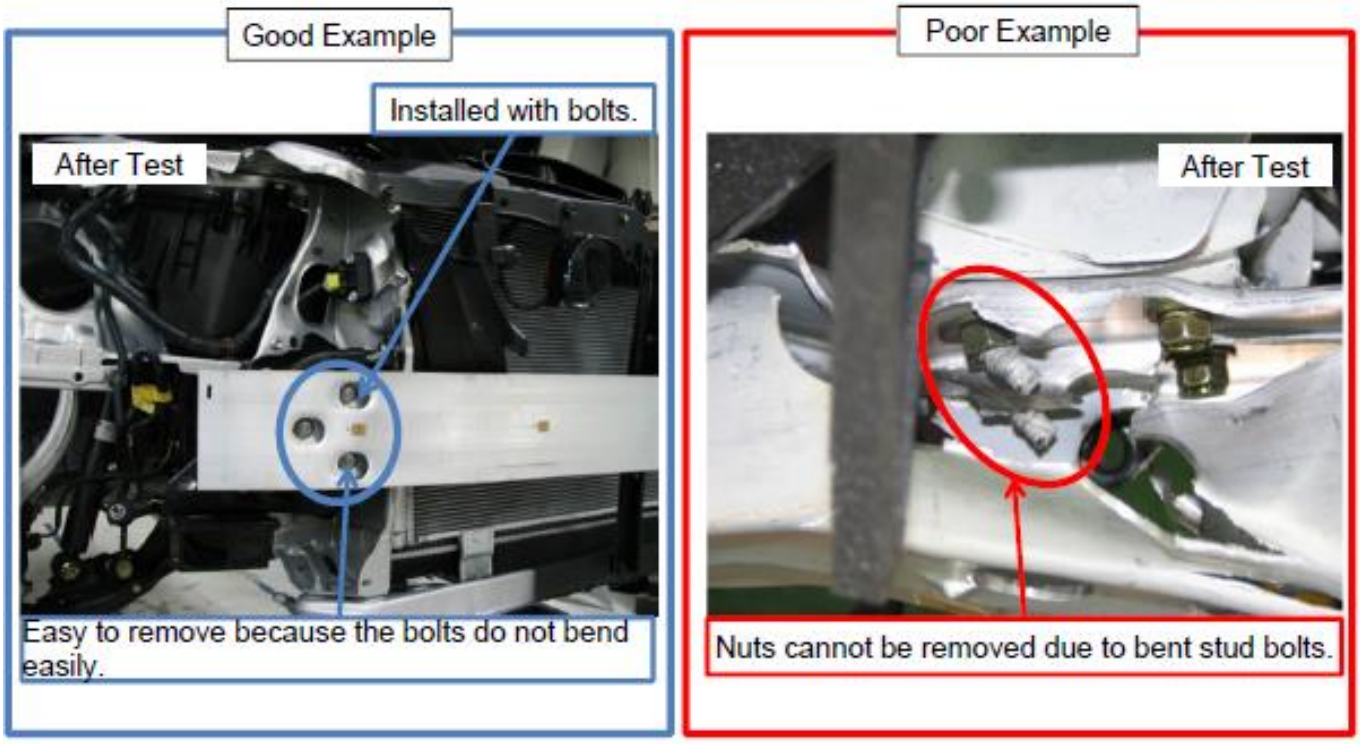
The front bumper reinforcement should be installed without using stud bolts.

Reason

Installing the front bumper without using stud bolts prevents the bumper reinforcement from getting stuck due to bent stud bolts in a collision, which reduces man-hours for the repair.



Example where stud bolts are not used



FRONT BUMPER REINFORCEMENT

Inspection criteria

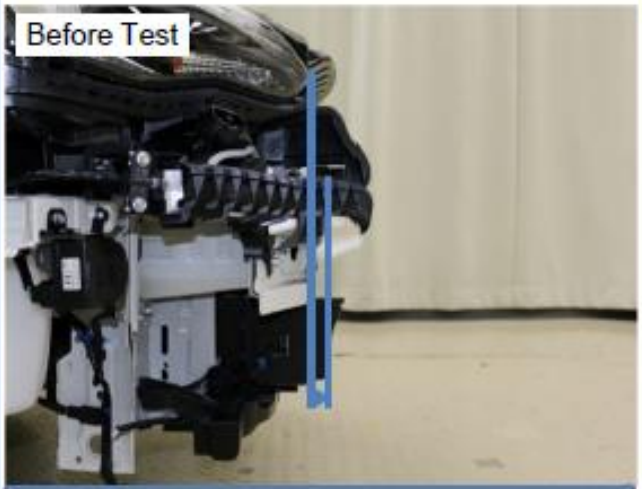
The front bumper reinforcement should be extended forward to prevent damage to the headlight and other parts caused by the penetrating bumper barrier in a collision.

Reason

When the front bumper reinforcement is extended forward, the front bumper reinforcement collides first, which helps prevent damage to the headlight and other parts caused by the penetrating bumper barrier.

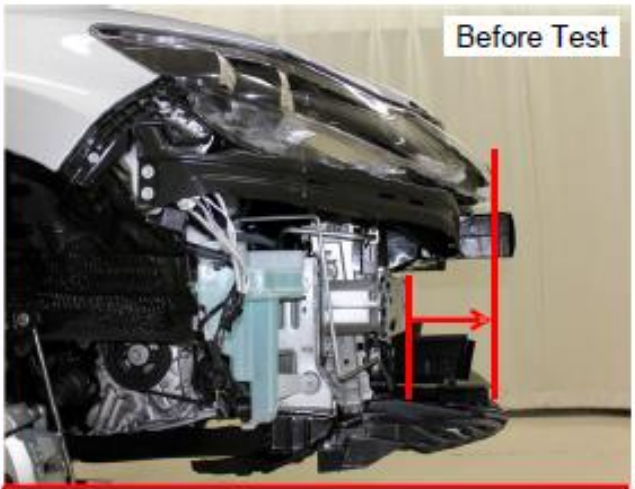
For the positional relationship between the bumper reinforcement and the headlights, see the pictures below.

Good Example



Headlights are located aft of the reinforcement.

Poor Example



Headlights are located forward of the reinforcement.

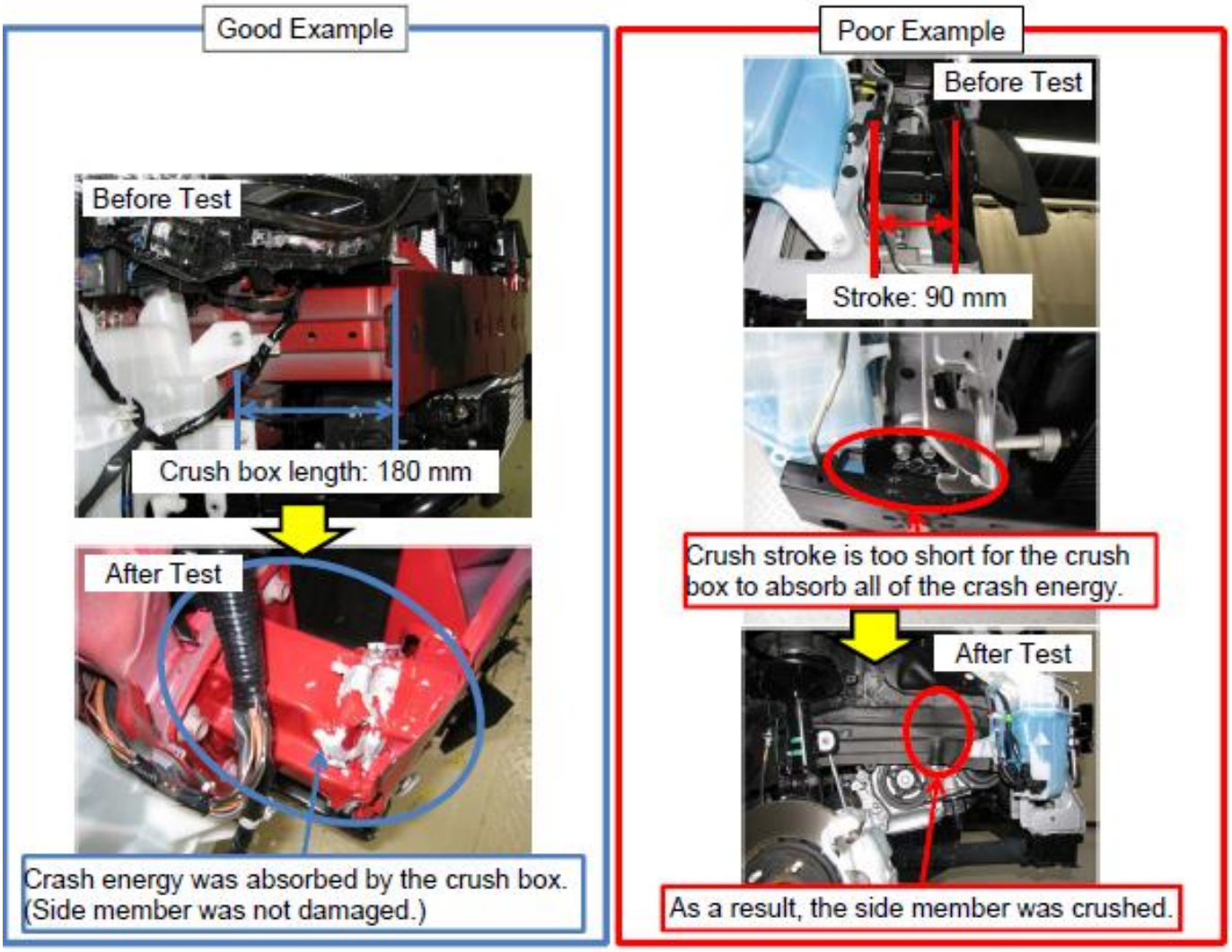
FRONT BUMPER REINFORCEMENT

Inspection criteria

The crush stroke of the front crush box should be 160 mm or more and the crush box should have a structure that ensures energy absorption capability and facilitates removal and installation.

Reason

When the crush stroke of the front crush box is 160 mm or more and energy absorption capability is ensured, damage is less likely to spread to the side member. Also, when bolts are used to facilitate removal and installation, man-hours for replacement work performed after the shock is absorbed can be reduced.



1.4.3. NO REPAIRS IN BUMPERS WITH EQUIPED ADAS SENSORS

Inspection criteria

According to some car manufacturers technical information, any bumper equipped with ADAS sensors, with damages that require some cover repair, must be replaced.

Reason

Some car manufacturers arguments about use of adhesive or welding repair procedures on bumper's covers, can affect ADAS operation. They only admit superficial refinishing operations on them, not exceeding 300 microns in total paint thickness. Any bumper cover which requires cover repair must be replaced.
This fact increases the repair costs, and do not match properly with sustainable operations.

Good example

In many manufacturers, the repair of bumpers is permitted, even if they are equipped with ADAS.

Poor example

The bumpers in some car models can't be repaired when they are equipped with ADAS. Only refinishing operations are allowed.

1.4.4. SUSPENSION STRUT TOWER (Inner wing)

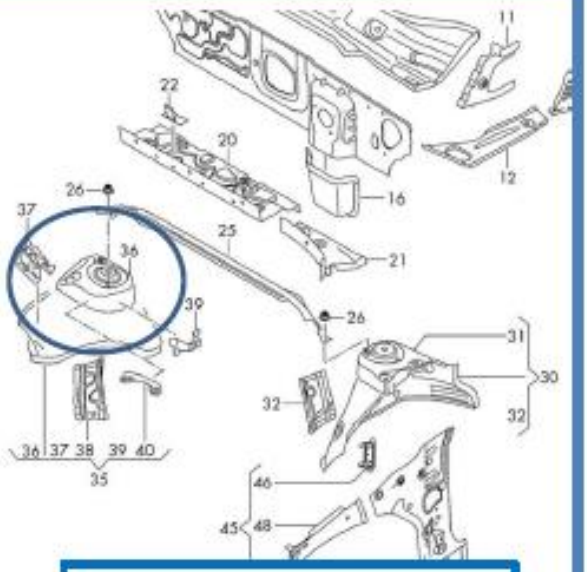
Inspection criteria

The strut tower should be a separated part from the front inner wing.

Reason

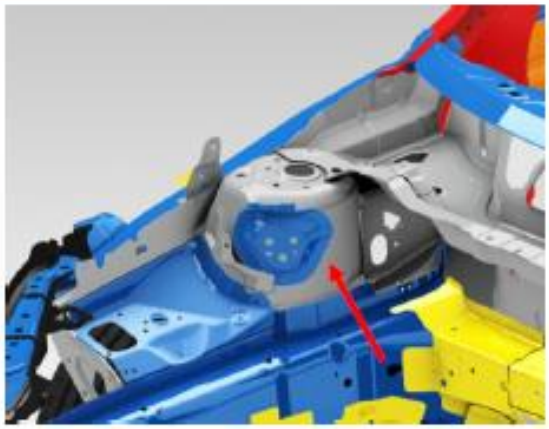
If the strut tower is a part of a front inner wing, which requires replacing after an accident, it will be also necessary to remove the suspension parts. This will significantly increase repair times.

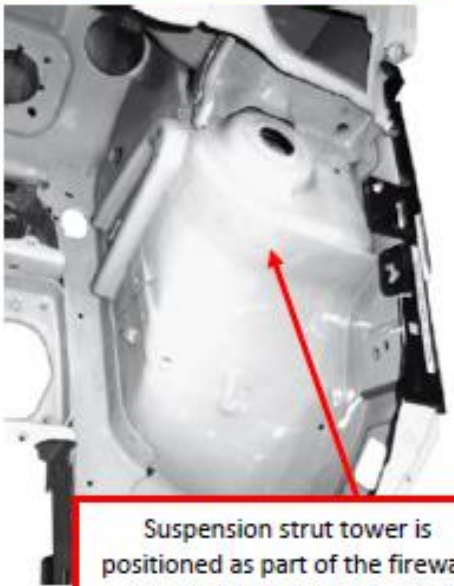
Good example



The strut tower is a separated part from the front inner wing.

Poor Example





Suspension strut tower is positioned as part of the firewall plenum chamber and the front inner wing.

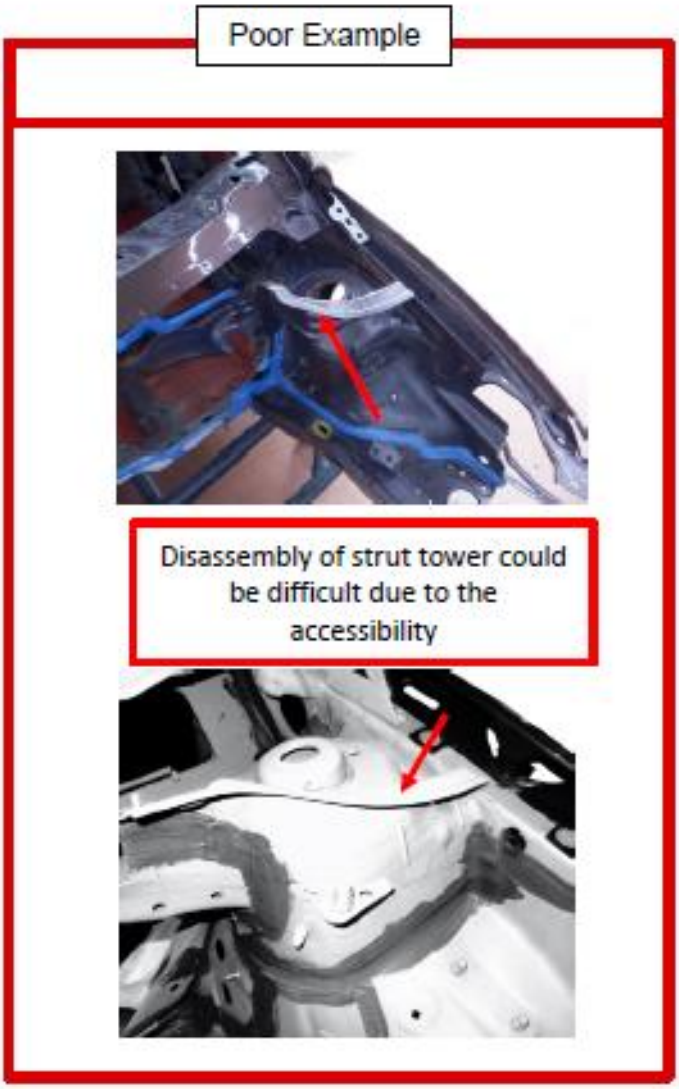
SUSPENSION STRUT TOWER (Plenum chamber)

Inspection criteria

The firewall plenum chamber should be designed as a separate part from the strut tower.

Reason

If the firewall plenum chamber is a part of the strut tower, it will be also necessary to remove the firewall plenum chamber. This will severally increase repair times.



SUSPENSION STRUT TOWER (Natural joints)

Inspection criteria

Design the inner wings with natural joints to simplify the replacement.

Reason

If the inner wing has no natural joints which can be used, the repairer will have to create them and to remove any evidence of repair. This will increase repair times.

Good example

Strut tower has been fitted to the body using spot weld. Any evidence of repair could be removed.

Poor Example

Strut tower is a unique part. Repair requires completely replacement.

1.4.5. FRONT PANEL (Fixing)

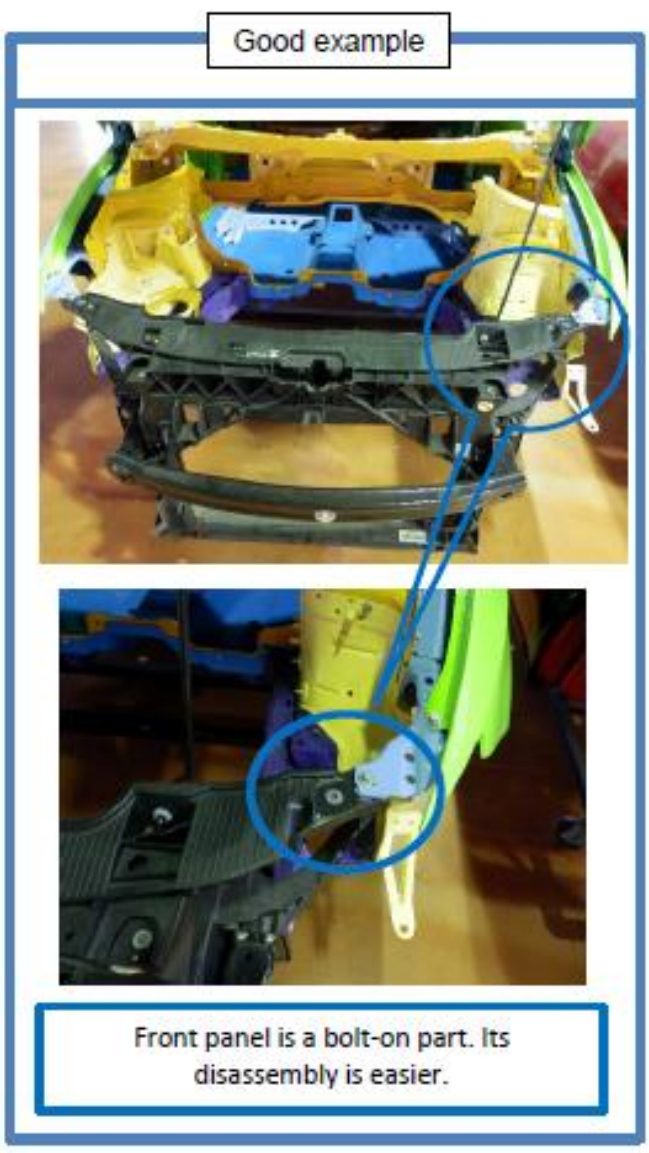
Inspection criteria

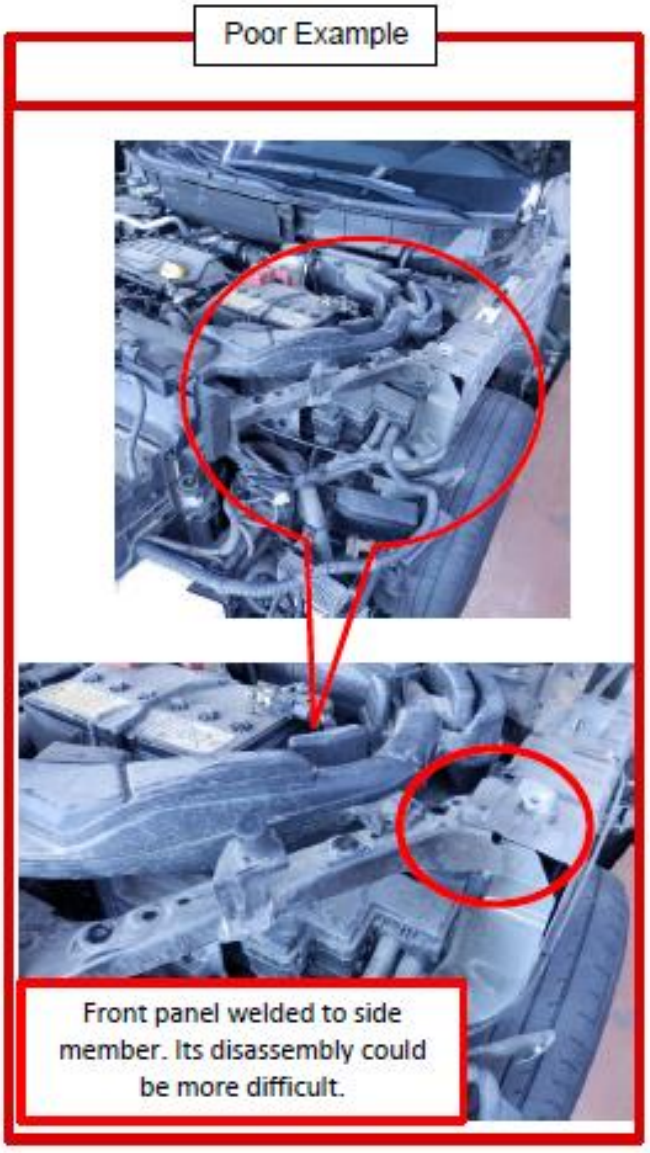
The front panel covers the front of the vehicle and, in general, it is fitted on the front chassis legs, supplying a support for both outer wings.

Front panel should be a bolt-on part to be easily removed after damage. Avoid front panel made by steel which requires spot welds.

Reason

Front panel is a frequently damage part in an accident. Its removal should take as little time as possible. Designing front panels in plastic material, it is avoided the permanent joints on the body (spot welds)





FRONT PANEL (Damage)

Inspection criteria

The front panel should not be fitted on the bumper, crush cans or chassis legs.

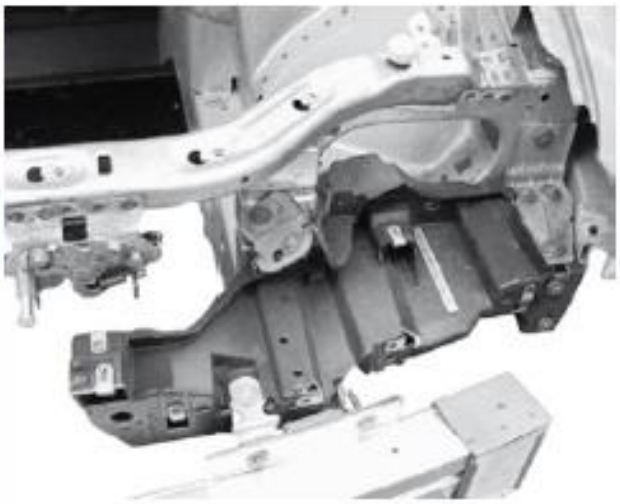
Reason

The front panel should have the ability to break away from its fixings. If the front panel is not fitted on the parts indicated in the previous section, surrounding parts would not be affected in an accident. Also, in a low-speed impact, the only one part affected would be the bumper whose replacement could be easy.

Good example

On impact the panel has broken, allowing parts fitted to the panel to move but not to be damaged.

Poor Example



Front panel welded to side member.

FRONT PANEL (Lower cross member)

Inspection criteria

The order of lower cross member assembly should be one which avoid the removal or replacement of surrounding parts.

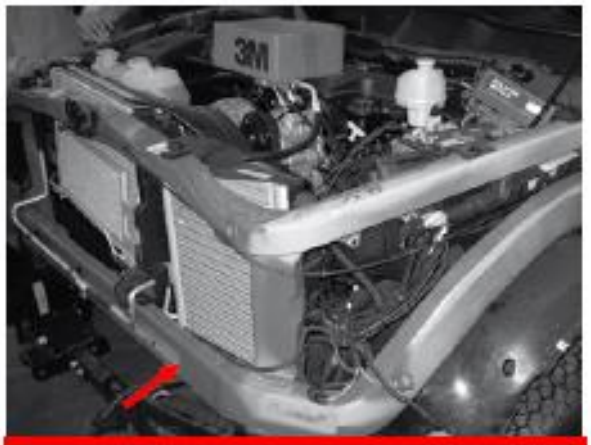
Reason

When the front section is completely assembled, the front cross member cannot be replaced. It is necessary to remove and replace additional parts.

Good example

Bolted part makes easier the disassembly or the removal in case of damage.

Poor Example



Complete part without fixation points which could make easier the partial disassembly.

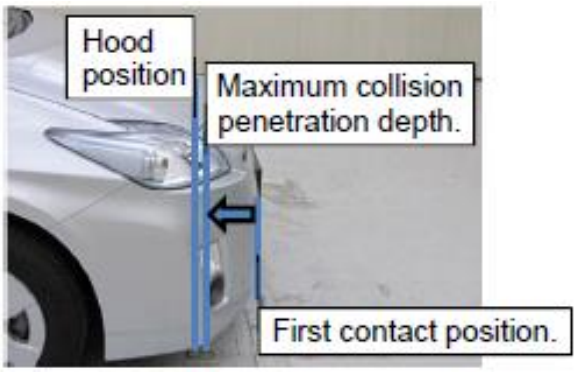
1.4.6. BONNET

Inspection criteria

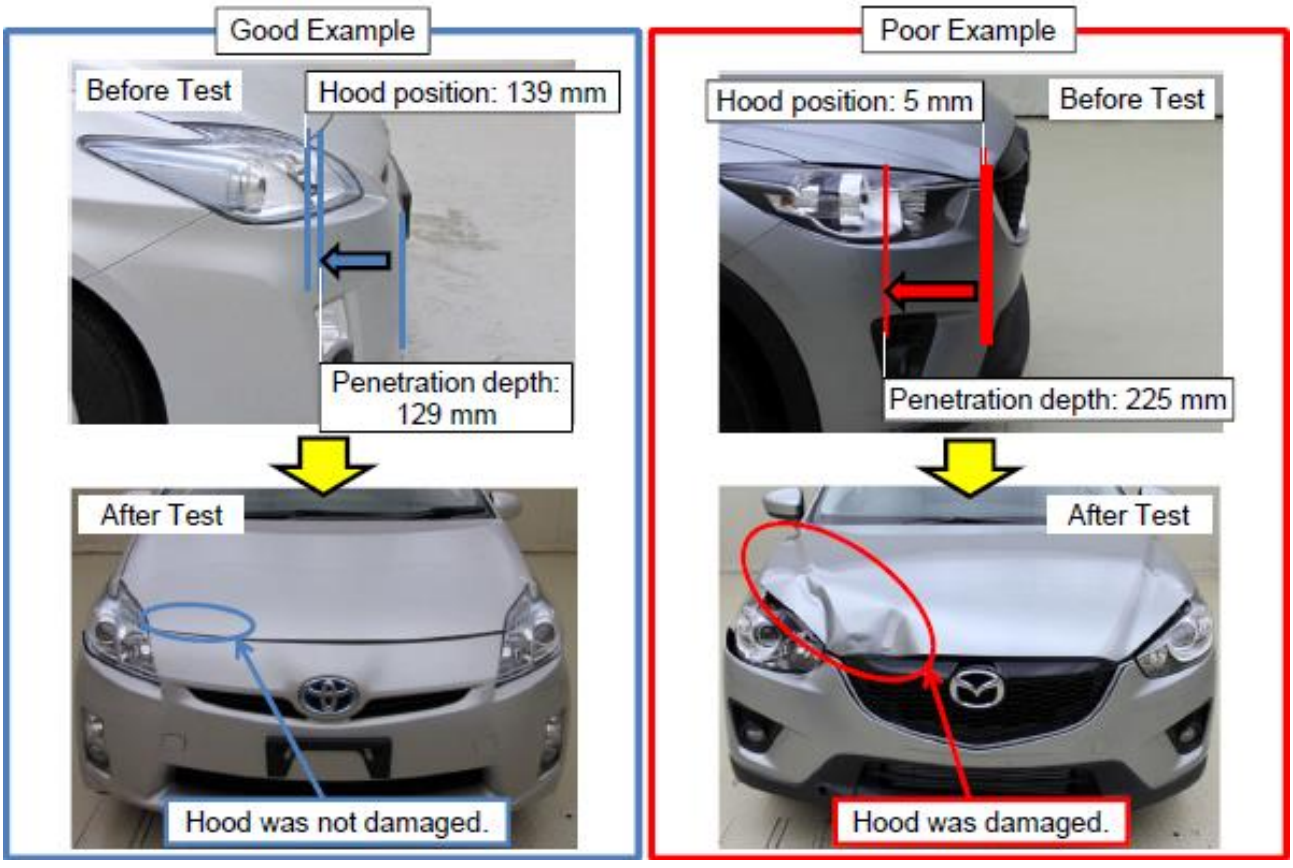
The distance from the front end of the bumper to the front end of the hood should be equal to the maximum collision penetration depth (RCAR test at 15 km/h) or longer.

Reason

When the distance from the front end of the bumper to the front end of the hood is longer than the maximum collision penetration depth, damage to the hood is less likely to occur.



Example where the distance from the front end of the bumper to the front end of the hood is longer than the maximum collision penetration depth.



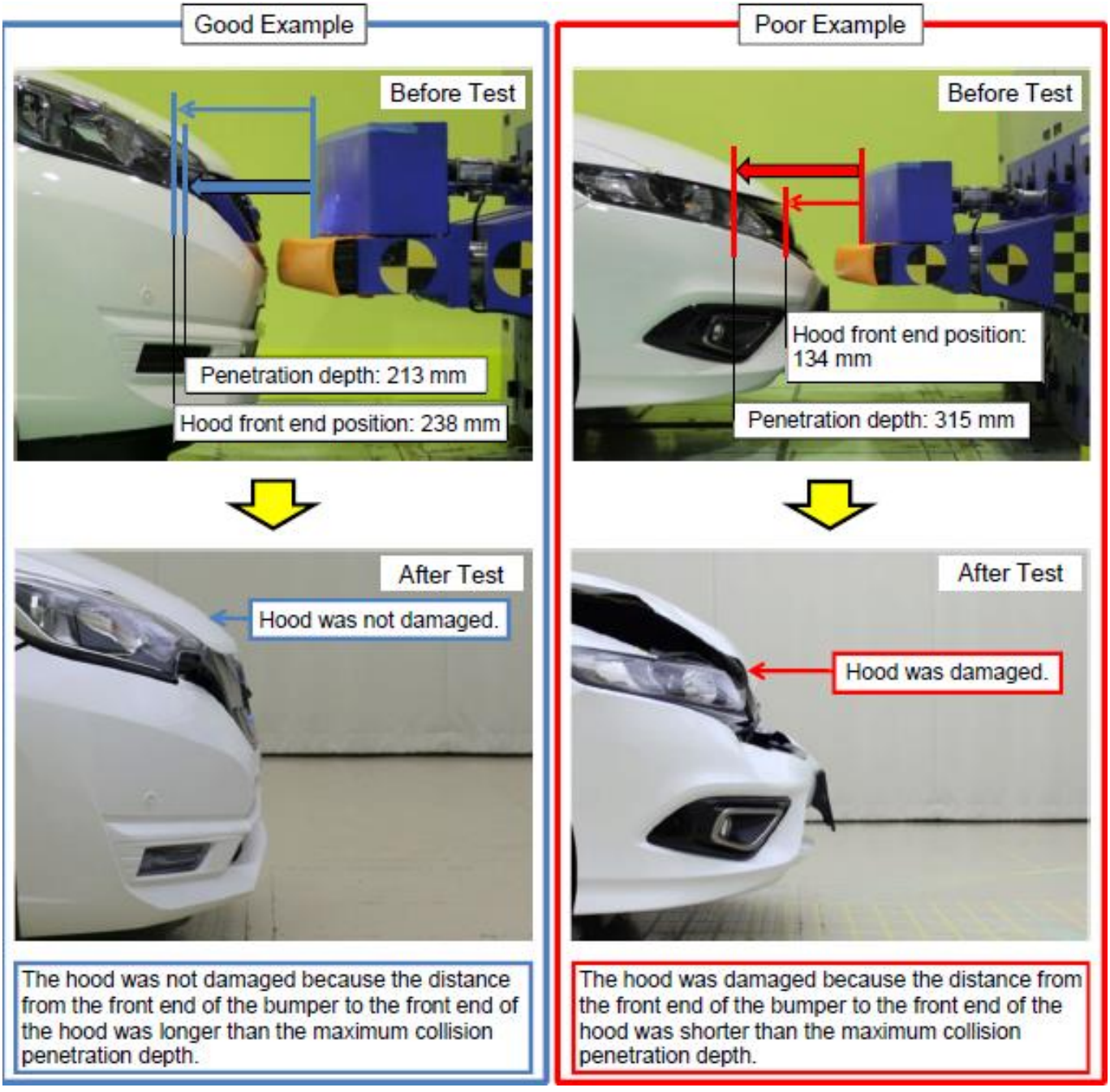
BONNET

Inspection criteria

The front end of the hood should be set back or higher than the back stop so that the hood does not hit the back stop even with the maximum collision penetration depth (bumper test).

Reason

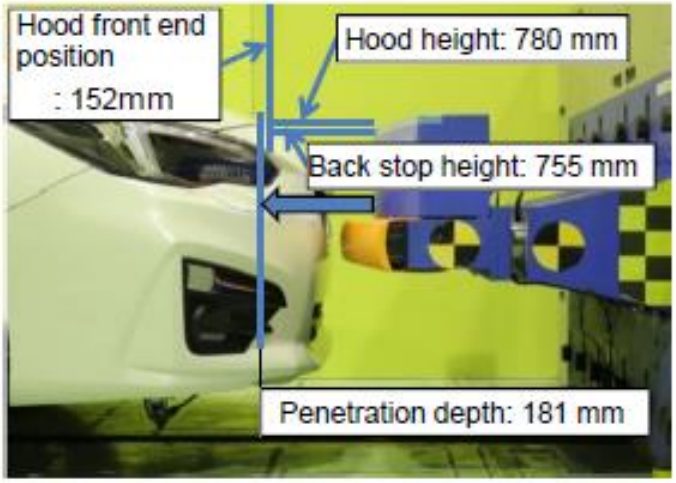
When the distance from the front end of the bumper to the front end of the hood is longer than the maximum collision penetration depth, or the front end of the hood is higher than the barrier back stop, damage to the hood is less likely to occur.



BONNET

Good Example

Before Test

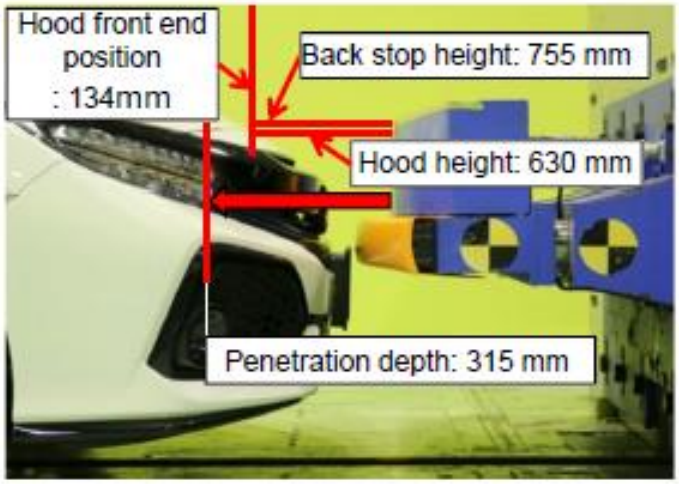


After Test

The hood was not damaged because the front end of the hood was higher than the barrier back stop.

Poor Example

Before Test



After Test

The hood was damaged because the front end of the bumper was lower than the barrier back stop.

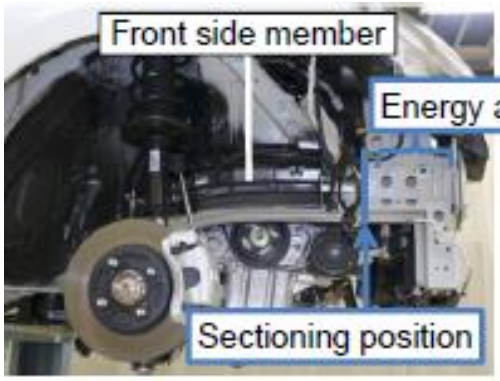
1.4.7. FRONT CHASIS LEG

Inspection criteria

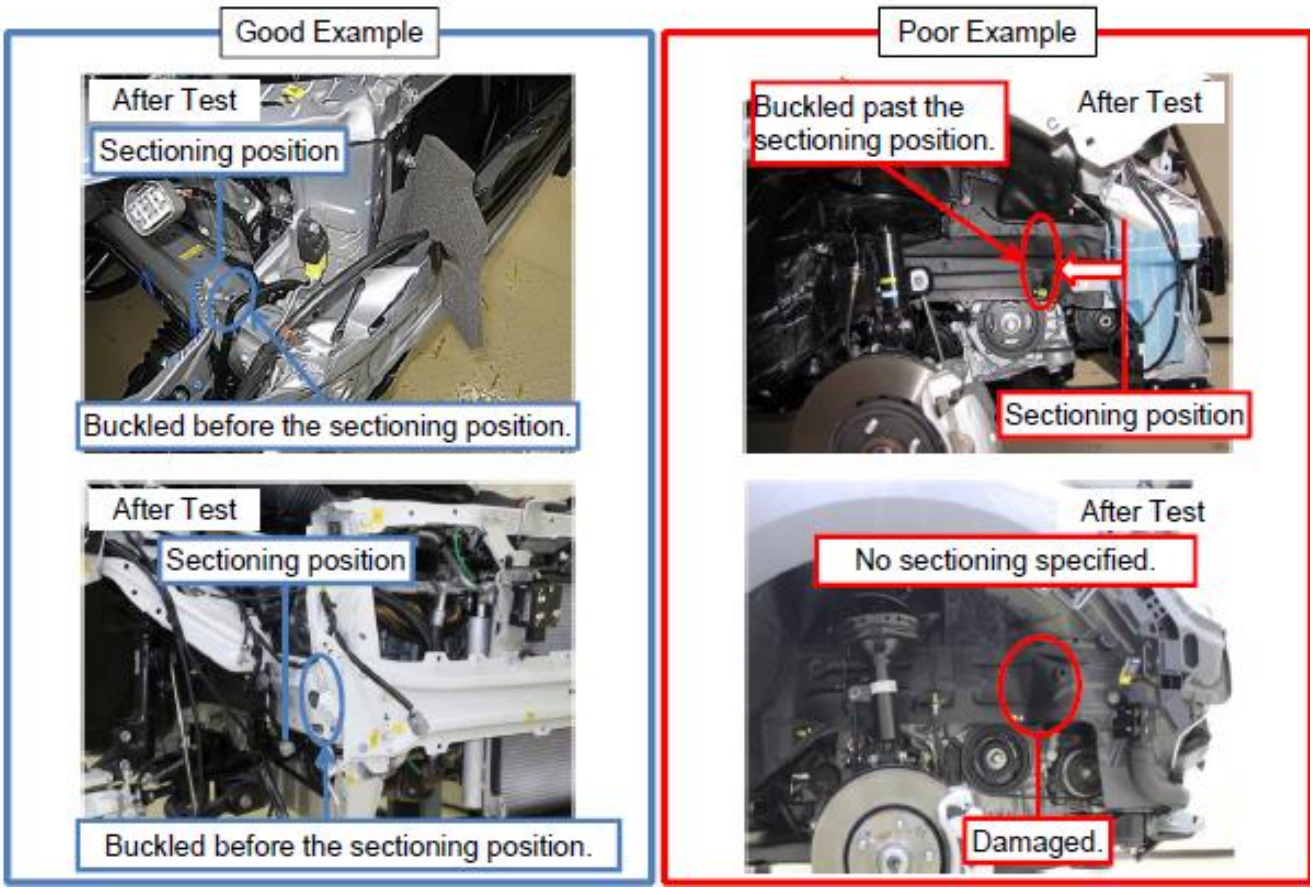
The front side member should have a structure where damage ends before the sectioning position.

Reason

If damage such as buckling occurs past the sectioning position, removal and installation of the engine, transmission and suspension are required and the side member assembly needs to be replaced.



Example of a structure where damage ends before the sectioning position



FRONT CHASIS LEG

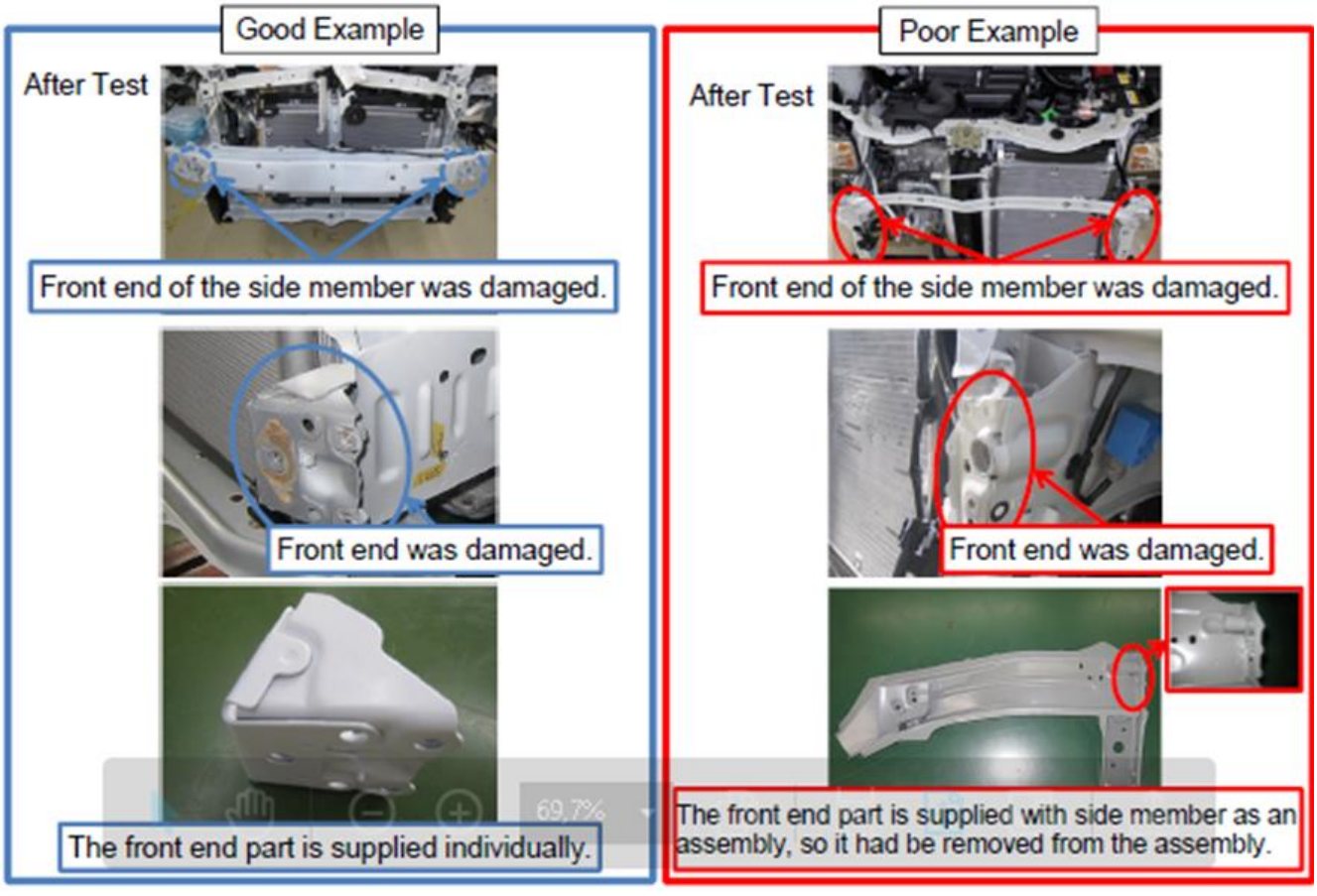
Inspection criteria

The part at the front end of the front side member, where the bumper reinforcement or crush box is installed, should be easily replaced and supplied individually.

Reason

When the part at the front end of the front side member, where the bumper reinforcement or crush box is installed, is easily replaced and supplied individually, if the front end of the side member is damaged, it is not necessary to take the front-end part from the side member assembly and install it to the front side member, which reduces the repair cost.

Example where the part at the front end of the front side member is supplied individually.



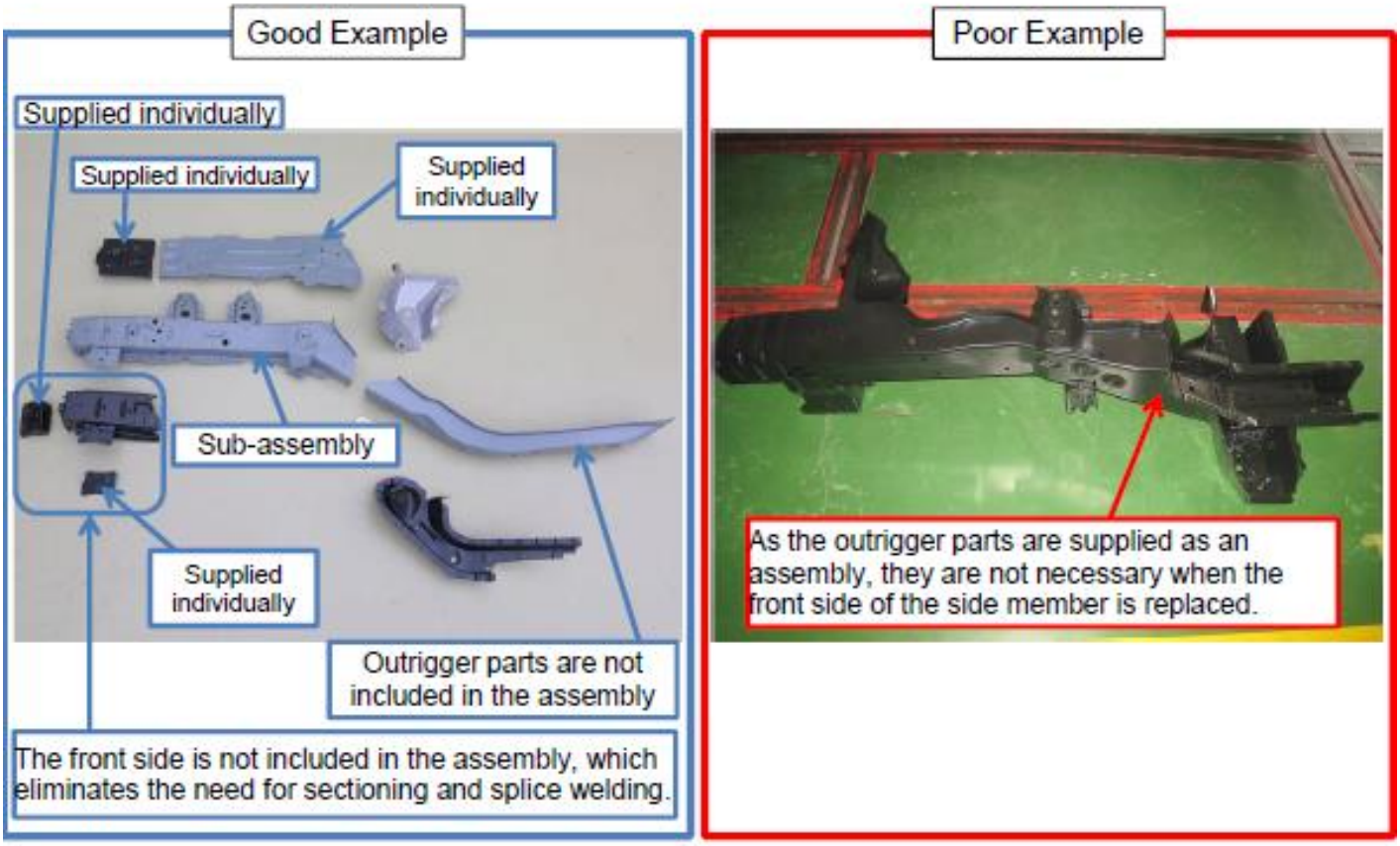
FRONT CHASIS LEG

Inspection criteria

For the front side member, the parts before the dash panel should be supplied individually or as a sub- assembly (front).

Reason

For the front side member, when the parts before the dash panel are supplied individually or as a sub-assembly (front), parts can be replaced according to the degree of damage, which reduces the repair cost.



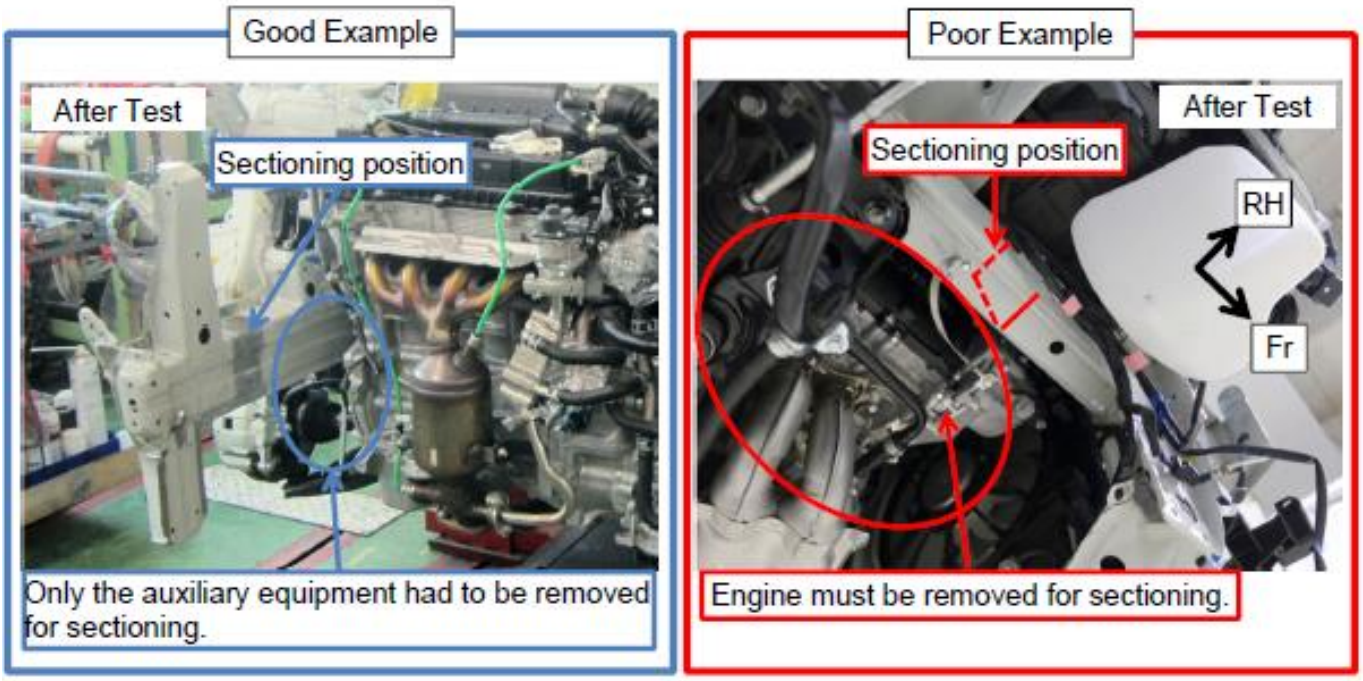
FRONT CHASIS LEG

Inspection criteria

The sectioning positions of the front side member outer and inner should be within the area where auxiliary equipment such as a compressor or alternator may need to be removed, but not where the engine and transmission need to be removed.

Reason

When the sectioning positions of the front side member outer and inner are within the area where auxiliary equipment such as a compressor or alternator may need to be removed, removal and installation work of the engine and transmission is not required, which reduces the cost of repair.



1.4.8. FRONT SUB-FRAMES

Inspection criteria

Sub-frames are used to position the engine and front suspension to the vehicle body during vehicle production. Engine removal is relatively simple using the same procedure.

Design the sub-frames to be shaped by two or more circular pieces (C-shape pieces).
Assembly the sub-fames should be done as far back as possible.

Reason

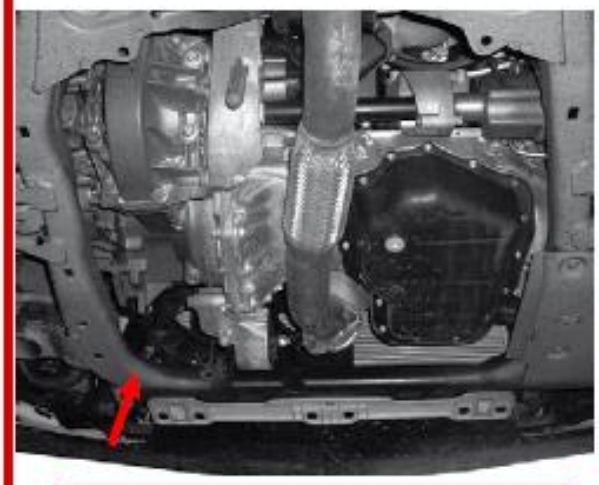
If sub-frames are conformed by two or more simple pieces, the repair operation is easier. In that case it should be removed only the area affected (not the whole part).

If the sub-frame is fitted as far back as possible and it also could contain crush cans to absorb energy, subframe damage would be reduced in case of accident.

Good example

Sub-frame is formed by two C-Shape single parts, fitted via bolts. Disassembly requires less time.

Poor Example



Sub-frame is a unique part. Its removal required its complete disassembly.

1.4.9. BODY SIDE GENERAL (‘A’ post)

Inspection criteria

The introduction of reinforcements made of Ultra High Strength Steels (UHSS) has affected the way sills ‘A’ and ‘B’ post are repaired.

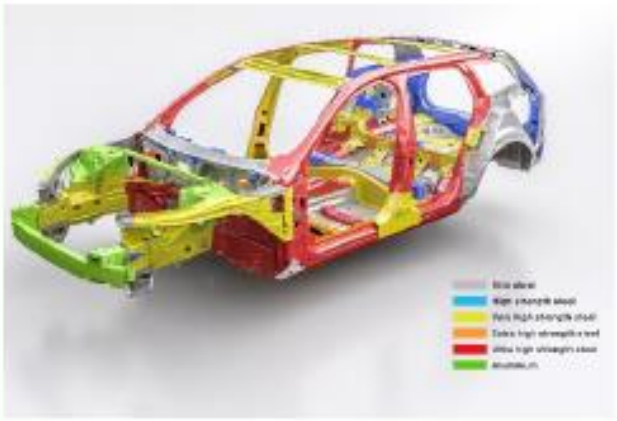
The UHSS areas should be indicated by the manufacturer (in repair manuals, and if is it possible in the own part as well, like the plastic parts).

Reason

The Ultra High Strength Steel has been introduced to provide more protection against intrusion from side impacts.

If the areas of UHSS are indicated, it will be easier to recognize the reparation process.

Good example



The parts made of Ultra High Strength Steel are clearly indicated.

Poor Example

BODY SIDE GENERAL (Single parts)

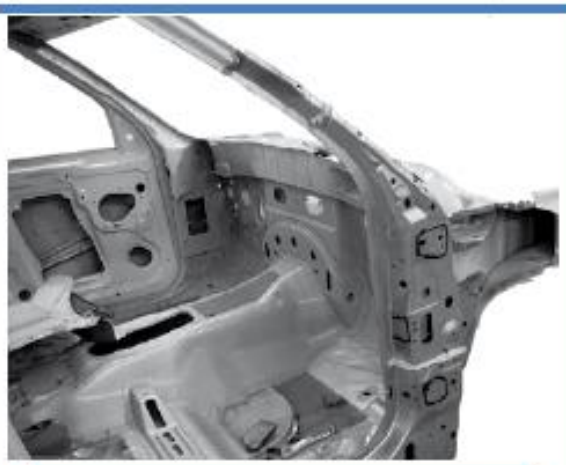
Inspection criteria

Design the ‘A’ post to be conformed by single parts.

Reason

If the ‘A’ post is shaped by single parts, the repair time will decrease. It would not be needed to replace the complete ‘A’ post, only the damage area.

Good example



‘A’ Post reinforcement is sectionable at natural joint in upper part, avoiding complete removal.

Poor Example

‘A’ Post reinforcement is a unique part. Its removal required its complete disassembly.

BODY SIDE GENERAL (‘A’ post overlap)

Inspection criteria

Avoid the overlap of “A” post under the side panel reinforcement and roof reinforcement to make easier the replacement and reduce the repair times.

Reason

In case of roof reinforcement would be fitted on the ‘A’ post (and not under the ‘A’ post), it is recommended to be conformed by several parts.

In case of the roof would be fitted on the roof reinforcement, it is recommended to ease the partial sections.

Good example

Bridging plate has been disassembled

Bridging plate creates a joint between ‘A’ Post and side panel reinforcement, easing removal of both panels.

Poor Example

‘A’ Post reinforcement is a unique part. Its removal required its complete disassembly.

BODY SIDE GENERAL (‘B’ post/sill)

Inspection criteria

Sills and ‘B’ post provide stiffness to the body and are normally conformed by several layers, including one or more reinforcements.

The sill is the lower visible panel. The ‘B’ post also forms the main structural protection for occupants against a side impact.

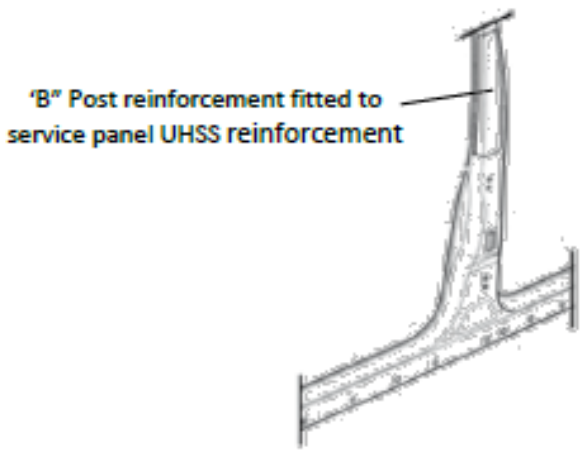
Design ‘B’ post with UHSS reinforcement which can be sectioned.

Reason

If the ‘B’ post can be sectioned, the repair and cost would be reduced.

Some manufacturers have started to supply the pillar A, the pillar B and the sill as unique part (Door ring). This provides lightness, however, increase the difficulty of replacement.

Good example



‘B’ Post with a UHSS reinforcement can be sectioned.

Poor Example

‘B’ Post made of UHSS, requires complete replacement.

BODY SIDE GENERAL (‘B’ post Overlap)

Inspection criteria

The possibility of removing sill reinforcements without extensive removal of other parts is recommended. This can be achieved by having reinforcements made of sections, allowing partial removal and reducing labour times and parts.

Reason

Damage to the sill reinforcement requires the removal of the outer panel which covers both the sill and ‘B’ Post. This will increase the time and overall cost of repair.

Good example

‘A’ Post cover and reinforcement where it joins the sill which are sectionable, making removal of the ‘A’ Post reinforcement easier and allowing for sectioning of the sill.

Poor Example

Sill reinforcement is a single piece and when damaged will require sill cover removal and sectioning.

BODY SIDE GENERAL ('B' post UHSS used in)

Inspection criteria

Introducing a smaller local UHSS reinforcements fitted to a lower strength full panel serviced as an assembly will allow sectioning the carrier panel.

Reason

When the reinforcements made of UHSS is joined to both the sill and the roof, it requires a complete replacement. This means excessive labour times and parts requirements, as both the roof and the sill must be opened. More time painting will also be required, due to the increased repair area

Good example

B' Post can be sectioned through reinforcements and both index outer and closing panel without having to cut into upper roof rail. Most reinforcements made from UHSS cannot be sectioned.

Poor Example

'B' Post has to be sectioned and roof rail has to be opened for the reinforcement to be fed between panels.

BODY SIDE GENERAL (‘B’ post sill joints)

Inspection criteria

Try to avoid any different joining configurations with can complicate the repair when panels are damaged.

Reason

When sill panels are joined to the chassis or the floor, a single joint is preferred over a bridging panel joining the sill panel and floor, as this reduces accessibility. It makes repairs awkward when both panels are damaged and increase the repairs times.

Good example

Sill cover panel runs from edge to edge over the reinforcement around the ‘B’ Post and rear reinforcement.

Sill cover panel in the rear reinforcement.

Poor Example

The sill cover panel runs to a bridging panel, not to the inner edge of the chassis/floor.

Reparability could be difficult due to the accessibility

BODY SIDE GENERAL (Reinforcements too close to outer panels)

Inspection criteria

Allow enough space for tooling, as specified in existing repair manuals, between the panels for sectioning in likely areas of repair.

Reason

The areas where several panels of different materials are used proximity create body side assemblies do not allow safe sectioning in repair. Due to the order of panel removal and stepping the joints, damage to subsequent panels can occur. This damage must be avoided, as it will reduce the strength.

Good example

'B' Post can be sectioned though reinforcements and both outer and closing panel without having to cut into upper roof rail. Most reinforcements made from UHSS cannot be sectioned.

Poor Example

To get access to the reinforcement it is necessary to open the roof rail.

BODY SIDE GENERAL (Accessibility for replacement)

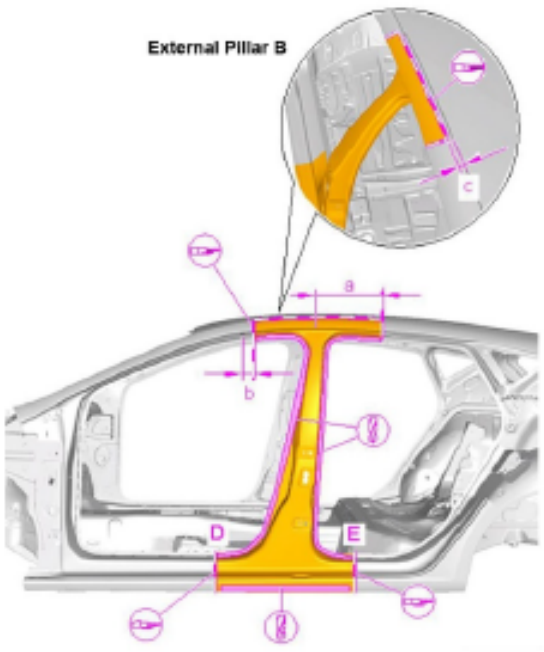
Inspection criteria

Due to the use of UHSS steel, the most of inner Pillar's B need to be replaced. In those cases, a partial section in the external Pillar B is necessary to carry out the complete replacement of the inner Pillar B. Manufacturer must provide the proper access and clear instructions to replace this part.

Reason

Accessibility for inner Pillar B replacement is necessary because it is made of UHSS steel and this part in most of cases must be replaced completely.

Good example



Manufacturer must provide the proper access and clear instructions to replace the complete inner Pillar B.

Poor Example

BODY SIDE GENERAL (‘’B’ post sill reinforcements)

Inspection criteria

Design sill covers as cosmetic panels only which can them be removed easily. Reinforcement should be made of separate parts to limit the requirements for removal.
This will reduce times and make the repair easier.

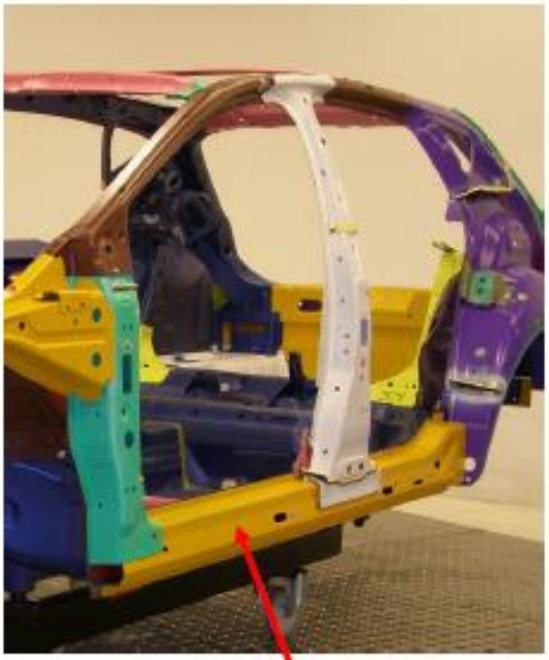
Reason

Sill reinforcements made from a single piece require extensive removal of both the sill cover and the reinforcement when damage.

Good example

Sill cover panel runs from front edge to rear edge, over the reinforcement and around the ‘B’ Post and rear reinforcement. Sill shape is given by fitting a plastic cover.

Poor Example



Sill reinforcement is a single part and when damaged will require sill cover removal and sectioning.

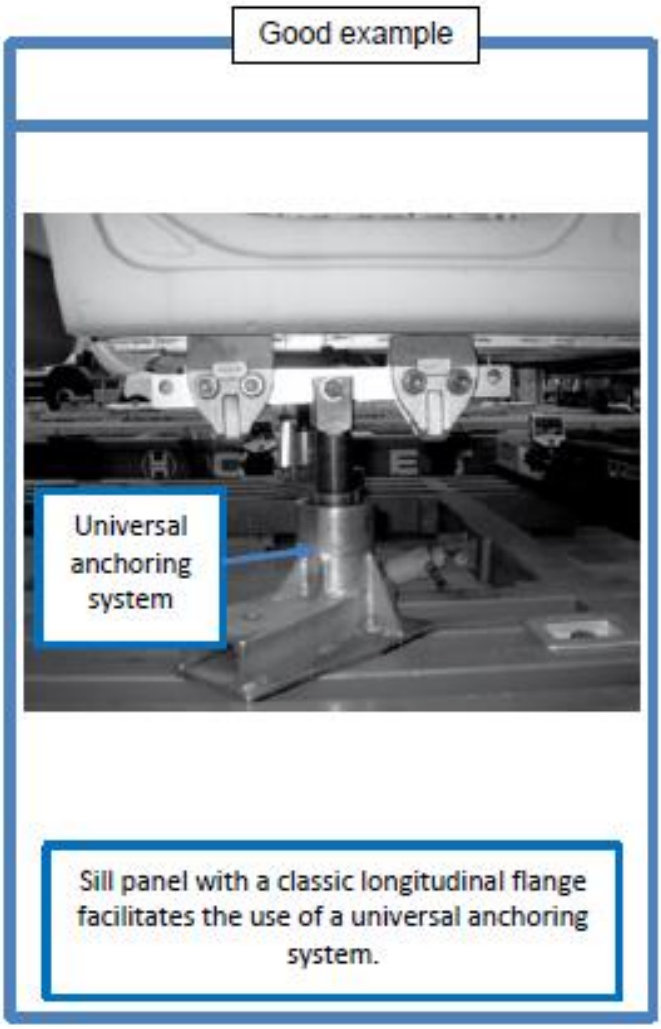
BODY SIDE GENERAL (‘’B’ post sill flange)

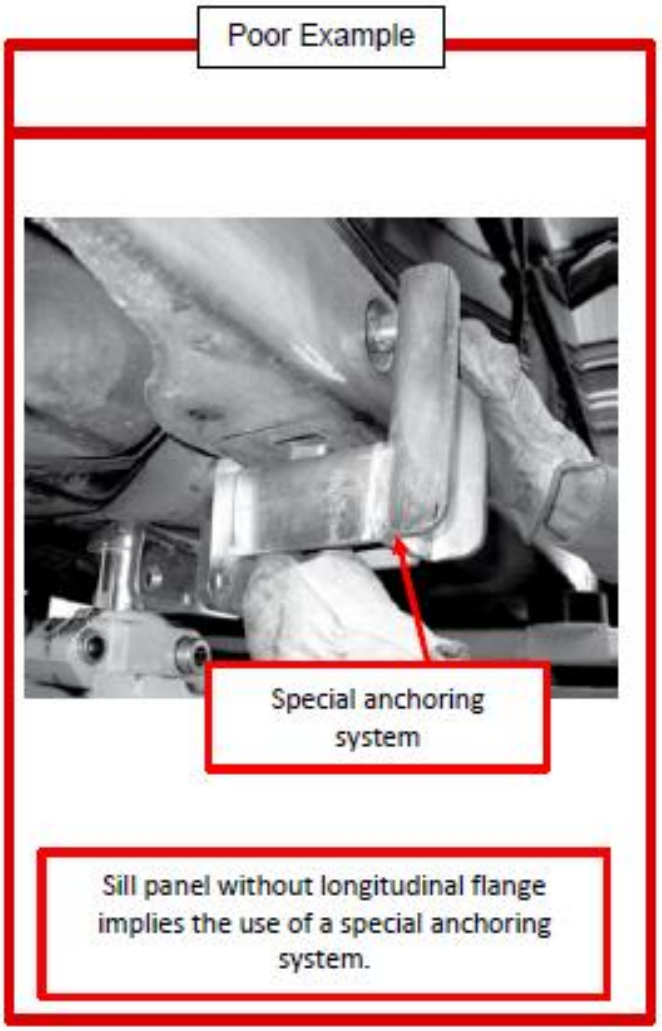
Inspection criteria

It would be advantageous for the sill panel to have a longitudinal flange joint, so a universal anchoring system can be used. It would simplify repair work and reduce the need for equipment investment in special anchoring systems to cope with certain vehicle models.
Maintain the sill joint as a traditional flange joint to allow the use of standard clamps.

Reason

The use of different type of sill joint requires the use of special jigs and requires the investment into this equipment, increasing costs for the body repair shop.





BODY SIDE - MATCHING SERVICE PARTS

Inspection criteria

The servicing of a good priced whole-body side panel avoids discrepancies on joints and also allows the repairer to cut the best section for each repair. Parts of panels can be separated out of the whole-body side and accurately positioned according to the damage on a vehicle.

Reason

Service parts are normally available as separate panels. Although this is in principle a good solution, the reality is that outer panels are cut from whole body sides and the location of the cuts varies, resulting in service panels not joining accurately. Also damage to the vehicle may occur between areas covered by two service panels.

Good example

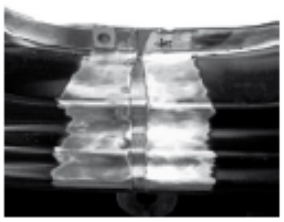
Service parts supplied as a whole that can be cut where required to suit the damage to the vehicle. This avoids any mismatching joints.

Service parts supplied as a whole rear segment to cover the most vulnerable parts like the dogleg.

Poor Example

Service parts supplied as a side panel segment but having a joint at one of the most vulnerable and most frequently damaged parts like the dogleg.

Service parts supplied in separate units need joining up when fitting, unless the part covers the damage area.



The alignment and joining of the supplied service panels do not match.

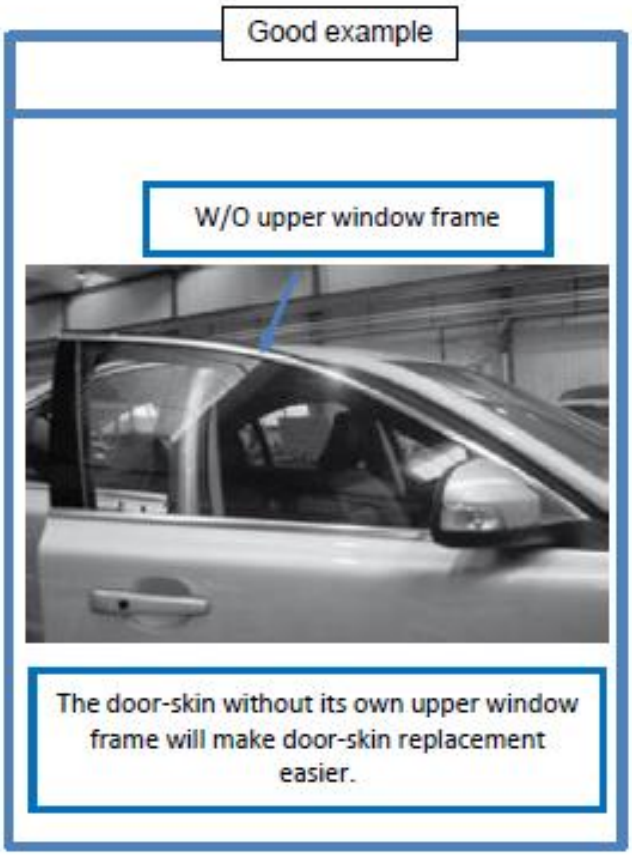
1.4.10. DOORS (Shape of door-skin makes replacement more difficult)

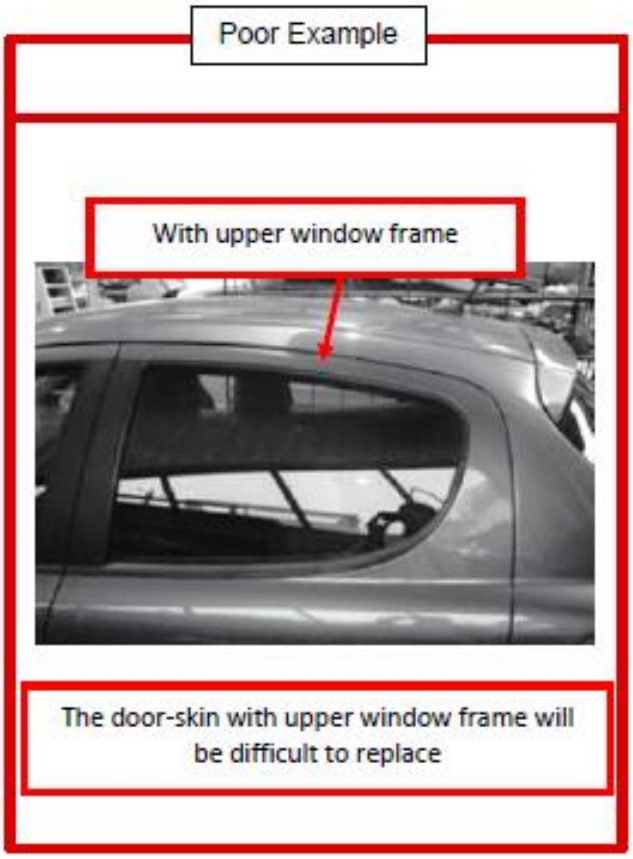
Inspection criteria

Avoid complicated door skin shapes surrounding windows. Make accessible the internal face of the panel.

Reason

A door-skin that surrounds the windows is more difficult to replace due to its complex shape. Avoid an inward curvature on the door-skin, as it would hinder the repair and paint operations. Having separate access covers in the door trim allows the removal and adjustment of the window, without needing to remove the door trim completely.





DOORS (Service the door-skin as separate part)

Inspection criteria

It is preferable for door-skin to be serviced as a separate part, which would allow only the door-skin to be replaced. (If the car manufacturer does not have the option to service the door-skin as a separate part, the only options are either to repair the door skin or to replace the complete door.)

Reason

Door-skins are usually manufactured from steel with a thickness of 0.7 mm. The door contains a side impact protection bar, welded to the inner structure and bonded to the door-skin, so it is not possible to remove it. The door-skin is fitted to the inner structure by means of a hem flange and some supplementary resistance spot welding.

DOORS (Internal accessibility)

Inspection criteria

Good access should be available to the door inner frame, so it can be worked on properly. Avoid an inward curvature on the door-skin, as it would hinder the repair and paint operations. To have a screwed central frame, on which the door mechanisms are fixed, would allow the removal of the entire system, which would reduce labour times. To have separate access covers in the door trim allows the removal and adjustment of the window, without needing to remove the door trim completely. This will reduce labour times.

Reason

Being able to repair the door-skin in a proper and effective cost way depends on factors included: type of material (usually steel), accessibility of the internal face of the panel, and the shape and configuration of the panel.

Good example

Most of the door mechanisms are fixed directly into its trim, which will facilitate repair and replacement operations.

Poor Example

A door-skin with the curvature inwards makes it difficult to repair and paint.

DOORS (Hinge bolts)

Inspection criteria

Make sure that when hinge bolts are used from inside the bodyshell, access is available using easily removable trim panels.

Reason

The use of door hinge bolts, which must be inserted from inside the bodyshell means that trim has to be removed for access. This causes excessive labour time requirements, if it is necessary to replace a hinge or align the door properly.

Good example

Good accessibility for panel beating operations. The side impact protection bas is mounted by bolts, so it is possible to remove it to facilitate access.

Poor Example

The access to the bolt causes problems in the repair. It is necessary to access from inside bodyshell, increasing the labour time.

DOORS (Centralized multiple electric connector)

Inspection criteria

All electrical wiring should have a centralized multiple connector, which will allow all electrical devices to be disconnected at the same point. This will allow the door to be removed as easily as possible.

Reason

Centralized multiple electric connector. When it is necessary to remove a door, the wiring system must be disconnected completely at the same time.

Good example

A central electrical multi-connector will make it easier to remove the door.

Poor Example

The door does not have a central electrical multi-connector, so it is necessary to remove the door trim and to disconnect the different electrical devices.

1.4.11. REAR CENTRE PANEL

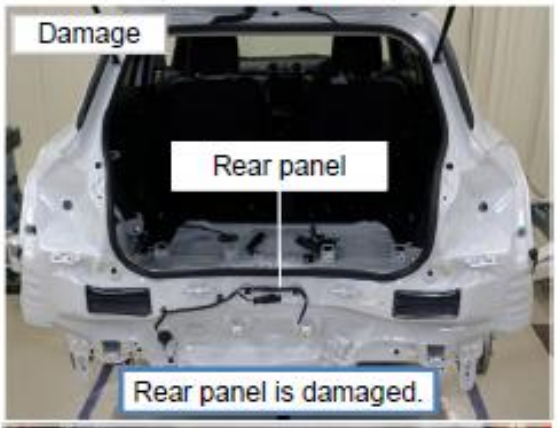
Inspection criteria

The rear panel should be installed at an outermost position more than the rear fender, tail light housing, etc. to facilitate replacement or repair.

Reason

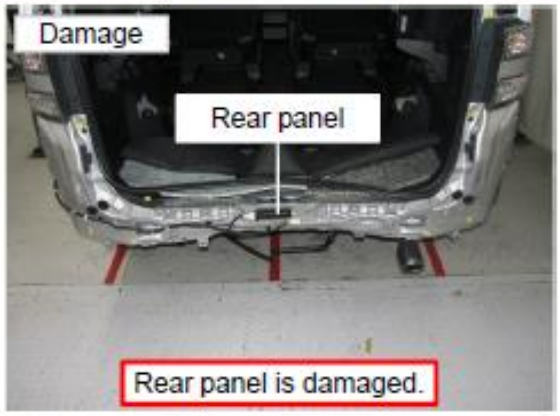
When the rear panel is installed at an outermost position to facilitate replacement or repair, removal or cutting work of the rear fender and other adjacent panels is eliminated, which reduces man-hours and parts cost.

Good Example



The adjacent panels did not have to be removed to replace the rear panel because the rear panel was installed in the outermost positon.

Poor Example



The adjacent panels had to be removed because the rear panel was installed in the inner position.

The left and right adjacent panels were removed so that the rear panel could be replaced.

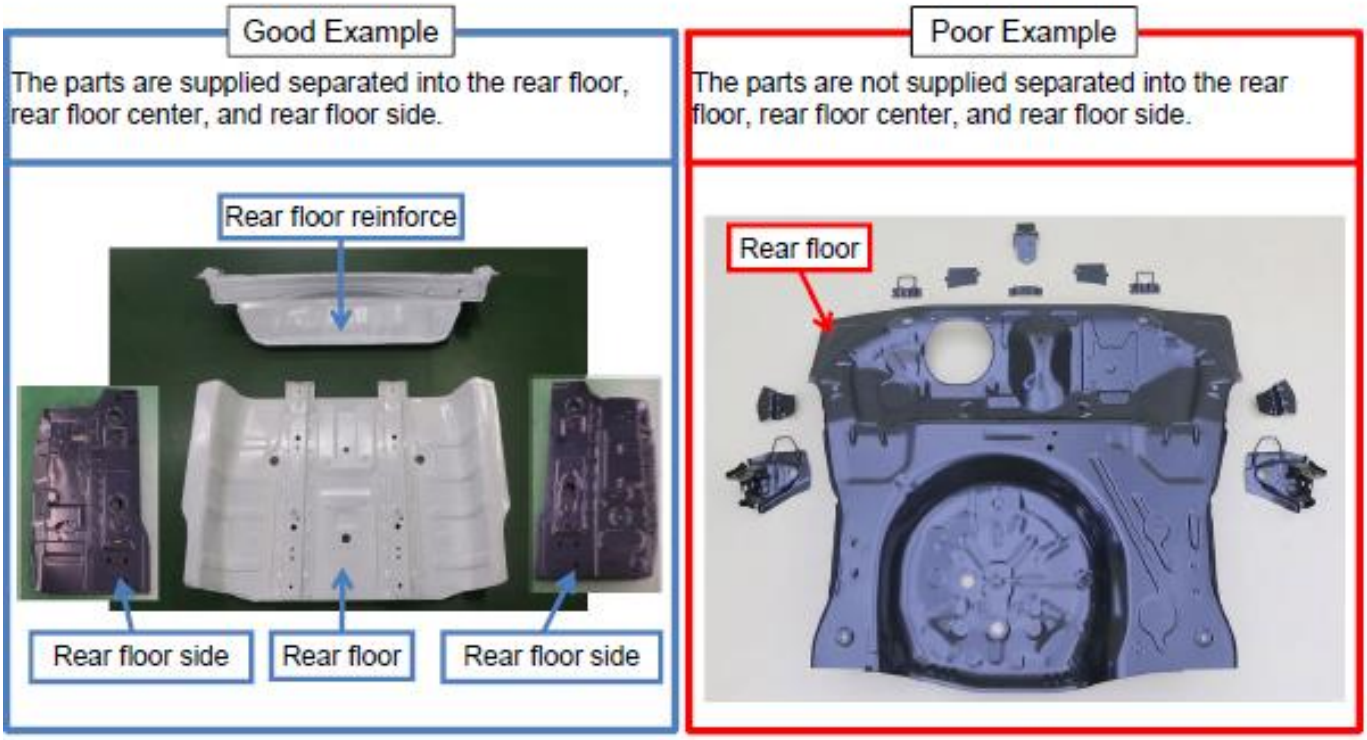
1.4.12. BOOT FLOOR

Inspection criteria

The parts for the rear floor should be supplied separated into the rear floor, rear floor centre, and rear floor side.

Reason

When the parts for the rear floor are supplied separated into the rear floor, rear floor centre, and rear floor side, it can be repaired according to the degree of damage, which reduces the repair cost.



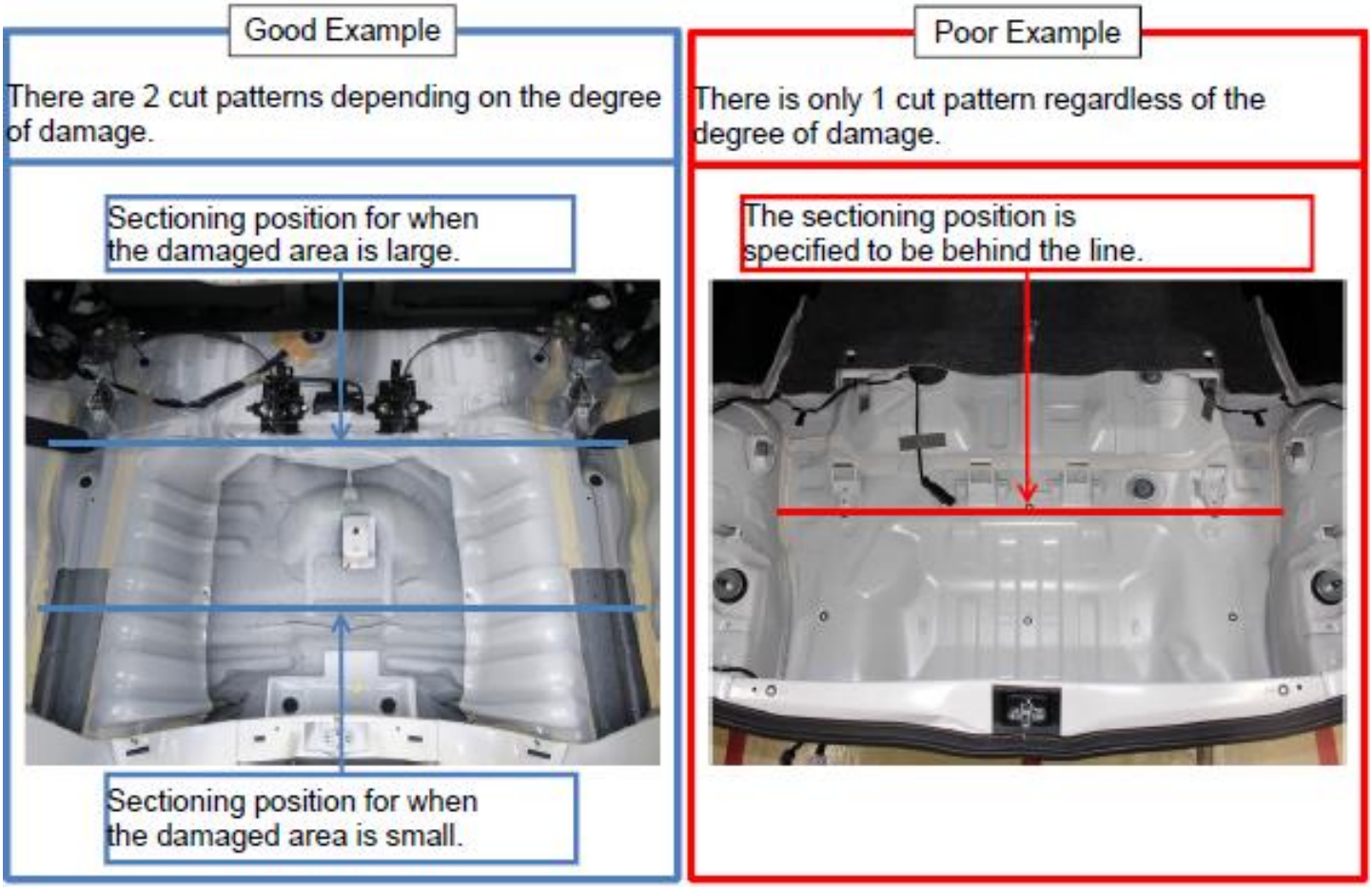
BOOT FLOOR

Inspection criteria

Sectioning at a desired position on the rear floor should be possible.

Reason

When sectioning of only the damaged area of the rear floor is possible, the replacement work range is smaller and man-hours for the replacement work is reduced.



1.4.13. REAR CHASSIS LEG

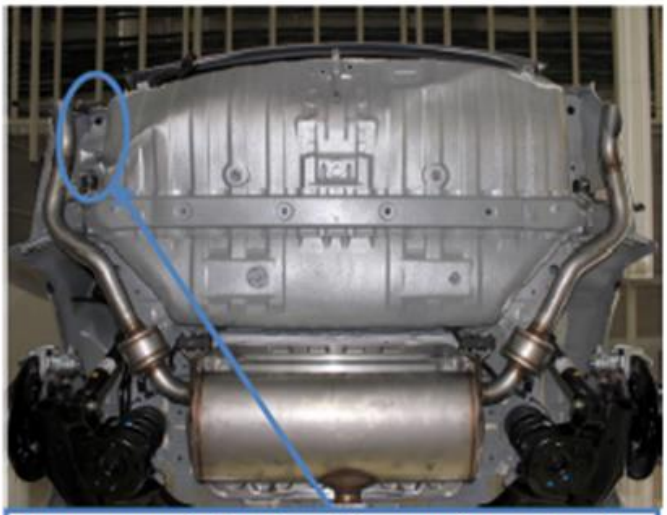
Inspection criteria

The rear side member extension should be installed, and damage should end at the rear side member extension.

Reason

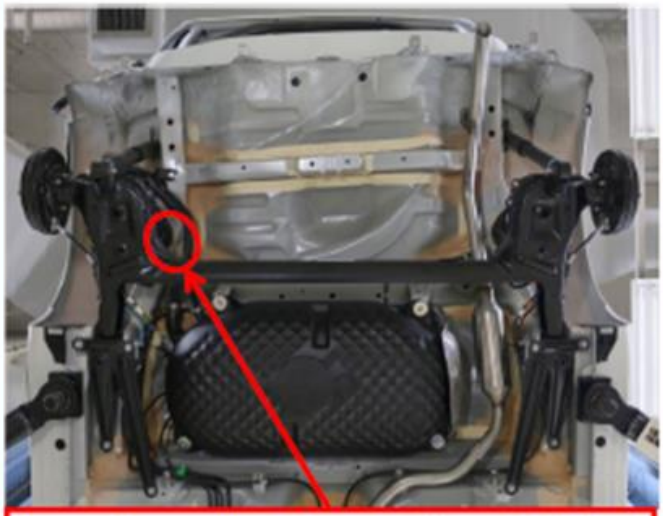
When the rear side member extension is installed and the damage ends at this part, it is not necessary to replace the rear side member assembly, which reduces man-hours and parts cost.

Good Example



Damage ended at the side member extension.

Poor Example



Rear side member extension was installed, but the damage spread to the side member.

REAR CHASSIS LEG

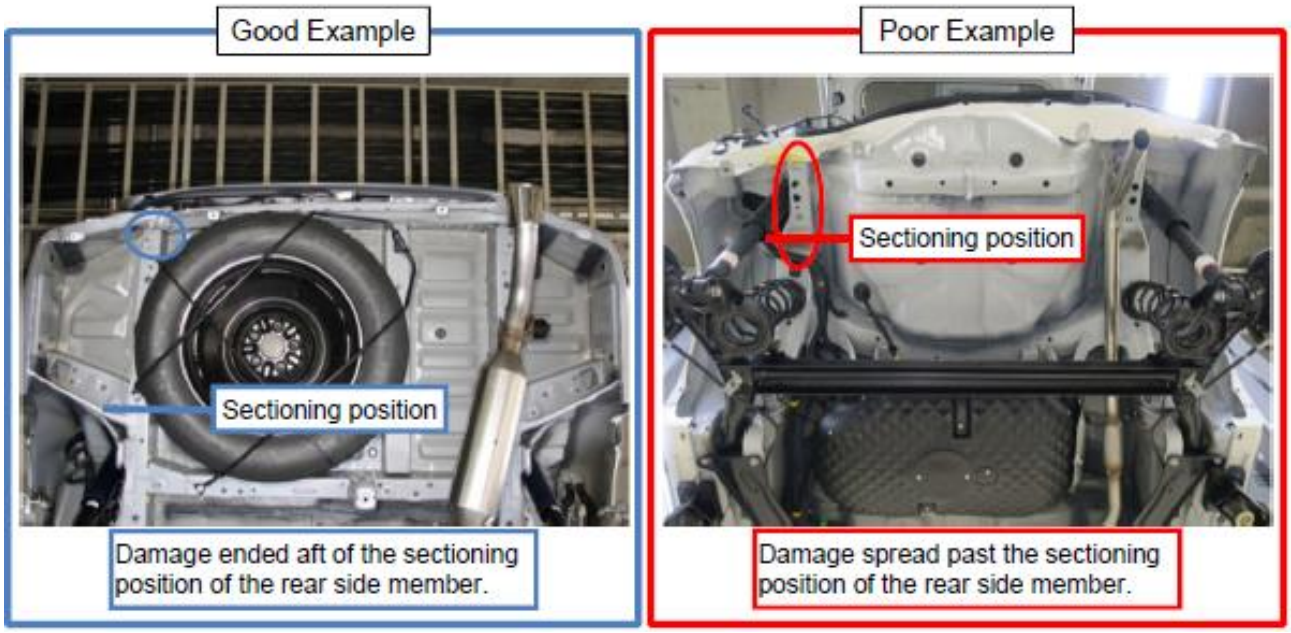
Inspection criteria

If the rear side member extension is not installed, a structure should be used that allows the damage to end aft of the sectioning position of the rear side member.

Reason

When the structure allows the damage to end aft of the sectioning position of the rear side member, it is not necessary to replace the rear side member assembly, which reduces man-hours and parts cost.

Example of a structure that allows damage to end aft of the sectioning position of the rear side member.



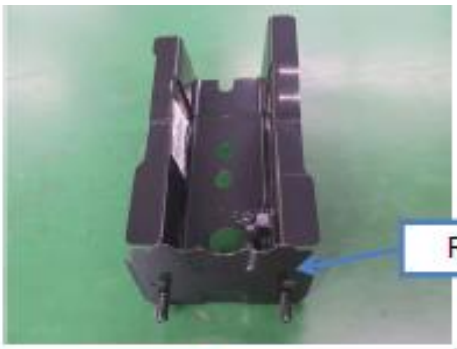
REAR CHASSIS LEG

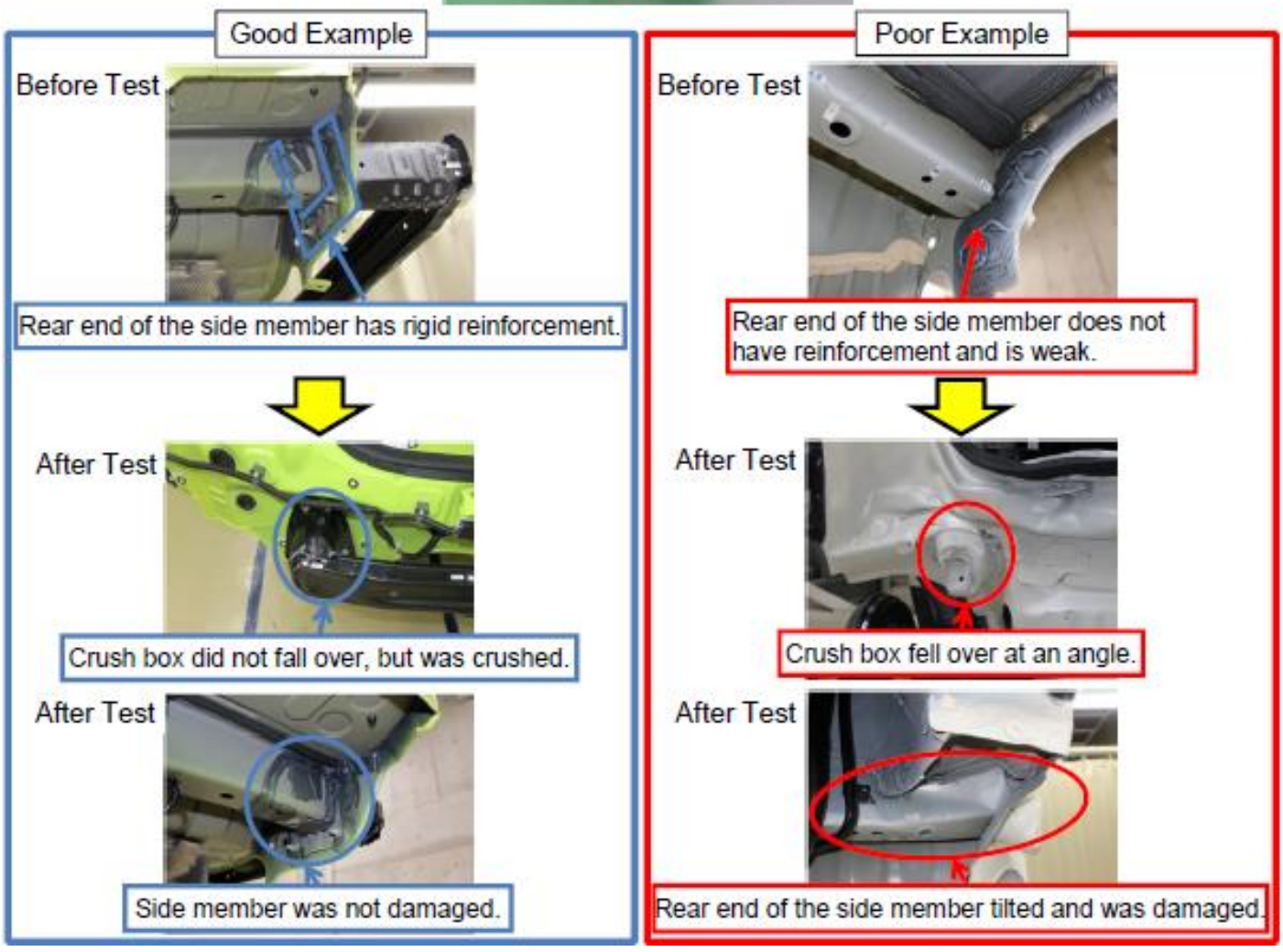
Inspection criteria

The rear side member end should be reinforced to prevent the crush box from falling over in an oblique collision.

Reason

When the rear crush box mounting surface at the side member end is strong, the crush box delivers its expected performance even in an oblique collision and damage to the side member end is less likely to occur.





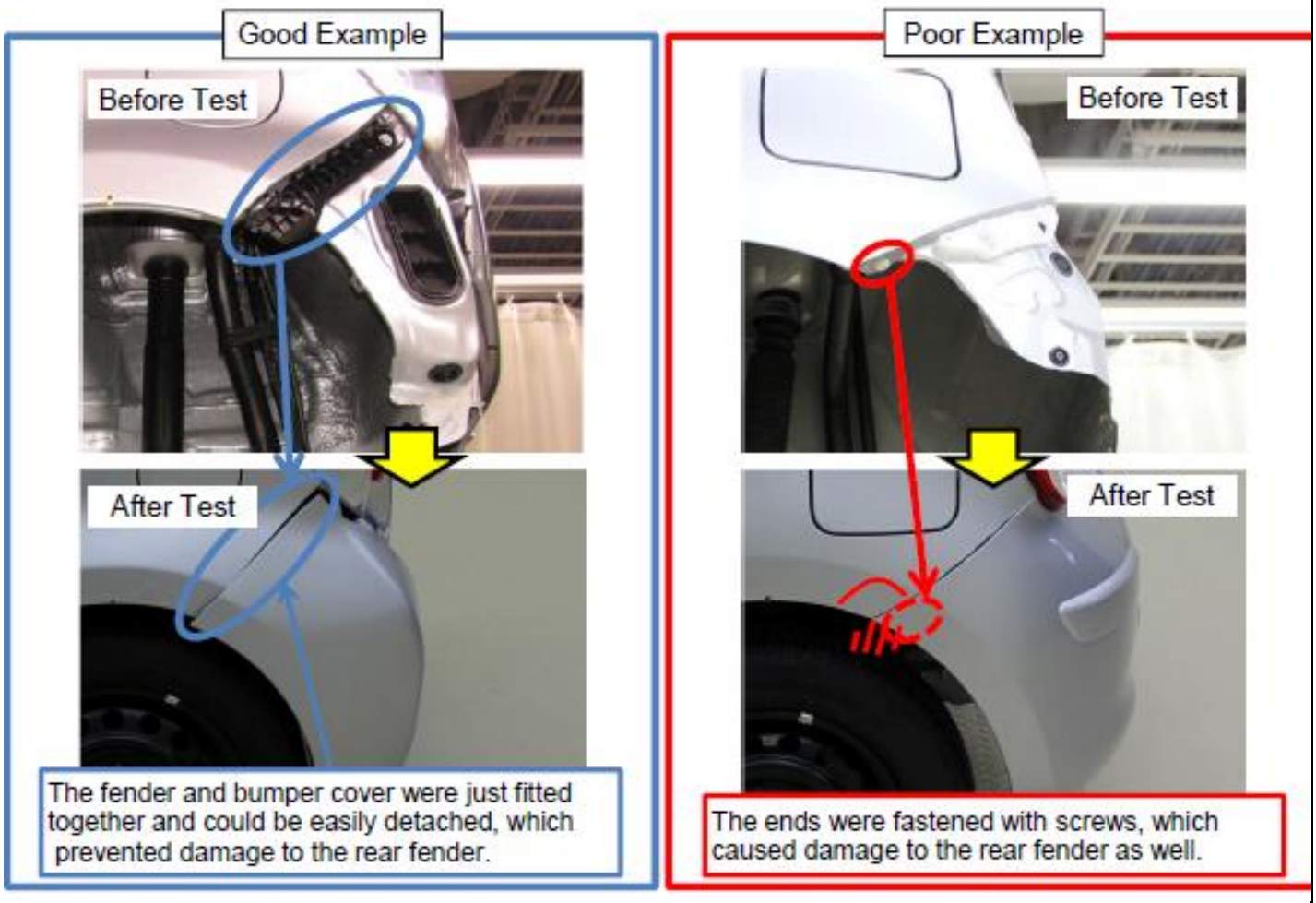
1.4.14. REAR BUMPER COVER

Inspection criteria

The rear bumper cover mount should be easily detached in a collision to prevent damage from spreading to the rear fender and other expensive peripheral parts.

Reason

If the rear bumper cover mount is easily detached to prevent damage from spreading to the rear fender and other expensive peripheral parts in a collision, damage is less likely spread to the rear fender and other expensive peripheral parts.



1.4.15. REAR BUMPER REINFORCEMENT

The rear bumper reinforcement is an element designed to reduce damages in rear crashes.

Inspection criteria

The material and the design of this part are very important to produce a good deformation in low-speed collisions.

Reason

Rear bumper reinforcement protects body panel and the structure of vehicle. There are some important characteristics, like material and design of the rear bumper reinforcement, that have an important influence in the behavior of this part in rear crashes. In addition, it is important that this part have an easy replacement using bolts, to reduce time of operation.
The experience in RCAR rear crash-tests, shows that the rear bumper reinforcement has an important influence to reduce damages in the structure of the car. Additionally, repair costs reduce up to 61%, because there it prevents damages on panels like:

- Rear bumper
- Rear chassis leg
- Rear body panel
- Rear boot floor
- Taillight

Example 1 - Good example

Element	Rear bumper reinforcement with rear crush cans.
Material	Metallic
Results	Good results
Structural Damages	There aren't damages on the rear body panel
Damageability	A good length of rear crush cans and clearance between bumper reinforcement and surrounding parts
Repairability	The barrier has bolts to easily replacement.

Deformation in bumper reinforcement

Deformation in rear crush cans

Note: The design and the material of the bumper reinforcement produces a good deformation that absorbs the energy of the crash.

Example 2 - Good example

Element	Rear bumper reinforcement with rear crush cans, and plastic elements
Material	Metallic and plastic
Results	Good results
Structural Damages	There aren't damages on the rear body panel
Damageability	A good length of the rear crush cans and clearance between bumper and surrounding parts
Repairability	The barrier has bolts to easily replacement

Deformation in bumper reinforcement

Deformation in rear crush cans

Note: The design and the material of the bumper reinforcement produces a good deformation that absorbs the energy of the crash.

Example 3 - Poor example

Element	Rear bumper reinforcement with rear crash cans.
Material	Reinforcement has compound by plastic and fiber material
Results	Poor results
Structural Damages	Severe damages on rear panel, rear chassis leg side left and boot floor
Damageability	The reinforcement was broke up
Repairability	The reinforcement has bolts to easily replacement

Damages on the body structure

Rear bumper reinforcement

The bumper reinforcement was broken

Note: The reinforcement was broken, therefore the element do not deform and the energy of the crash is transmitted to the body structure.

Example 4 - Poor example

Element	Only polystyrene without reinforcement
Material	Polystyrene
Results	Poor results
Structural Damages	Several damages on rear body panel, rear chassis leg, side left and boot floor, these parts were replaced. The rear panel was repaired.
Damageability	N/A
Repairability	The polystyrene is mounted on the rear panel.

Damages on the rear panel

Only polystyrene mounted on the rear panel

Repair side panel

Replace rear panel

Note: The vehicle only have polystyrene on the rear panel. Therefore, the protection to the rear body panel and the structure of the car is very poor.

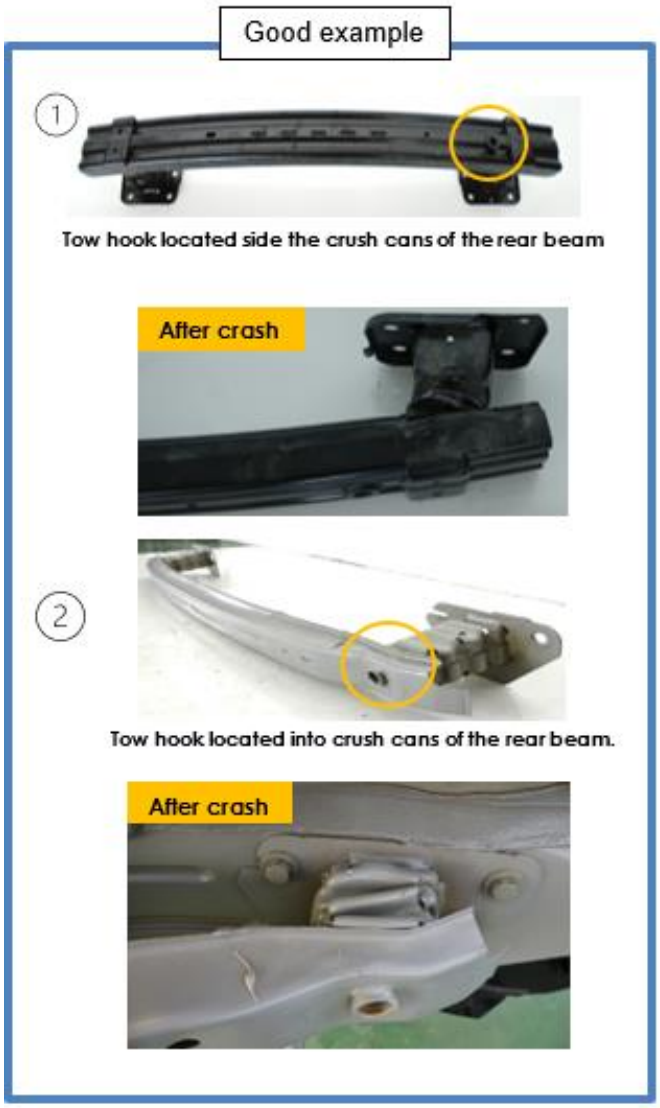
1.4.16. LOCATION OF REAR TOW HOOK

Inspection criteria

Location and fixing type of towing hook in the rear side is important to the repairability. Sometimes tow hook are install on the rear bumper beam or into the chassis legs, that situation can increase damages in rear part as rear panel, boot floor and rear chassis legs after a crash.

Reason

The towing hook support is an element which, due to the function it performs, should have a certain value of rigidity, and must be fixed to elements that supports the load. However, if this element is placed on the same direction on the chassis legs or over rear panel, could be a rigid element and not absorb energy in the collision, that situation could increase damages in rear panels, boot floor and rear chassis legs.



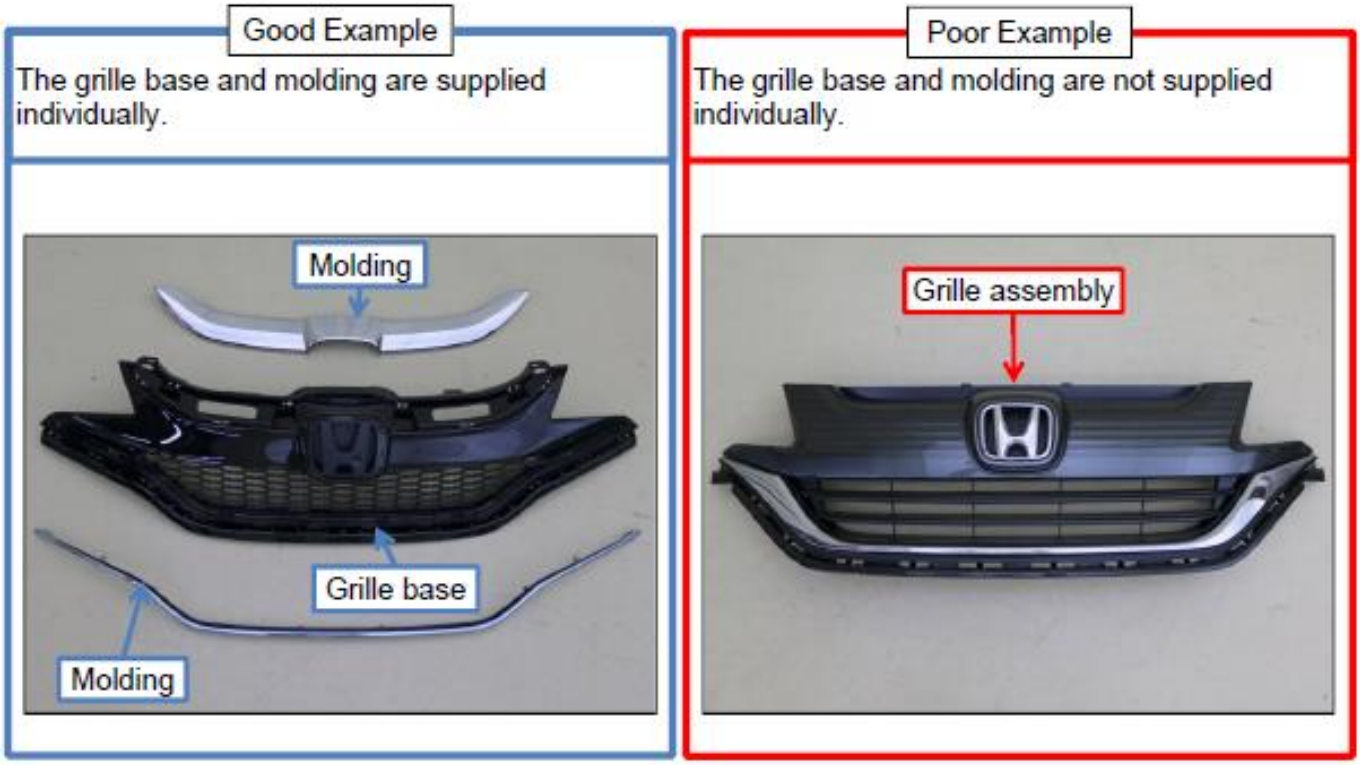
1.4.17. RADIATOR GRILLE

Inspection criteria

The molding and other parts that are installed on the radiator grille as separate parts should be supplied individually.

Reason

When the radiator grille consists of a molding and radiator grille base and the molding and grille base are supplied individually, if either part is damaged, only the damaged part needs to be replaced, which reduces the repair cost.



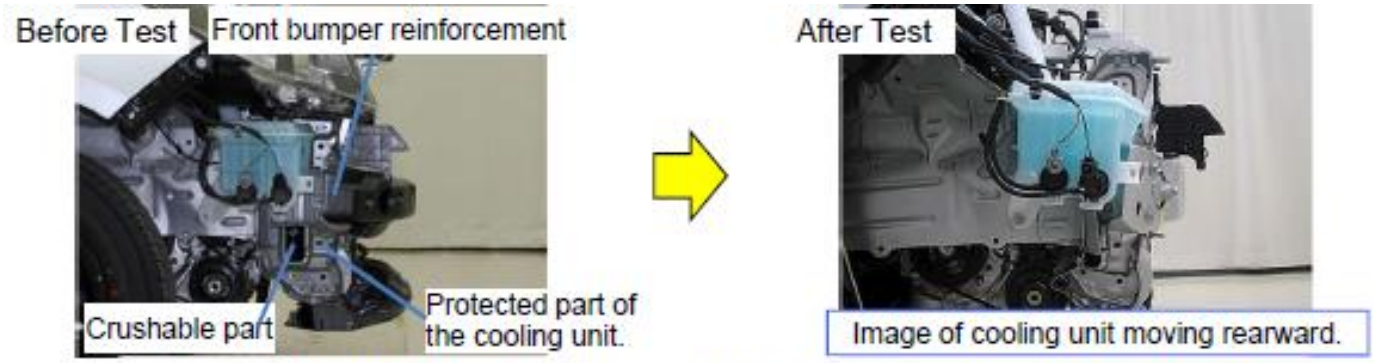
1.4.18. RADIATOR SUPPORT

Inspection criteria

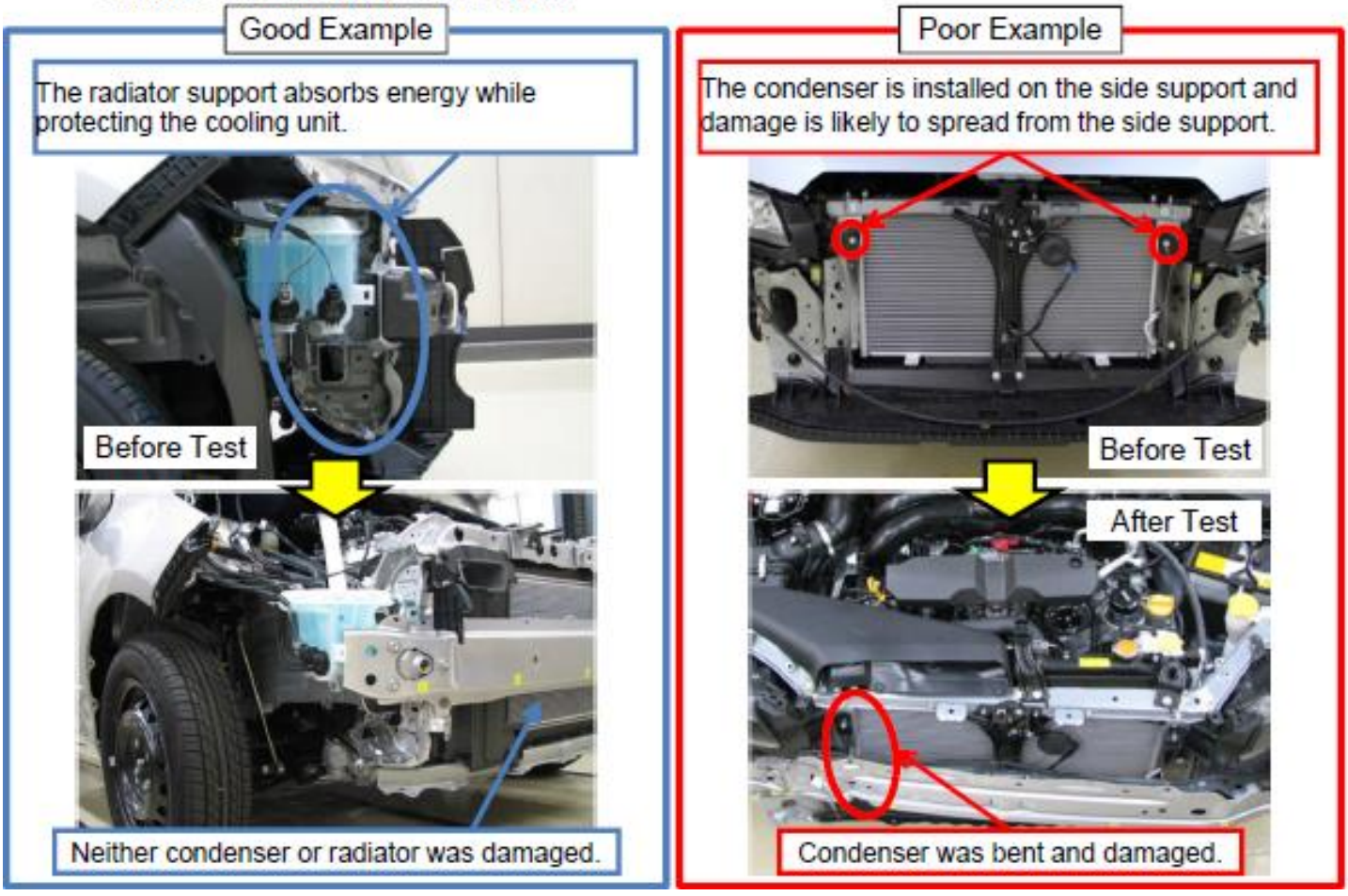
The radiator support should allow the condenser and radiator to slide rearward together when a force is applied.

Reason

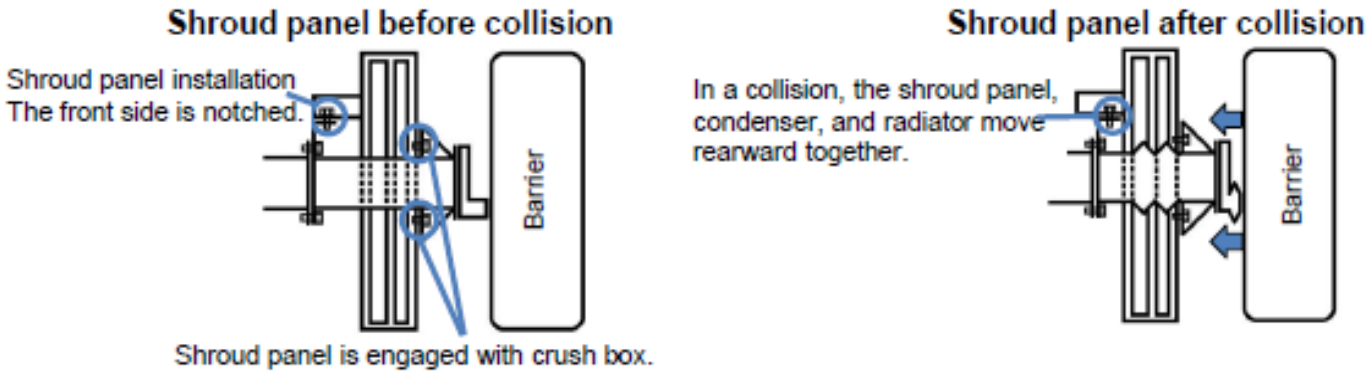
When the radiator support allows the condenser and radiator to slide rearward together with the radiator support, damage to the condenser and radiator is less likely to occur.



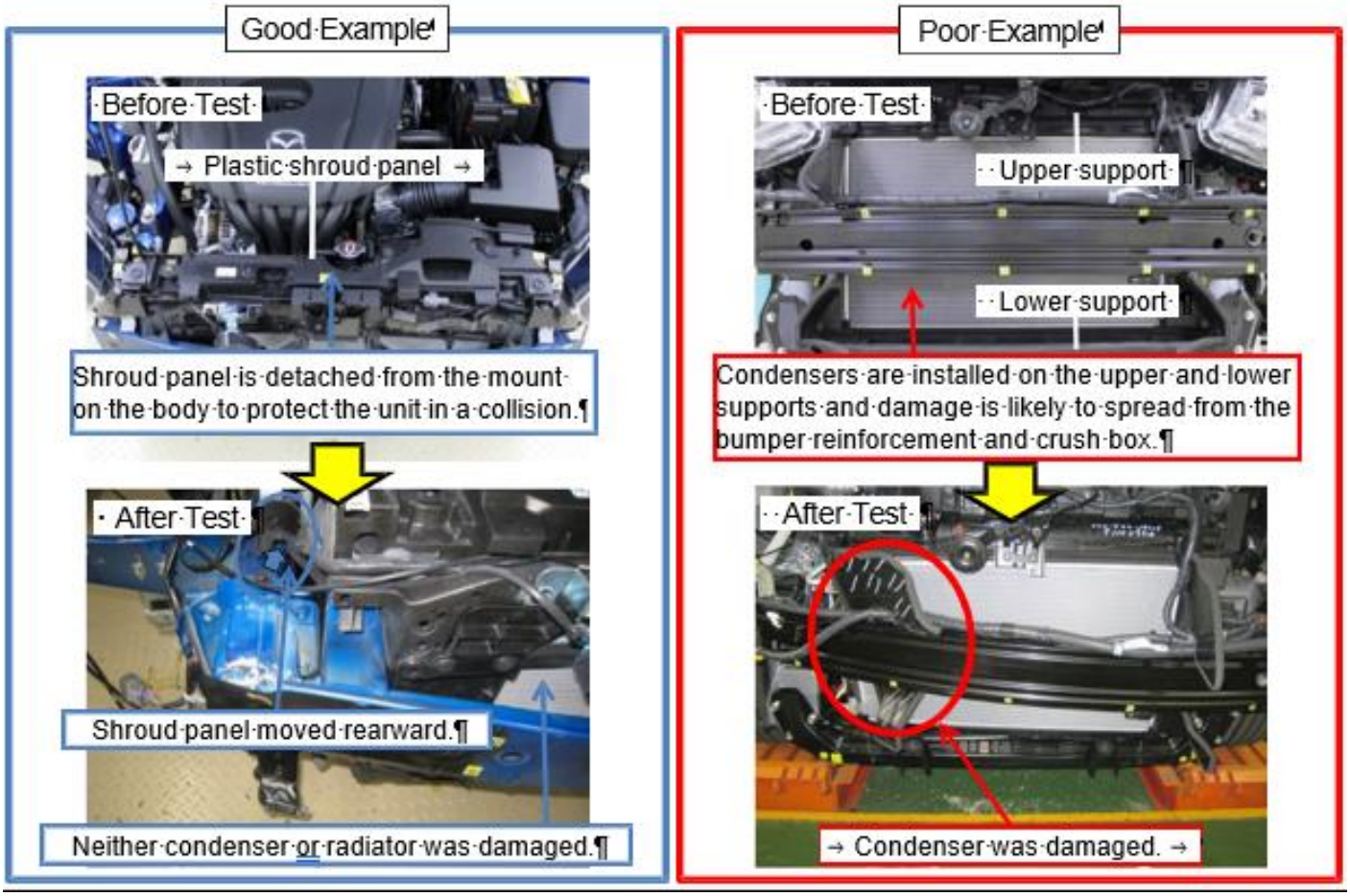
Example of a structure that allows the side, upper, and lower radiator supports to crush together with the bumper reinforcement while efficiently absorbing collision energy and move the cooler condenser and radiator rearward to minimize deformation.



RADIATOR SUPPORT



Example of a structure where the condenser and radiator slide rearward together with the shroud panel that moves rearward when the crush box crushes in a collision.



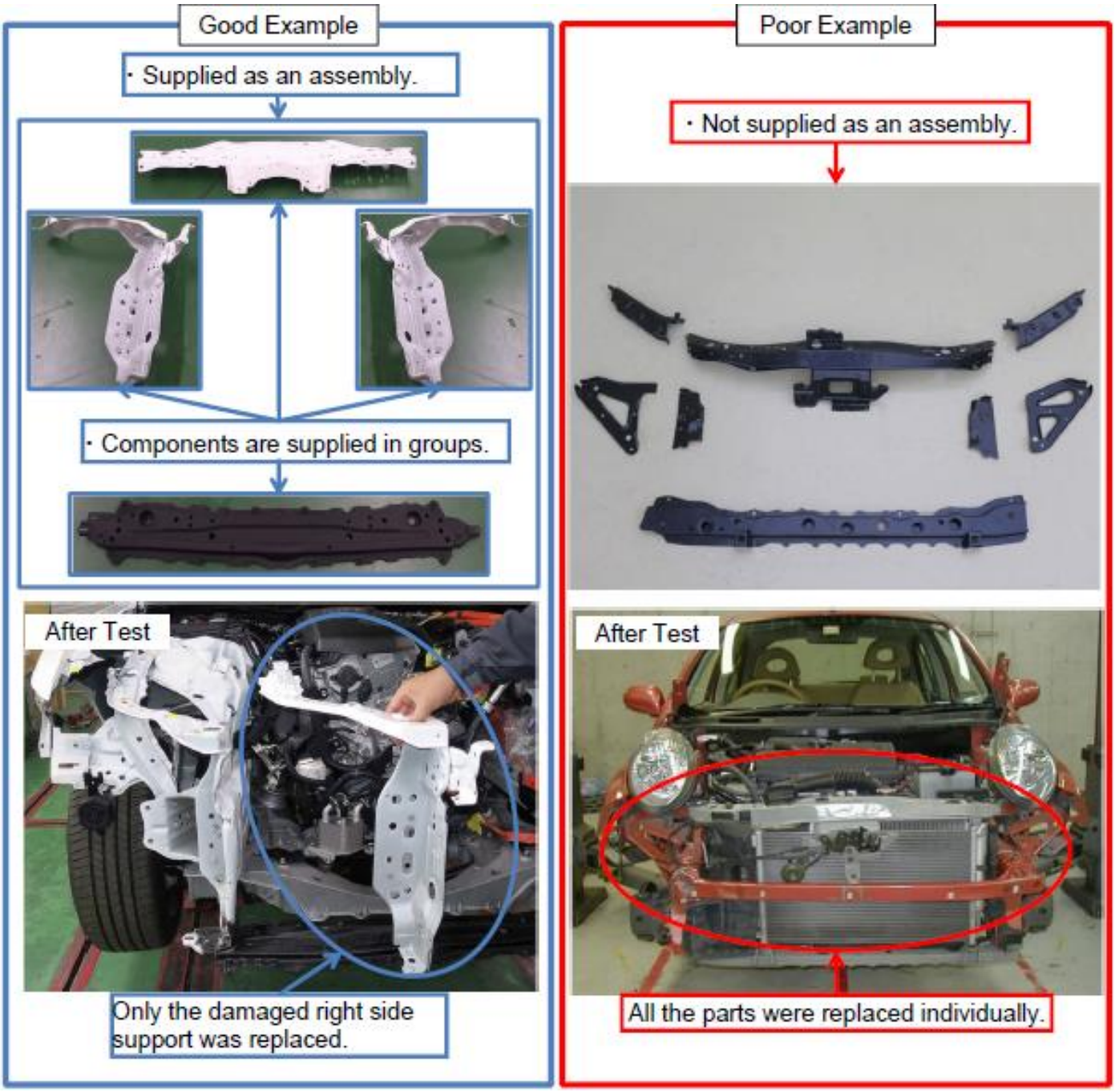
RADIATOR SUPPORT

Inspection criteria

The radiator support should be replaceable as an assembly, sub-assembly, or individually according to the degree of damage.

Reason

When the radiator support is supplied as an assembly, sub-assembly, or individually, it can be replaced according to the degree of damage, which reduces the repair cost.



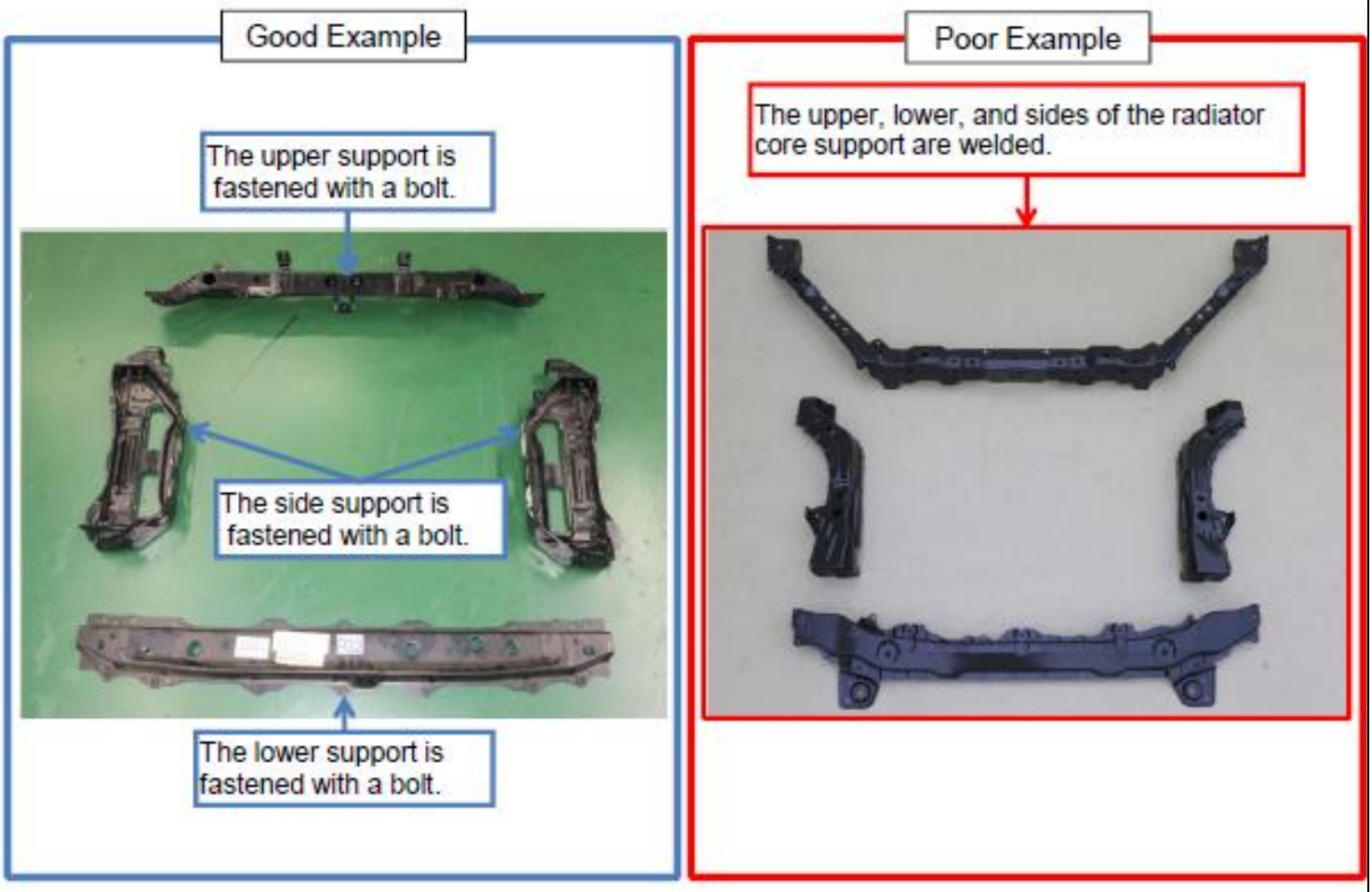
RADIATOR SUPPORT

Inspection criteria

The upper and lower radiator supports should be fastened with bolts.

Reason

Because the radiator supports are not welded, they can be removed easily if damaged, which reduces man hours. Also, the condenser and radiator can be removed by removing the upper or lower radiator support.



1.4.19. HOOD (BONNET) LOCK

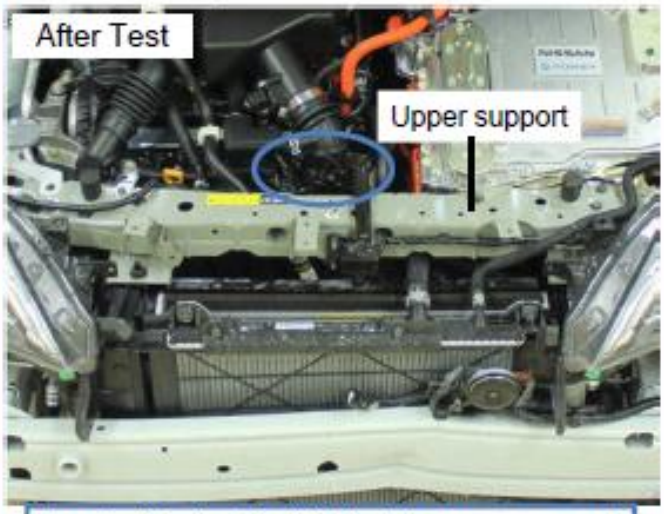
Inspection criteria

The hood lock should have a structure that helps prevent damage from spreading to the hood via the lock in a collision.

Reason

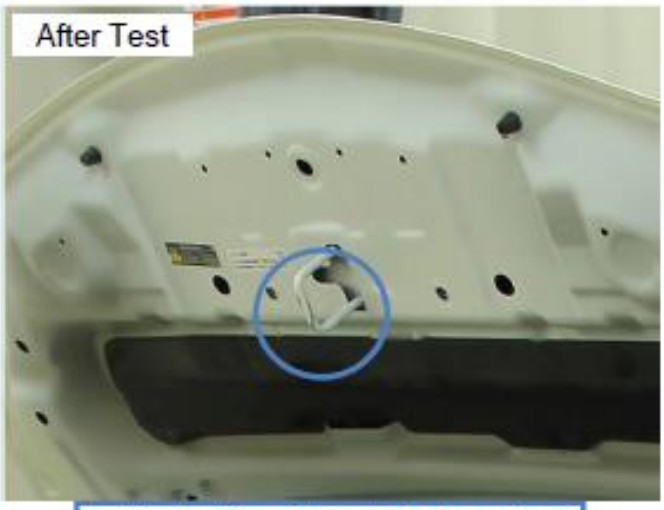
When the hood lock is located on the rear side of the radiator upper support and has a structure that helps prevent damage from spreading to the hood striker via the hood lock, damage is less likely to spread to the hood.

Good Example



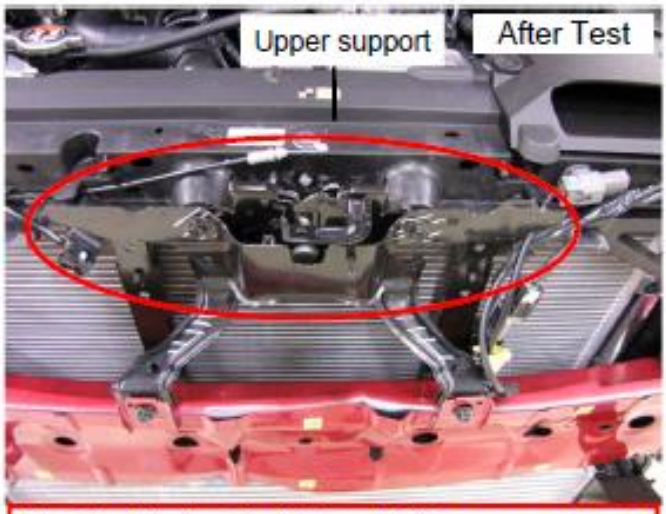
Hood lock is installed behind the upper support.

Hood was not damaged.



Hood striker is located further aft.

Poor Example



Hood lock is installed in front of the upper support.

Hood was damaged via the hood lock.

Hood striker is located on the front portion of the hood and the front to rear length of the striker is shorter than the distance the hood lock slides

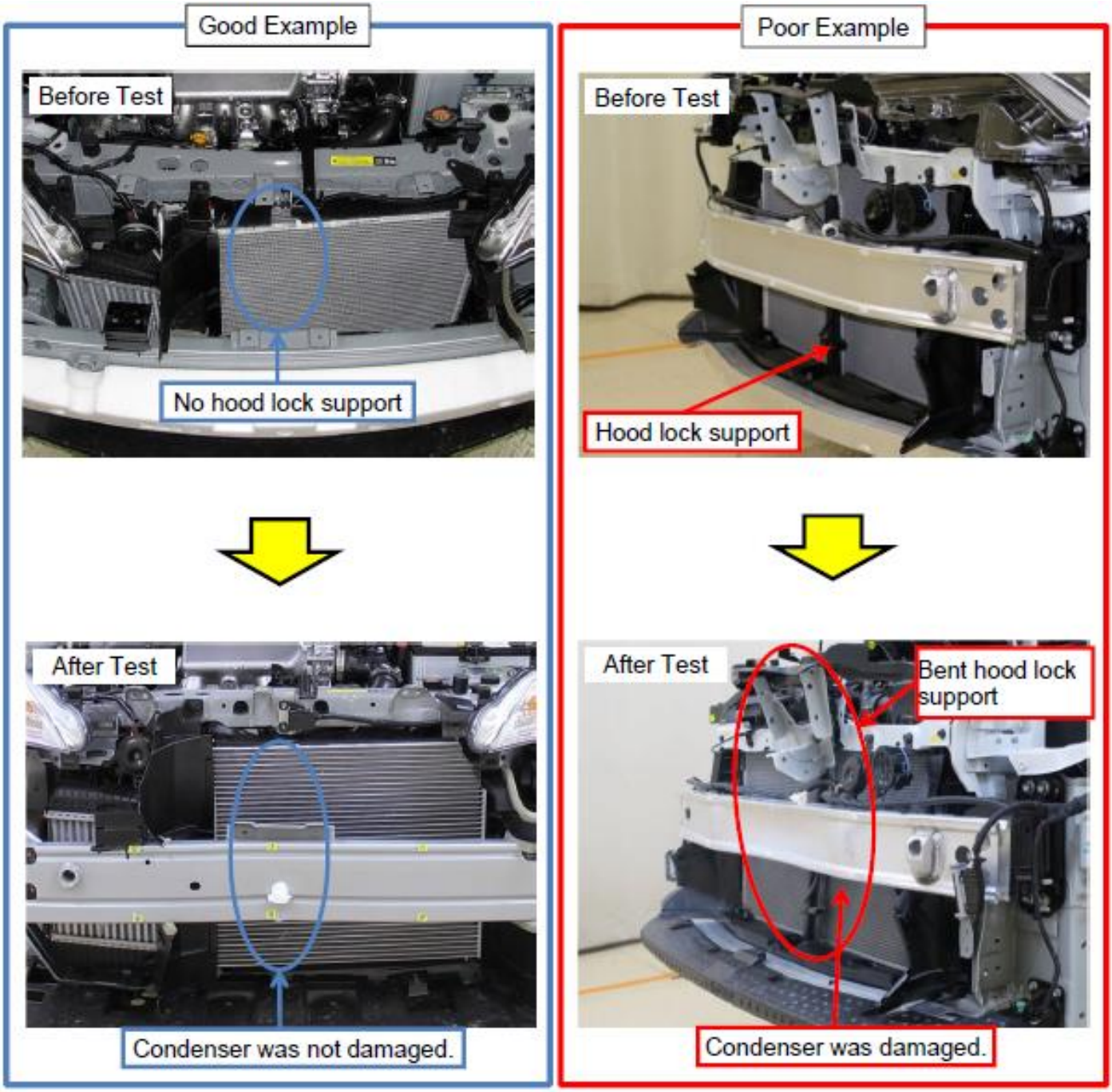
1.4.20. HOOD (BONNET) LOCK SUPPORT

Inspection criteria

A hood lock support should not be used as it can damage peripheral parts in a collision.

Reason

When a hood lock support is not used, damage to the hood, radiator upper support, condenser, radiator, etc. due to the hood lock support moving rearward is less likely to occur in a collision.



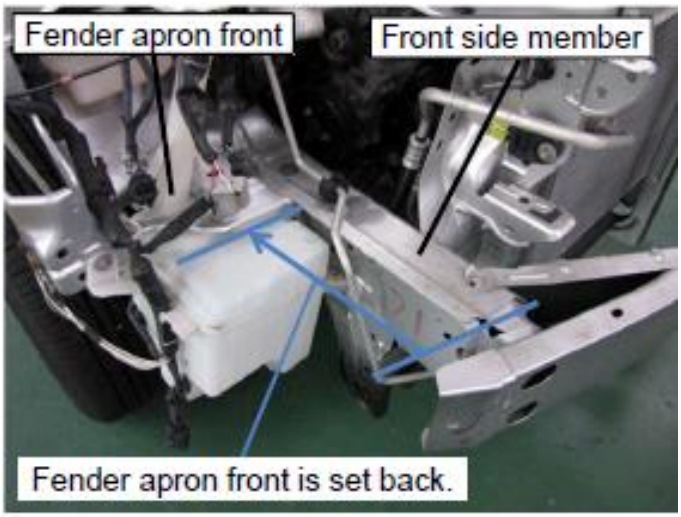
1.4.21. FRONT FENDER APRON

Inspection criteria

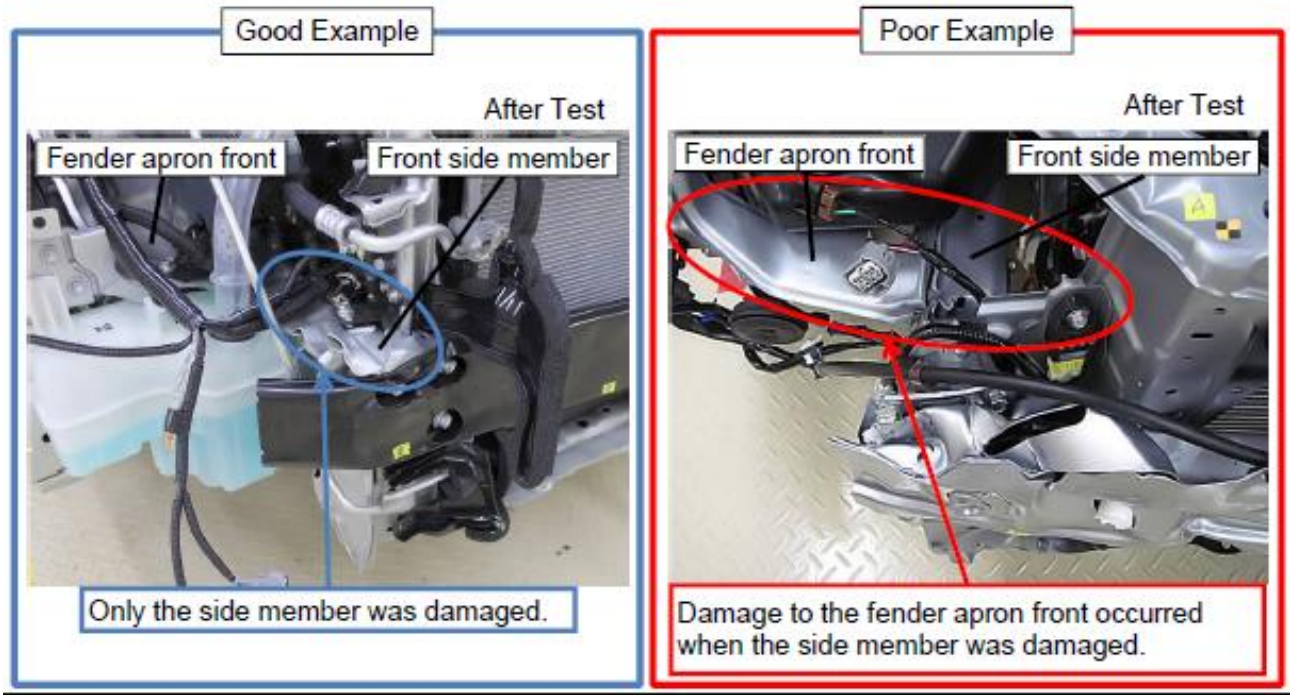
The front fender apron should be set back from the side member

Reason

When the front fender apron is set back from the side member, damage to the front fender apron is less likely to occur when the side member is damaged.



Example of a structure where the fender apron front is set back from the side member.



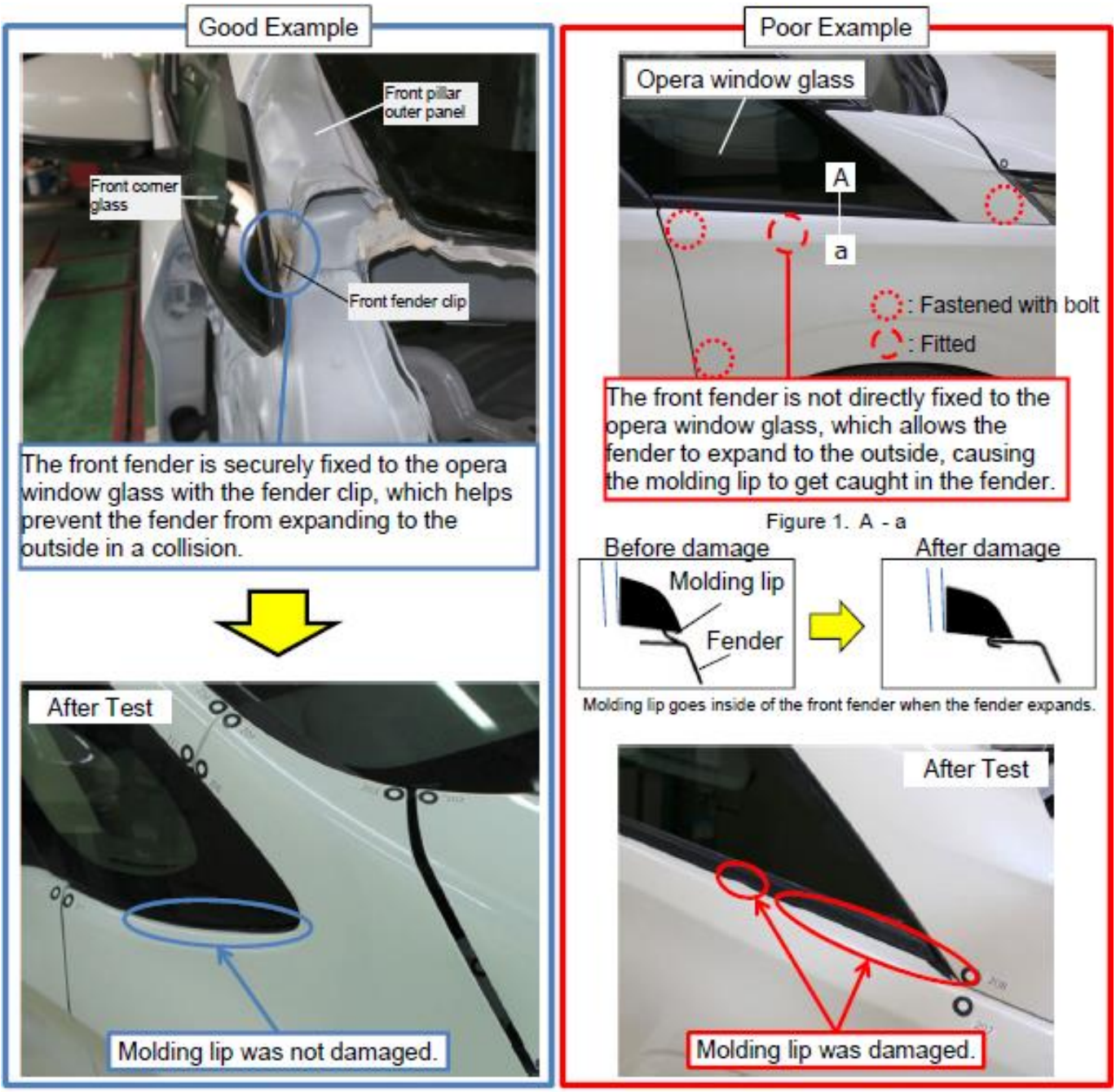
1.4.22. OPERA WINDOW GLASS (FRONT VENT GLASS)

Inspection criteria

The fender should not expand to the outside so that the opera window glass molding does not get caught and damaged by the front fender in a collision.

Reason

When the fender does not expand to the outside in a collision, the opera window glass molding does not go inside of the front fender, which helps prevent damage to the opera window glass.



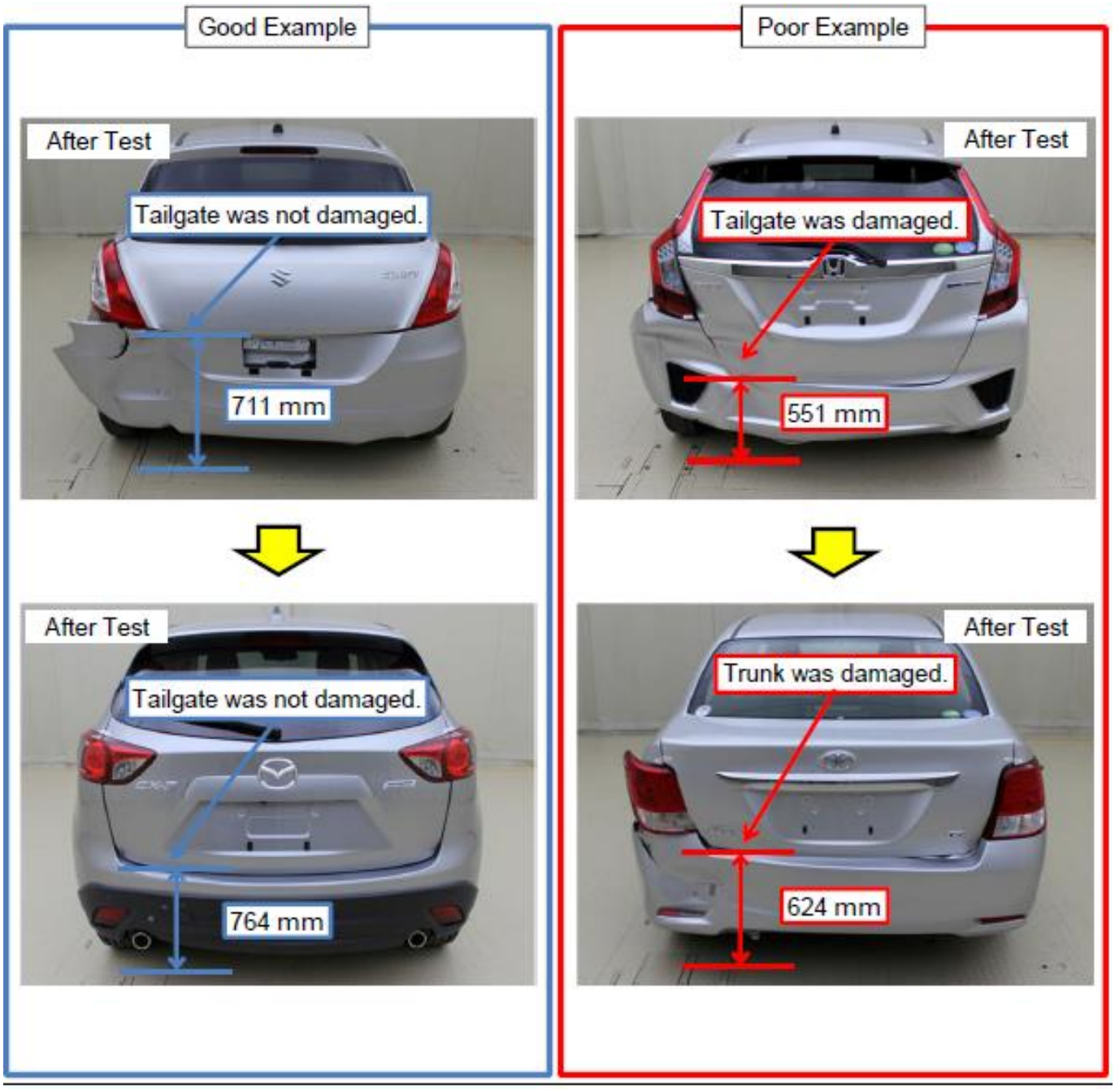
1.4.23. TAILGATE/TRUNK

Inspection criteria

The bottom end of the tailgate (or trunk) should be higher than the barrier (705 mm).

Reason

When the bottom end of the tailgate (or trunk) is higher than 705 mm, damage to the tailgate (trunk) is less likely to occur.



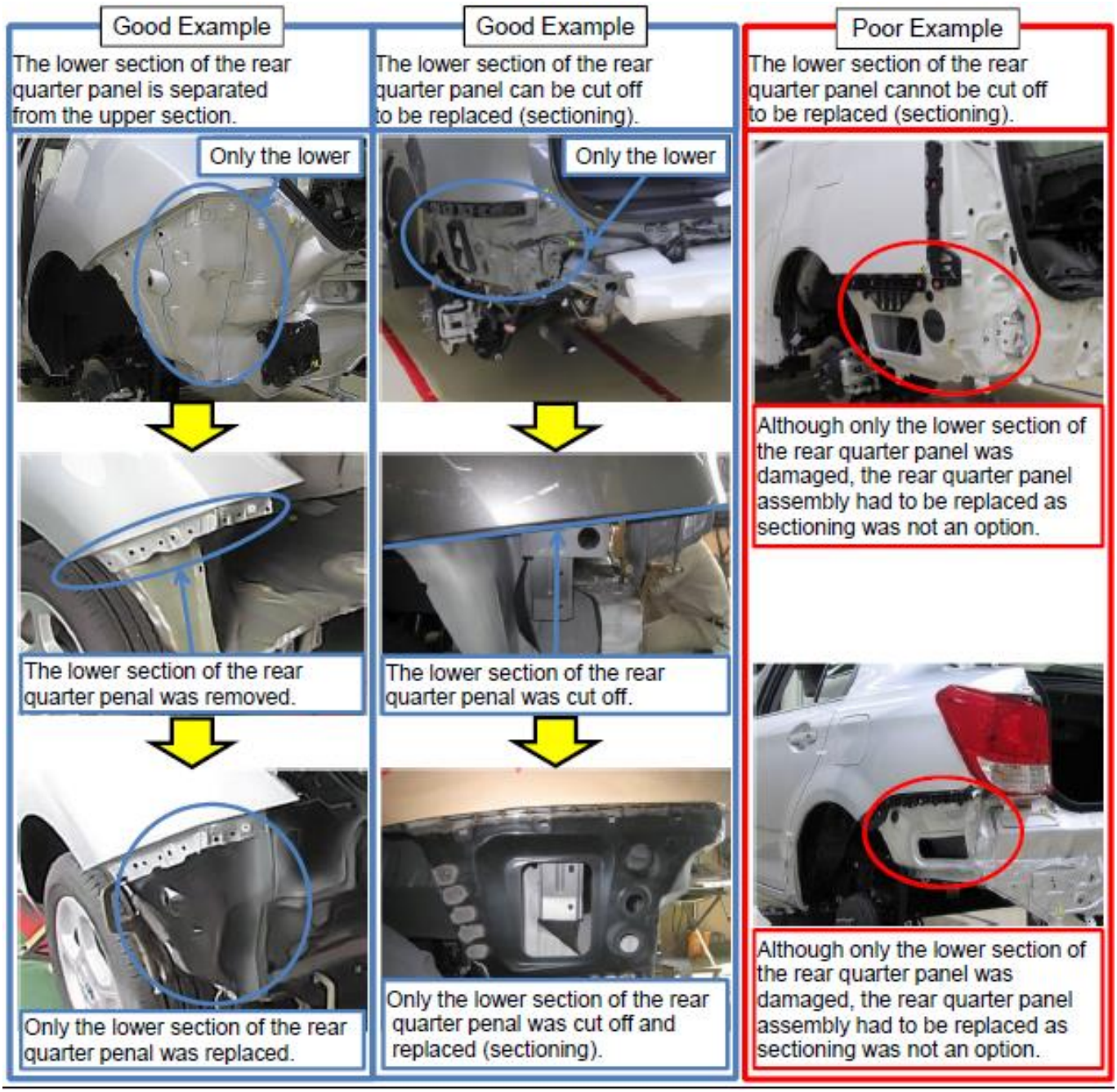
1.4.24. REAR QUARTER PANEL

Inspection criteria

The rear quarter panel should be divided into upper and lower sections, or the lower section can be cut off to be replaced (sectioning).

Reason

When the rear quarter panel is divided into upper and lower sections or the lower section can be cut off to be replaced, if the lower section is damaged, the rear quarter panel assembly need not to be replaced, which reduces the repair cost.



REAR QUARTER PANEL

Inspection criteria

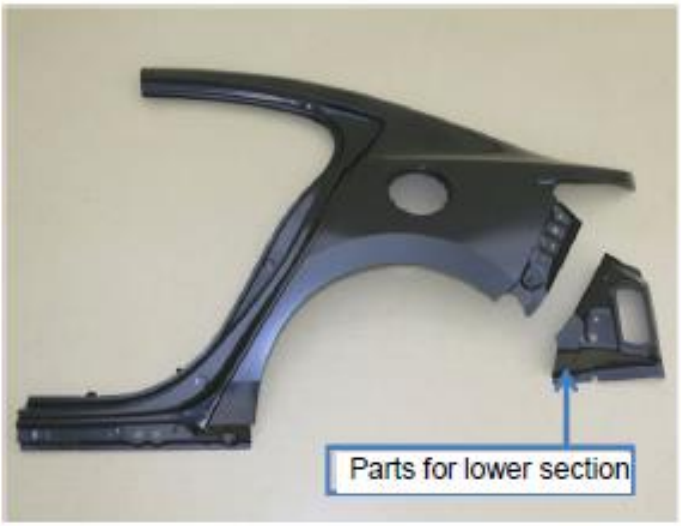
The lower section of the rear quarter panel should be supplied individually.

Reason

When the lower section of the rear quarter panel is supplied individually, it is not necessary to perform sectioning using a rear quarter assembly or remove individual parts from a rear quarter panel assembly, which reduces the parts cost.

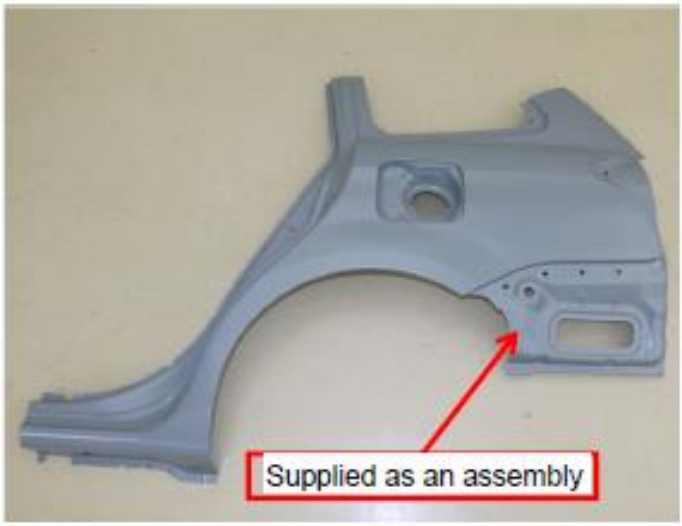
Good Example

The lower section of the rear quarter panel is an supplied individually.



Poor Example

The rear quarter panel is supplied only as assembly.



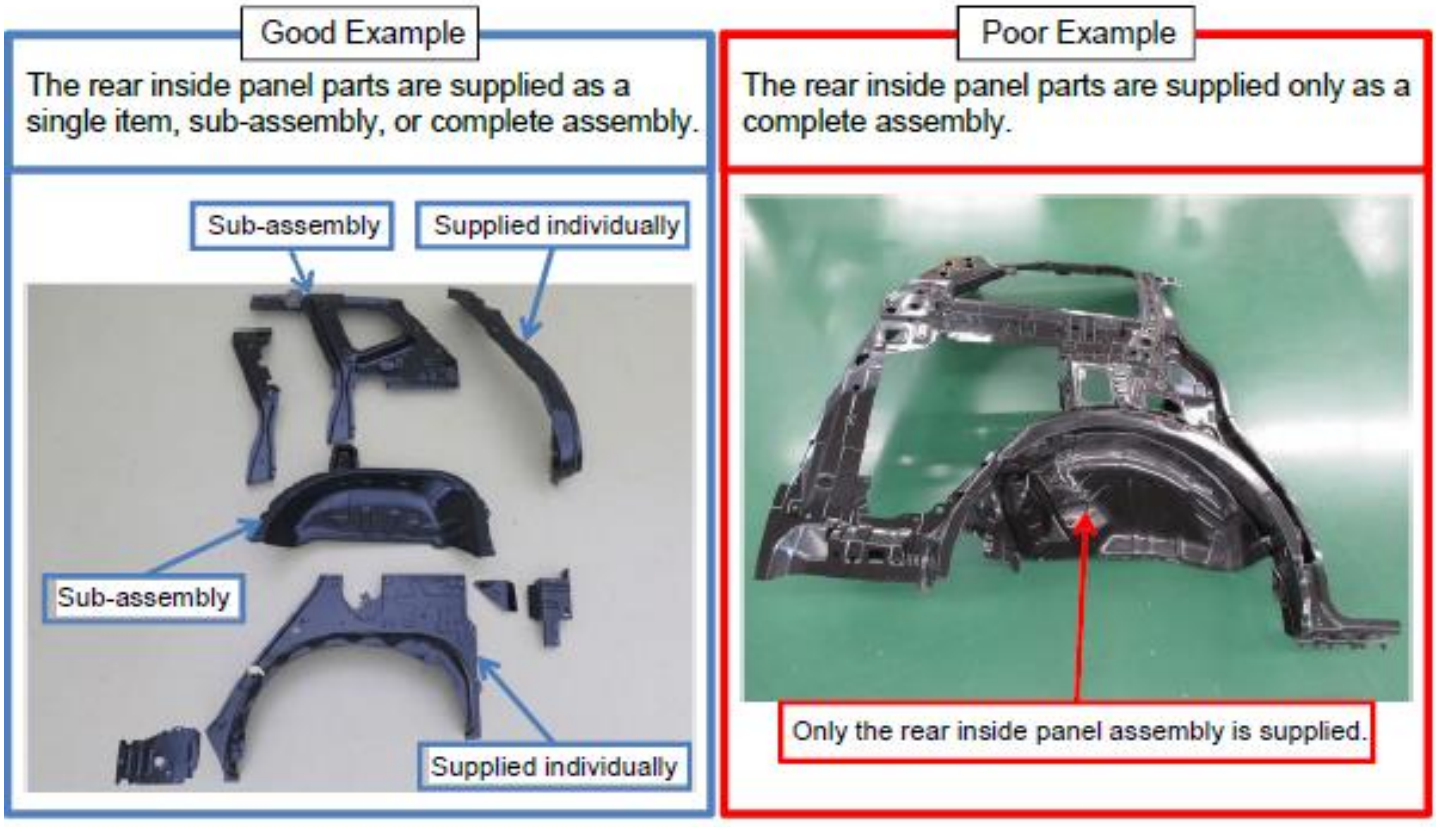
1.4.25. REAR INSIDE PANEL

Inspection criteria

The rear inside panel should be supplied as a sub-assembly or individually so that it can be replaced according to the degree of damage.

Reason

When the service parts for the rear inside panel are supplied as a sub-assembly or individually so that it can be replaced according to the degree of damage, only part of the panel needs to be replaced and it is not necessary to take the necessary parts from the assembly, which reduces man-hours and parts cost.



1.5. SENSORS, RADARS, AND CAMERAS

Advanced driving assistance systems (ADAS) are systems that improve safety levels for both vehicle occupants and other road users. Some can take control of the vehicle in certain circumstances to avoid an accident or minimize its consequences.

In a dangerous situation, these systems can react in just tenths of a second, while a person, under normal conditions, may take between 1 and 2 seconds to act using the vehicle's controls.

ADAS (advanced driver-assistance systems) make use of built-in sensors to detect and calculate the surrounding environment, the technologies behind ADAS and take a deep dive into the three types of commonly used sensors: camera, radar, and LiDAR.

1.5.1. PARKING SENSOR (DAMAGE AS A RESULT OF HIS POSITIONS ON THE BUMPER)

Inspection criteria

The parking sensor should be installed in a position where it cannot be easily damaged.

Reason

The parking sensors should be mounted on mouldings and removable grilles independent from the bumpers and should be placed in a rearmost position than the outside of the vehicle to minimize possible damage due to a direct hit on them.
In a front or rear crash, it should not be damaged. In the most adverse case, only their support should be replaced.

REAR BUMPER

Good example

Parking sensors installed in parts independent of the bumper and in a rearmost position than outer surface of the bumper. That increases de difficulty of being damaged in impacts of the bumper.

After test

Poor Example

Parking sensors installed on the surface of the rear bumper and in an area very exposed to direct impacts.

After test

PARKING SENSOR
(DAMAGE AS A RESULT OF HIS POSITIONS ON THE BUMPER)

FRONT BUMPER

Good example

Parking sensors installed on supports independent from the bumper and in a rearmost position from the outer surface of the bumper will have no damage in impacts on these areas.

After test

Poor Example

Parking sensors installed on the surface of the bumper are highly exposed to be damaged in impacts to the bumper.

After test

PARKING SENSOR

Inspection criteria

The parking sensors should be “Plug and play”.

Reason

If parking sensors need calibration after replacement repair costs increases.

1.5.2. CAMERAS IN THE REPLACEMENT OF WINDSHIELDS

Inspection criteria

The camera should be installed in a position where it does not interfere with a windshield replacement.

Reason

To avoid potential ADAS system issues, the front view camera should be mounted in such a way that its removal and installation is not required when performing a windshield replacement. Additionally, post windshield installation calibrations, if needed, should be minimum.

FRONT VIEW CAMERA

1.5.3. RADAR SENSOR

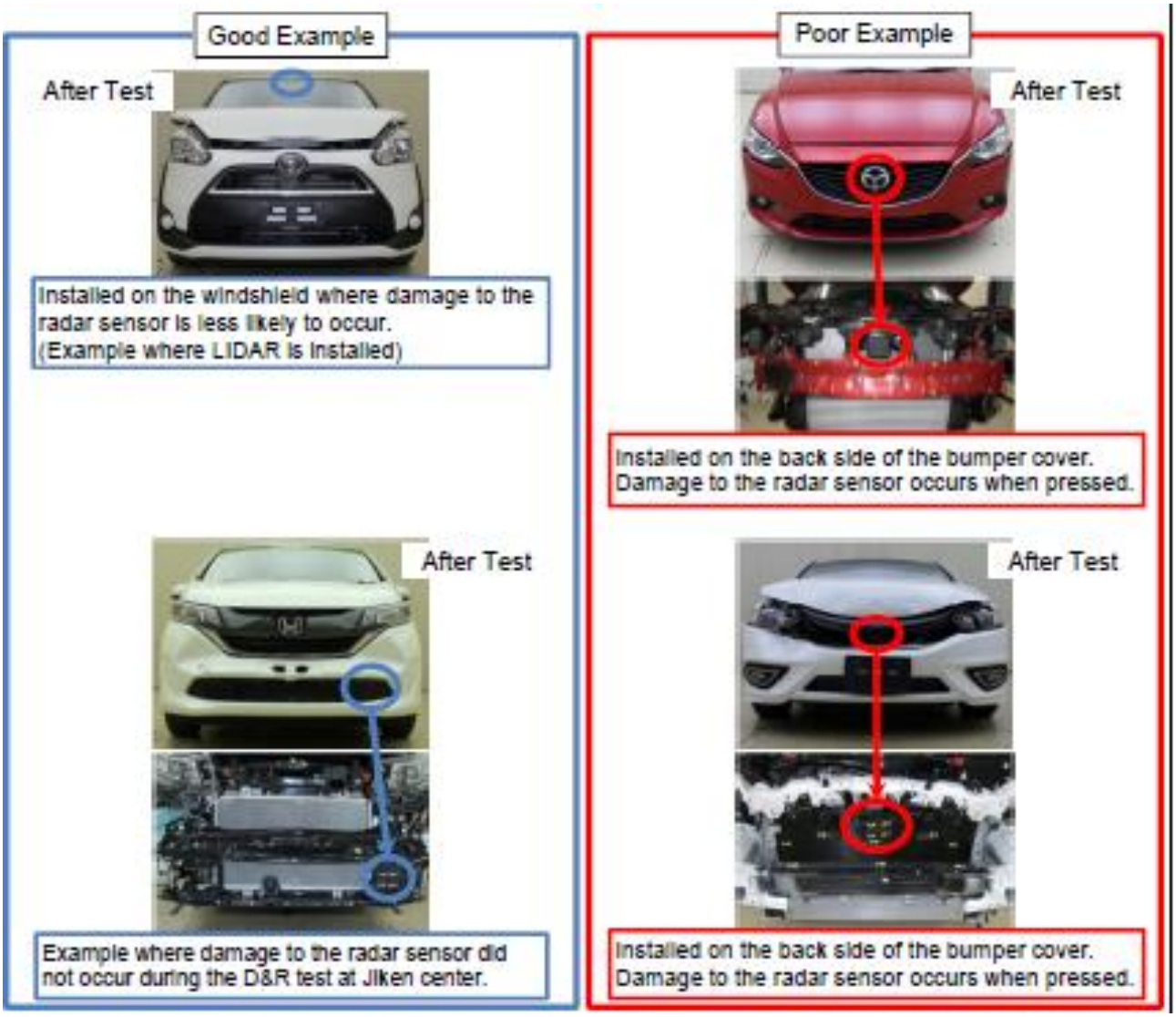
Inspection criteria

The radar sensor should be installed at a position where it cannot be easily damaged.

Reason

The radar sensor is expensive. When it is installed on the inside of the windshield or other location that is not on the front portion of the vehicle, damage is less likely to occur.

- The camera or LIDAR should be installed on the inner surface of the windshield.
- As for the radar, the D&R test shows they should be installed anywhere but the centre position, but whether this is true in reality has to be confirmed by checking the insurance data.



RADAR SENSOR

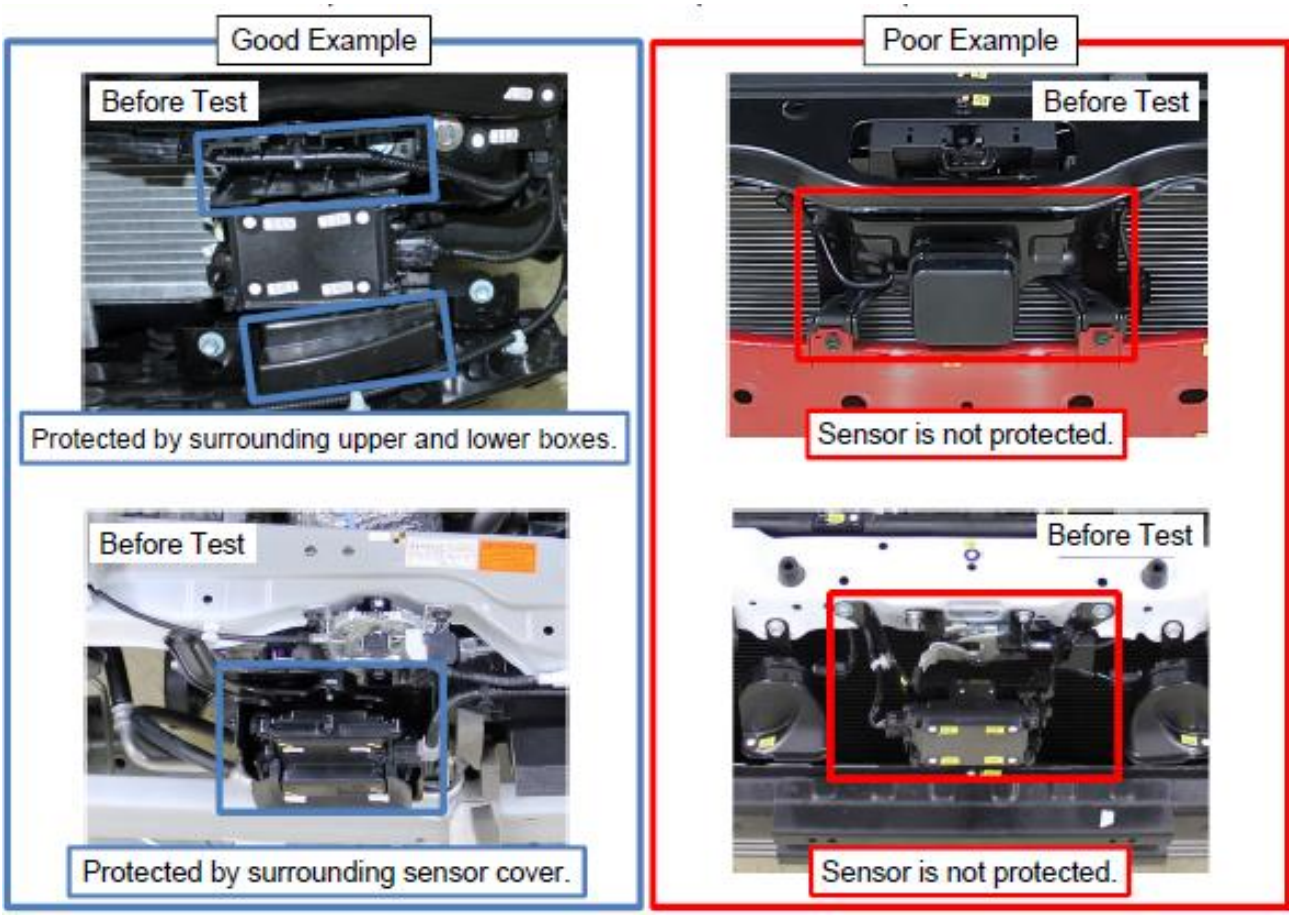
Inspection criteria

The radar sensor should be protected to prevent it from contacting peripheral parts in a collision.

Reason

When the radar sensor is protected with a protective cover, damage to the radar sensor is less likely to occur even if it contacts the bumper cover or the radiator grille in a collision.

Example where the radar sensor is protected with a protecive.



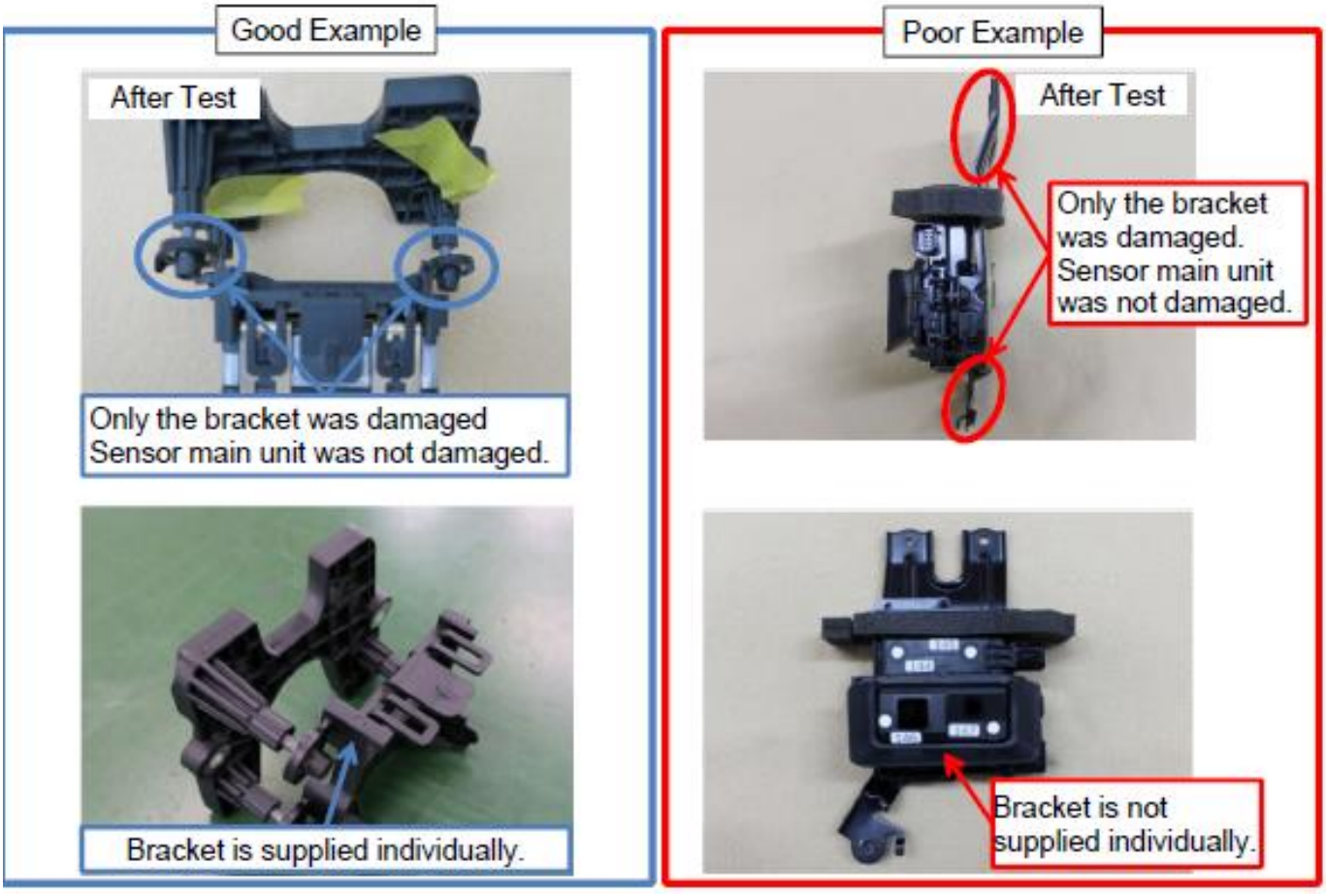
RADAR SENSOR

Inspection criteria

The radar sensor bracket should be supplied individually.

Reason

When the radar sensor bracket is supplied individually, if the bracket is damaged, only the bracket needs to be replaced, which reduces the repair cost.



RADAR SENSOR

Inspection criteria

The inspection procedure for the radar sensor should be provided in the repair manual.

Reason

When the inspection procedure for the radar sensor function is provided in the repair manual, it helps determine whether the sensor is usable or not when the sensor does not have any sign of external damage. This prevents unnecessary repairs, reducing the repair cost.

Good Example

Whether or not the millimeter-wave radar is radiating correctly can be checked with the oscilloscope function of a PC with a diagnostic device installed.

Poor Example

The inspection procedure for the radar sensor function is not provided in the repair manual.

1.5.4. ADAS SENSORS CALIBRATION

Inspection criteria

In certain situations, such as when the windshield is replaced and a camera is located there, or a bumper is repaired in the area where a radar is located, it is necessary to perform a calibration of the sensors used by the ADAS.

Reason

Calibration of these sensors is necessary in certain situations to ensure the correct functioning of the ADAS incorporated in the vehicle.

There are two types of calibration, static and dynamic. A few years ago, the type of calibration to be performed on a camera or radar depended on the vehicle model in which it was installed; it could only be static or dynamic and could not be chosen. In recent years, some OEMs, in some of their models, allow the workshop to choose the type of calibration to be performed on the sensor, something very advantageous for the workshop.

Good example

Camera calibration type:

Static X

Dynamic X

OEMs that allow to choose the type of calibration on an ADAS sensor.

Poor example

Camera calibration type:

Static ☐

Dynamic X

OEMs that don't allow to choose the type of calibration on an ADAS sensor.

1.5.5. 360º CAMERAS CALIBRATION

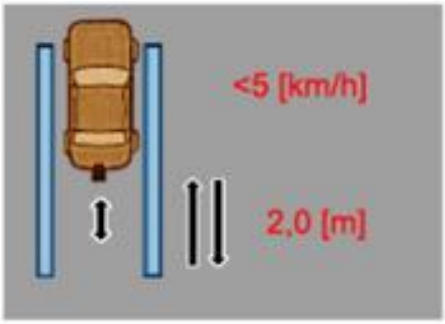
Inspection criteria

In certain situations, such as when replacing a parking camera of the 360° system, it is necessary to perform calibration of these cameras. In these cases, we can find situations in which the OEMs indicates to calibrate all the cameras in the system, or only the affected camera. Furthermore, depending on the OEM, the calibration of the system must be done by three different methods, with a necessary equipment, which needs to be purchased, create the equipment by the technicians or not need special equipment, only the diagnostic tool.

Reason

Calibration of these sensors is necessary in certain situations to ensure the correct functioning of the vision of the cameras about the park system. There are three types of calibration, static, static with slight movements of the vehicle, and dynamic, for example, driving the car between lines of a parking.
In these cases, the need for specific tools is an additional cost for the workshop, in addition to the fact that calibrating parking cameras is not a common operation in workshops, and therefore has a long payback period.

Good example



180° Calibration System

The calibration of the rear camera in some car models can be carried out using the lines of a parking as a reference, without specific tools.

Poor example

360° Calibration System

The calibration of the 360° parking system requires specific tools or paint on the floor specific references.

2. SINGULARITIES IN VEHICLES

In addition to all these generalities, there are other particularities and technologies that have a growing influence on the repairability of vehicles.

Basically, it is about:

Electric and hybrid vehicles
An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. A hybrid electric vehicle (HEV) is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system (hybrid vehicle drivetrain). The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance.

Gas vehicles
Compressed natural gas (CNG) vehicles operate much like gasoline-powered vehicles with spark-ignited internal combustion engines. The engine functions the same way as a gasoline engine. Natural gas is stored in a fuel tank, or cylinder, typically at the back of the vehicle. The CNG fuel system transfers high-pressure gas from the fuel tank through the fuel lines, where a pressure regulator reduces the pressure to a level compatible with the engine fuel injection system.

Body on frame platforms
Frame design has changed significantly over the years and has evolved with current designs being much more complex. The complexity of these design parameters is due to various Reasons. Fuel economy and safety regulations have played a significant role in pushing to enhance the development of frame designs utilised in current full frame vehicles. Body over Frame design is principally used for light / medium / heavy trucks, pickup trucks, and SUV platforms.

2.1. ELECTRIC AND HYBRID VEHICLES

An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. A hybrid electric vehicle (HEV) is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system (hybrid vehicle drivetrain). The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance.

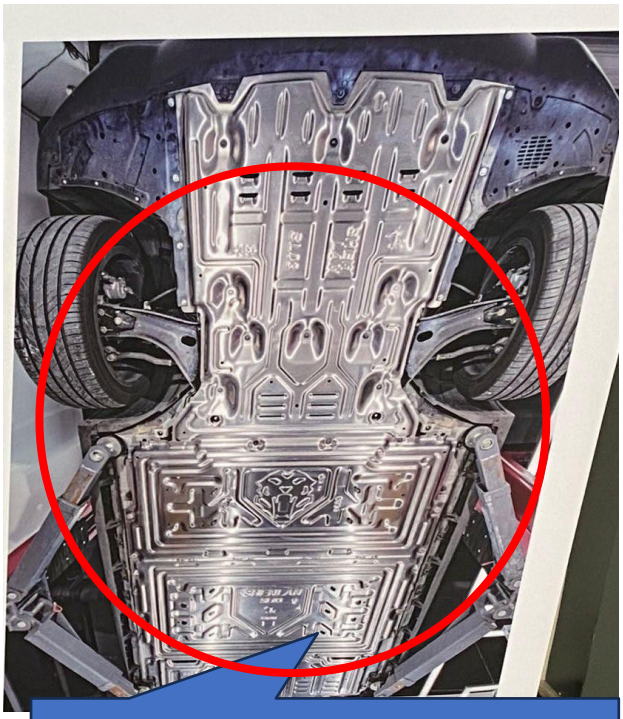
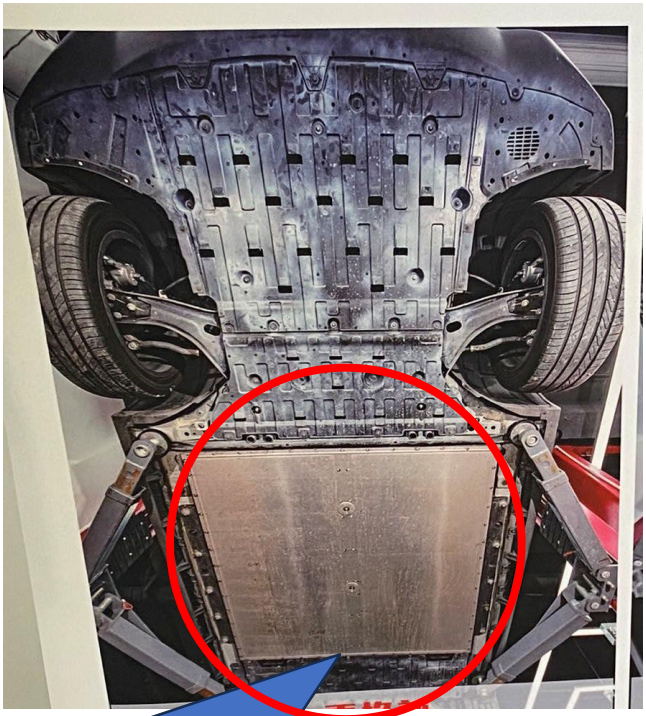
2.1.1. POWER BATTERY PACK BOTTOM AND SIDE PROTECTION DESIGN

Inspection criteria

Power battery pack should be equipped with bottom and side protection equipment.

Reason

Bottom and side protection equipment can protect the power battery pack from damage caused by accidents of foreign object splashing, bottom bumping etc. or reduce the degree of damage.

Good example	Poor example
 Power battery pack with high-strength bottom guard is less susceptible to damage.	 Power battery pack without high-strength bottom guard is more susceptible to damage.

2.1.2. PROTECTIONS DESIGN

In general, the location of the battery itself, as well as of the different elements that make up the high-voltage network, is fundamental to minimise damage because of an incident.

Implementing appropriate protection systems in the design of vehicles will help to prevent the transmission of damage to these systems, facilitate their repair and trying to control the associated costs.

2.1.2.1. POWER BATTERY CONNECTOR PROTECTION

Inspection criteria

Power battery pack should be equipped with connector protection equipment and protection equipment should meet at least IP67 waterproof requirement.

Reason

Protection equipment meets at least IP67 can protect power battery pack from damage caused by flooding, foreign object splashing, bottom bumping etc. or reduce the degree of damage.

Good example	Poor example

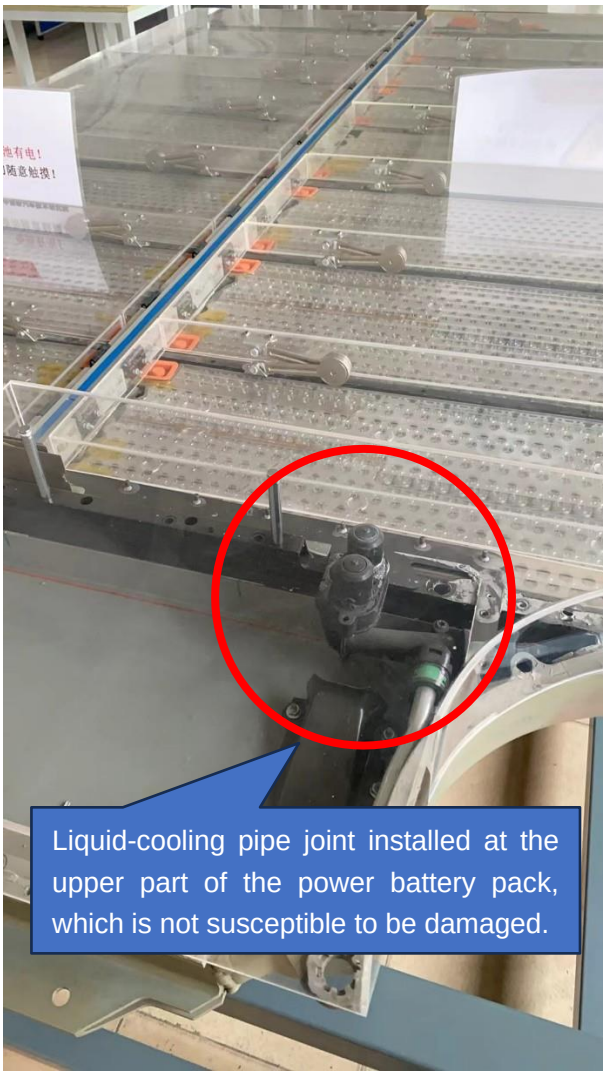
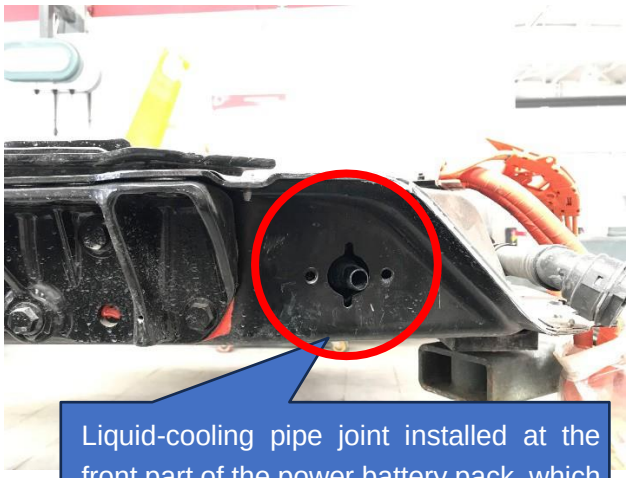
2.1.2.2. POWER BATTERY PACK LIQUID-COOLING PIPE JOINT PROTECTION

Inspection criteria

Power battery pack liquid-cooling pipe joint should be installed at a position that is not easily damaged, such as the upper surface of the power battery pack. If it is necessary to install liquid-cool pipe joint in vulnerable location, corresponding protection equipment is required.

Reason

Power battery pack liquid-cooling pipe joint installed at a position that is not easily damaged or equipped with corresponding protection equipment can protect the power battery pack from damage caused by accidents of foreign object splashing, bottom bumping etc. or reduce the degree of damage.

Good example	Poor example
	

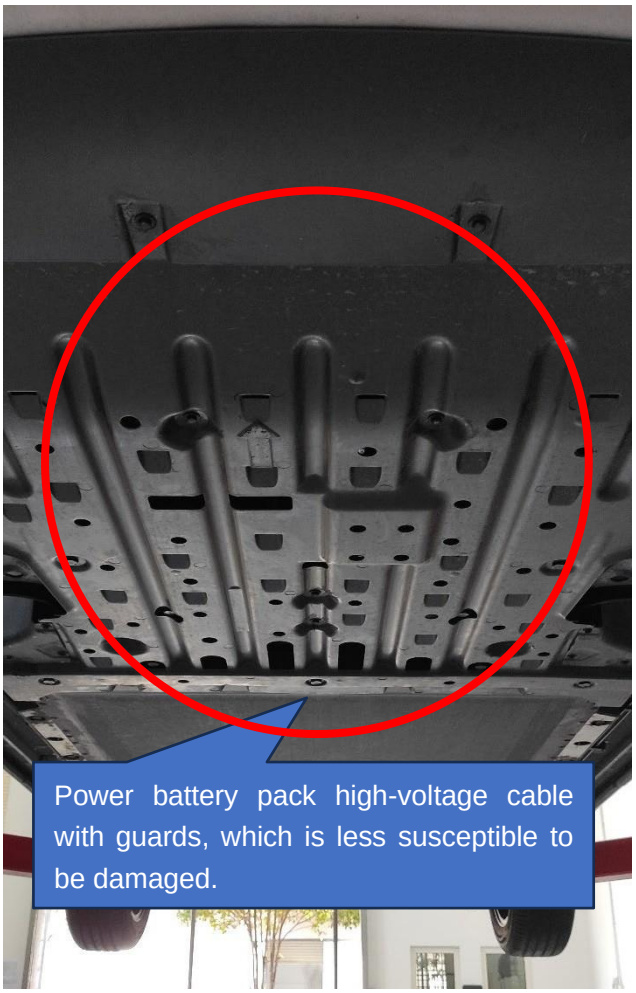
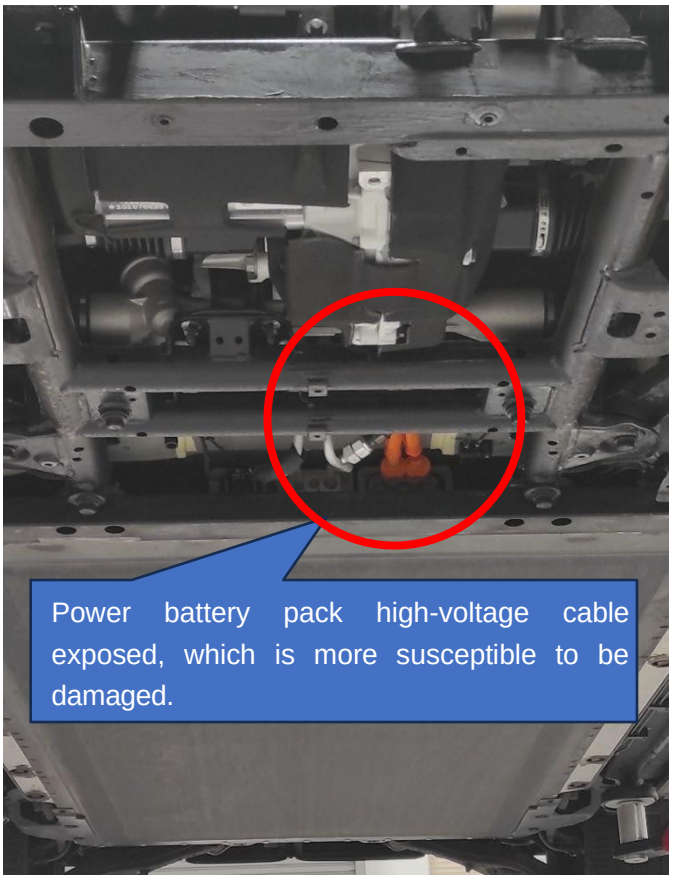
2.1.2.3. POWER BATTERY PACK HIGH-VOLTAGE CABLE PROTECTION

Inspection criteria

Power battery pack should be equipped with high-voltage cable protection equipment.

Reason

High-voltage cable protection equipment can protect the power battery pack and the high-voltage cable from damage caused by accidents of foreign object splashing, bottom bumping etc. or reduce the degree of damage.

Good example	Poor example
	

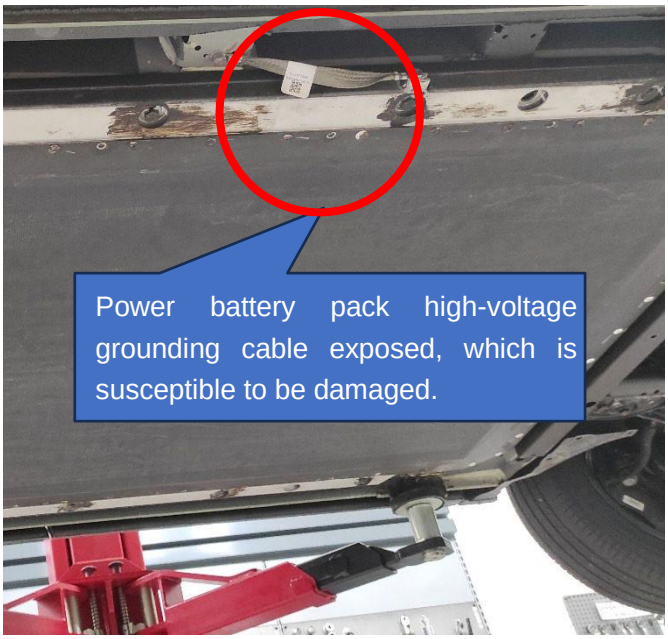
2.1.2.4. POWER BATTERY PACK HIGH-VOLTAGE GROUNDING CABLE PROTECTION

Inspection criteria

Power battery pack should be equipped with high-voltage grounding cable protection equipment with appropriate warning signs.

Reason

High-voltage grounding cable protection equipment can protect the power battery pack and the high-voltage grounding cable from damage caused by accidents of foreign object splashing, bottom bumping etc. or reduce the degree of damage. Corresponding warning signs can avoid or reduce the risk or accidentally cut off of the high-voltage grounding cable.

Good example	Poor example
	

2.1.3. POWER BATTERY PACK ANTI-COLLISION BEAM DESIGN

Inspection criteria

Power battery pack should be equipped with front and rear power battery pack anti-collision beam.

Reason

Front and rear power battery pack anti-collision beam can protect the power battery pack from damage caused by accidents of bottom bumping etc. or reduce the degree of damage and provide warning for driver during low-speed bumping.

Good example	Poor example
	

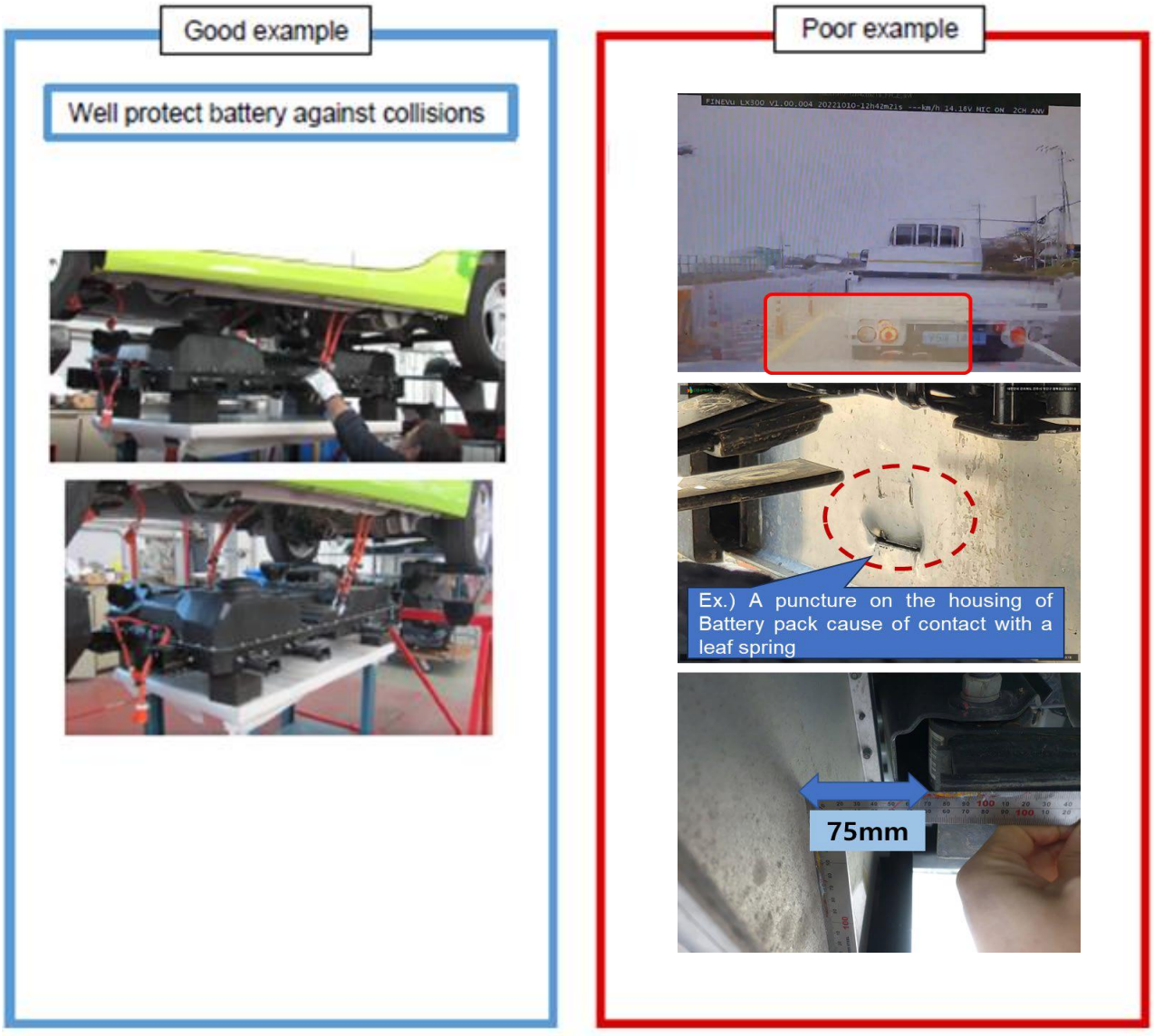
2.1.4. LOCATION OF BATTERIES AND THEIR PROTECTION

Inspection criteria

The battery should be attached to the car so that it does not move on impacts.
It is also necessary to have a safety space (a gap) between the battery and the other elements of the car.

Reason

If the battery is correctly secured and there is a safety distance between it and the other car elements, it is possible to prevent damage to the battery due to the displacement of these elements in collisions.



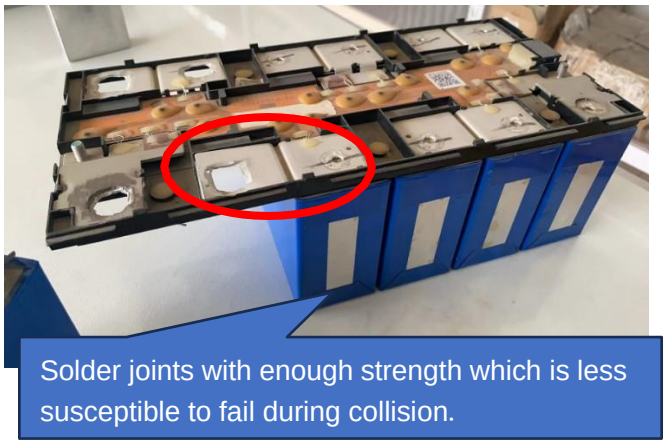
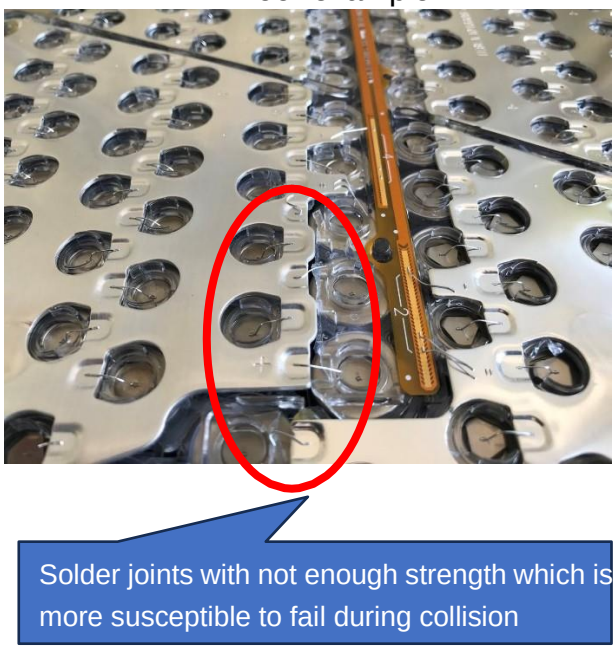
2.1.5. POWER BATTERY SOLDER JOINTS STRENGTH REQUIREMENT

Inspection criteria

Power battery pack solder joints should have enough strength.

Reason

Solder joints with enough strength can protect the solder joints from damage caused by accident of collision, bumping etc. or reduce the degree of damage.

Good example	Poor example
	

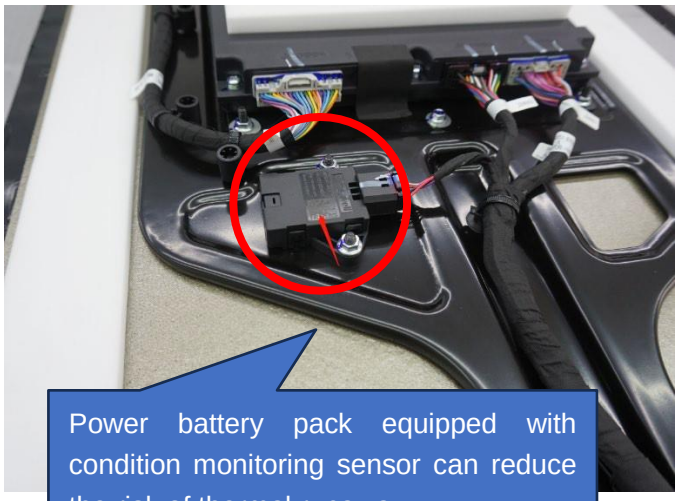
2.1.6. POWER BATTERY PACK CONDITION MONITORING SENSOR DESIGN

Inspection criteria

Power battery pack should be equipped with condition monitoring sensor.

Reason

Power battery pack condition monitoring sensor can monitor the presence and concentration of smoke, liquids, debris and other objects inside the power battery pack and provide early warning information to protect the power battery pack, vehicle, and occupants from thermal runaway accidents or reduce the degree of damage.

Good example	Poor example
 Power battery pack equipped with condition monitoring sensor can reduce the risk of thermal runaway.	

2.1.7. POWER BATTERY PACK NP TECHNOLOGY REQUIREMENT

Inspection criteria

Power battery pack should be equipped with NP technology.

Reason

NP technology can protect the power battery pack, vehicle, and occupants from thermal runaway accidents or reduce the degree of damage.

Good example	Poor example

2.1.8. POWER BATTERY LIQUID COOLANT CONDUCTIVITY REQUIREMENT

Inspection criteria

The conductivity of power battery liquid coolant should be no more than 100us/cm.

Reason

Insulated liquid coolant can protect the power battery pack from internal short circuits caused by accidents of liquid coolant leakage and reduce the risk of spontaneous combustion of the power battery pack after an accident.

Good example	Poor example
The conductivity of liquid coolant ≤100us/cm	The conductivity of liquid coolant ＞ 300us/cm

2.1.9. POWER BATTERY PACK REMOVABLE UPPER COVER DESIGN

Inspection criteria

The upper cover of power battery pack should be able to individually removable and replaceable without destructive and should be sealable after reinstallation.

Reason

Individually removable, non-destructively replaceable and reinstalled sealable Power battery pack upper cover can reduce the difficulty and cost of repairs.

Good example	Poor example

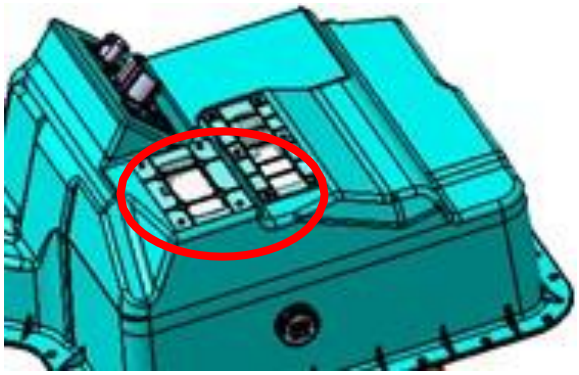
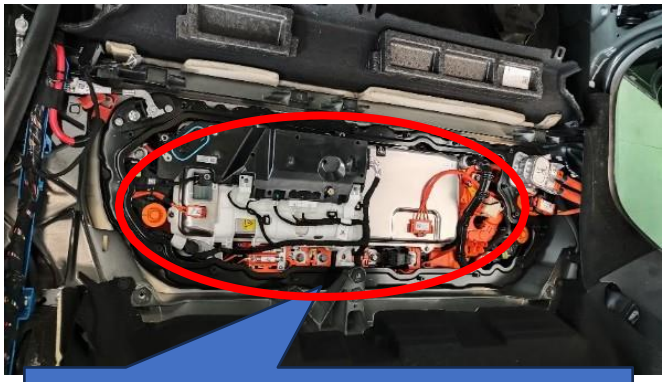
2.1.10. POWER BATTERY PACK MAINTENANCE WINDOW DESIGN OR EASY TO REMOVE METHOD DESIGN

Inspection criteria

The power battery pack should have a service window that can be opened individually or should have an easy procedure to remove it from the vehicle body, as well as open and repair methods.

Reason

An individually opening service window can eliminate the need to disassemble the battery pack for service, reducing the difficulty and cost of repairs. If this window is not possible, a simple method of removing the battery from the vehicle body is a good way of keeping service costs down.

Good example	Poor example
  No need to disassemble the whole battery pack or the upper cover when there is a maintenance window for repairing wear parts.	

2.1.11. **POWER** BATTERY PACK FIXING METHOD REQUIREMENT

Inspection criteria

Power battery pack should be installed from the outside of the vehicle body instead of from the inside of the vehicle body.

Reason

Fixing the power battery pack from the outside of the vehicle eliminates the need to disassemble the interior parts when removing the power battery pack, which reduces the difficulty, costs and man-hours of repair.

Good example	Poor example

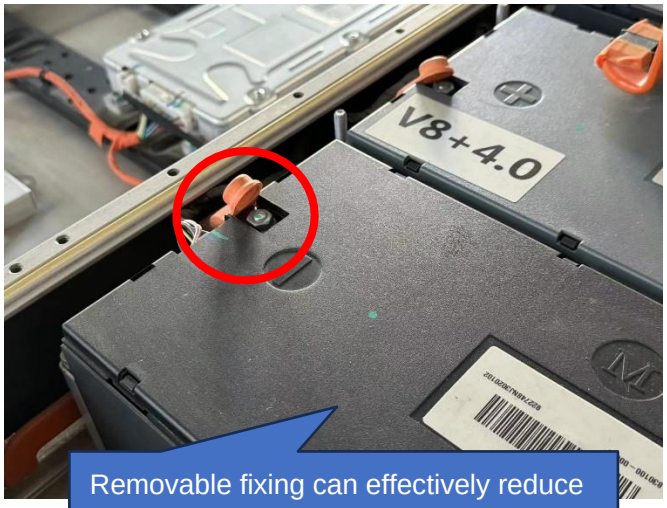
2.1.12. POWER BATTERY PACK CASING AND CELL/MODULE FIXING METHOD REQUIREMENT

Inspection criteria

Power battery cells or modules should be able to be nondestructively dismantled and separated from casing. If it is necessary to use adhesive method to fix, corresponding repair process should be provided.

Reason

Power battery cells and modules that can be non-destructively disassembled and separated from the casing can reduce the difficulty and costs of repair and reduce the risk of damage to the cells and modules during maintenance.

Good example	Poor example
	

2.1.13. POWER BATTERY PACK SOH DATA AVAILABILITY REQUIREMENT

Inspection criteria

The SOH data of the power battery should be clearly readable, and the corresponding calculation method should be provided.

Reason

Clearly readable SOH data for power battery with corresponding calculations can reduce the difficulty and cost of battery evaluation and repair.

Good example	Poor example

2.1.14. POWER BATTERY DIAGNOSTIC PROCESS REQUIREMENT

Inspection criteria

Inspection and diagnostic procedures for the power battery pack and its internal components should be provided by the manufacturer in a service manual and be available to the insurance company or other third-party agency.

Reason

Power battery pack inspection and diagnostic procedures can reduce the difficulty and costs of battery evaluation and repair.

Good example	Poor example

2.1.15. POWER BATTERY PACK REPAIR REQUIREMENT AFTER AIRBAG DEPLOYMENT

After the airbag deployment, after confirming that the main body of the power battery pack is not damaged, the manufacturer should provide the inspection and maintenance treatment process for the power battery pack, which can be powered up and used after replacing the relay and other components or computer processing.

2.1.15.1. NEED TO REPLACE 48 VOLTS BATTERY IN CASE OF A CRASH

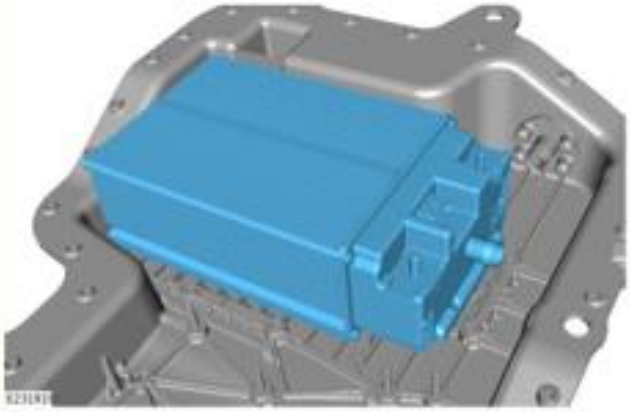
Inspection criteria

In different mild-hybrid car models, the 48 volts battery is blocked when the SRS (Supplementary Restraint System) has been activated automatically, even if that battery hasn´t been damaged.

Reason

In case of an accident in which the SRS has sent a crash signal, even if there´s no activation of pretensioners or airbags and the 48 volts battery has not been damaged, that battery will be electronically deactivated in a permanent way, and its replacement will be mandatory.

Good Example



In many mild-hybrid models, the 48 volts battery mustn´t be replaced in case of SRS signal.

Poor Example

In some mild-hybrid models, the 48 volts battery had to be replaced after the rear RCAR crash (neither pretensioners nor airbag were activated, and there was not any damage in the battery). The price of that battery it is usually very expensive.

2.1.15.2. HIGH VOLTAGE BATTERY REPLACEMENT IN CASE OF SRS ACTIVATION

Inspection criteria

In some car electric vehicles models, the HV battery must be replaced in case of SRS activation (pretensioners, airbags), even if the battery has not been damaged.

Reason

The HV battery has a pyrotechnic fuse that is activated when one of the SRS (Supplementary Restraint System) works, such as any pretensioner or airbag. Even if the HV battery hasn´t any damage, it must be replaced. The cost of these batteries is several thousand euros.

Good example

If the HV battery is not damaged, it has not to be mandatory its replacement.

Poor example

In some cars models when the airbags were activated in a crash. The HV battery didn´t suffer any damage, but it had to be replaced because the activation of the pyrotechnic fuse.

2.1.16. POWER BATTERY PACK COMPONENTS SUPPLY REQUIREMENT

Inspection criteria

The manufacturer should be able to supply the internal parts of the power battery pack (e.g. brackets, liquid cooling tubes, casing, cells, plates, etc.) separately.

Reason

Individually available parts for power battery packs reduce the difficulty and costs of repair.

Good example	Poor example

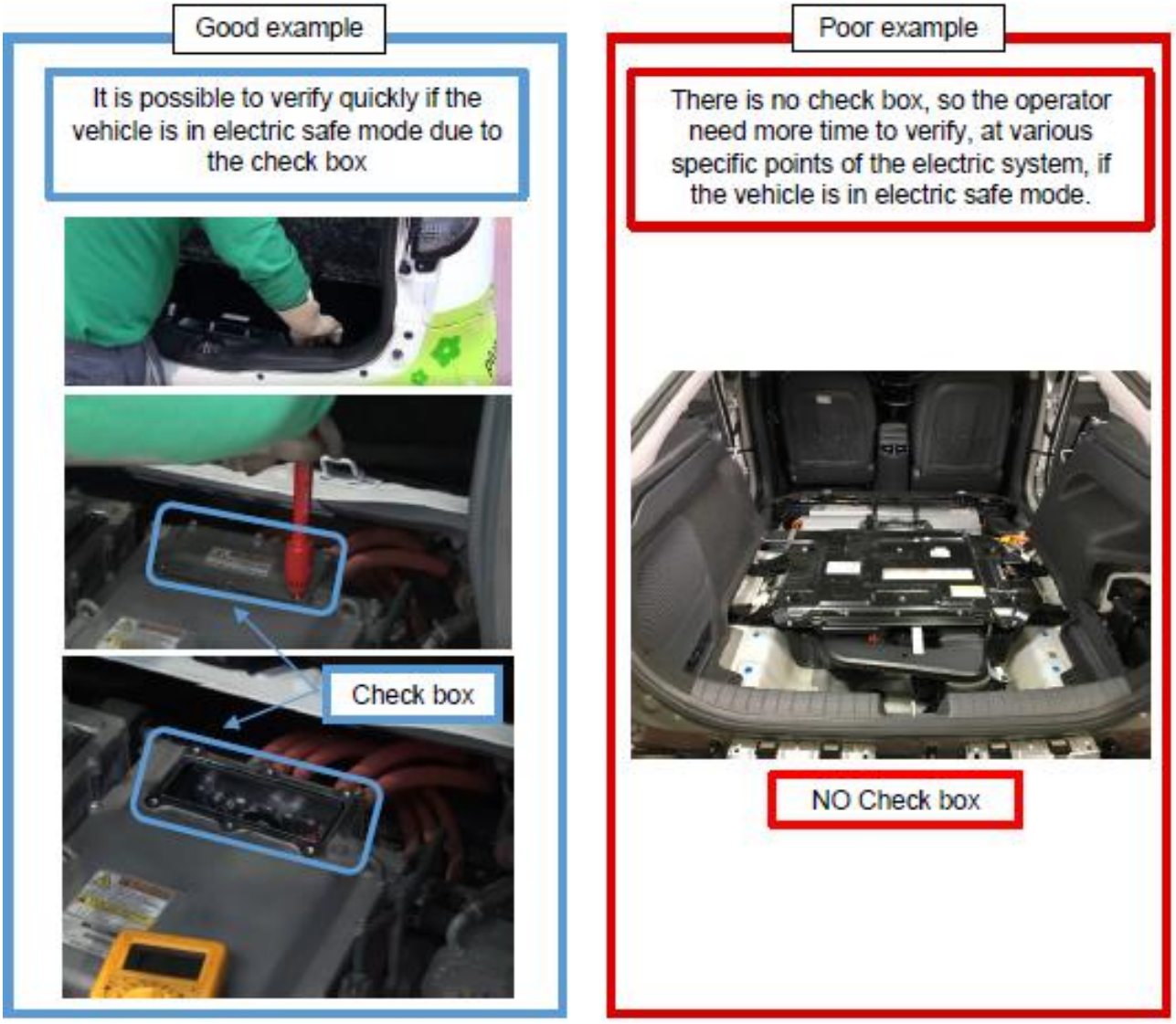
2.1.17. POWER BATTERY PACK MANUAL SERVICE DISCONNECT REQUIREMENT

Inspection criteria

An electricity check box should be incorporated in an easily accessible vehicle location, preferably under the hood.

Reason

If an electric or hybrid vehicle incorporates an electricity check box under the hood, which access is easy and direct, the necessary person-hours to check if the vehicle is in electric safe mode reduces significantly.



2.1.17.1. PUT IN SAFE MODE OF EV AND HV

Inspection criteria

The location of the high voltage cut off plug into an electric or hybrid vehicle should permit an easy and direct access.

Reason

If the location of the high voltage cut off plug, into an electric or hybrid vehicle, permit an easy and direct access, without the necessity of remove some car parts, the person-hours to put this vehicle in safe mode reduces significantly.

2.1.18. POWER BATTERY PACK UNIVERSAL AIR TIGHTNESS TESTING PLUGGING DESIGN

Inspection criteria

The same brand and different models of power battery packs shall be equipped with universal airtightness plugging.

Reason

Universal power battery pack airtightness plugging can reduce the difficulty and cost of airtightness testing of batteries after repair.

Good example	Poor example

2.1.18.1. POWER BATTERY PACK UNIVERSAL INTERFACE DESIGN

Inspection criteria

Different models of batteries of the same brand should be equipped with universal interfaces, such as high-voltage interface, low-voltage communication interface, gas-tightness testing interface.

Reason

A common battery interface can reduce the difficulty and cost of repairing this component.

Good example	Poor example

2.1.19. HIGH VOLTAGE BATTERY DISMOUNTING WHEN PAINTING A CAR IN A SPRAYBOOTH

Inspection criteria

High-voltage batteries must bear the temperatures needed in the spray booth to paint the car in bodyshops.

Reason

High-voltage batteries installed in (hybrid-) electric vehicles are restricted relating to the temperature they are exposed to.

While a (hybrid-) electric vehicle is being painted in the painting cabin, the temperatures during drying may increase to values that need cooling of the battery.

Active cooling is in many cases not possible as e.g., the HV-system is disconnected for the repair or the climate control unit is evacuated, which results in the need for dismounting the high-voltage battery before painting. Thereby appreciable costs are generated.

Good example

It is possible to paint the car inside the paint spray boot without the need of dismantling the HV battery.

Poor example

The dismantling of HV battery from car in paint operations, would increase the repair time and cost unnecessarily.

2.2. GAS VEHICLES

Compressed natural gas (CNG) vehicles operate much like gasoline-powered vehicles with spark-ignited internal combustion engines. The engine functions the same way as a gasoline engine. Natural gas is stored in a fuel tank, or cylinder, typically at the back of the vehicle. The CNG fuel system transfers high-pressure gas from the fuel tank through the fuel lines, where a pressure regulator reduces the pressure to a level compatible with the engine fuel injection system.

2.2.1. SPECIFIC WORK PROCESSES

Inspection criteria

Vehicle manufacturers should provide information and tools to extract the gas that is in the tank at the end of the vehicle's useful life.

Reason

If after the useful life of the vehicle, the gas tanks are stored without extracting the gas they contain, problems of inflammation or explosion of these deposits may arise.

When you repair gas supply system, you should remove the remain pressure.

1. Open the trunk.
2. Turn off the key and detach the minus terminal of battery.
3. Open service cover (A).

4. Fully close multi valve (A) to shut off the gas supply line.

5. Turn the key on after reattaching minus terminal of battery, wait until the engine stops by using the gas all.

2.2.2. GAS TANK REQUIREMENTS (APLICABLE ONLY IN KOREA)

Inspection criteria

Reason

<table>
<tr><td rowspan="2">Gas type</td><td colspan="2">passenger car and van<= 4.5ton</td></tr>
<tr><td>Test</td><td>Requirements</td></tr>
<tr><td>LPG(Liquefied petroleum gas)</td><td rowspan="2">- Frontal impact :
48.3kph with fixed barrier
- Rear impact :
48.3kph with moving barrier
- Side impact :
32.2kph with moving barrier</td><td>- no leak of gas for 90 minutes after the vehicle stops
- the gas pressure in a bombe same and higher than 95% that of before the test
- bombe should not be detached from its original fixed location</td></tr>
<tr><td>NG(Natural Gas)</td><td>- Pressure drops should be less than higher one of followings
→ 1,062Kpa
→ 895 X (T/Vfs)

where, T : average absolute temperature of the gas
Vfs : inner volume of fuel pipe from bombe to the first regulator</td></tr>
</table>

<table>
<tr><td rowspan="2">Gas type</td><td colspan="2">Van>4.5ton</td></tr>
<tr><td>Test</td><td>Requirements</td></tr>
<tr><td>NG (Natural Gas)
or
Hydrogen</td><td>- rollover test with real vehicle
- rollover test with major structure of real vehicle
- rollover test with FEM</td><td>Fuel system(bombe, bombe valve, fuel pipe, and , etc.) except gas filling port and line, should not directly contact to vehicle or ground even though at the moment of the vehicle's deformation</td></tr>
</table>

2.3. BODY ON FRAME PLATFORMS

Frame design has changed significantly over the years and has evolved with current designs being much more complex. The complexity of these design parameters is due to various Reasons. Fuel economy and safety regulations have played a significant role in pushing to enhance the development of frame designs utilised in current full frame vehicles. Body over Frame design is principally used for light / medium / heavy trucks, pickup trucks and SUV platforms.

2.3.1. BODY ON FRAME PLATFORMS (WELDING)

Inspection criteria

Manufacturers should supply the repairers all the necessary requirements, such as: parameters, gas mixture, distance between components and filler wire, to ensure good quality in welding operations.

Manufacturers should give guidance on the use of welded tabs for minor frame deformation and cosmetic frame repairs (tabs are additional lugs welded onto the frame to create an additional pulling point, where standard points are not enough).

Reason

Precise instructions are necessary to avoid failures in welding procedures, that could cause resistance problems in this crucial part of the vehicle.

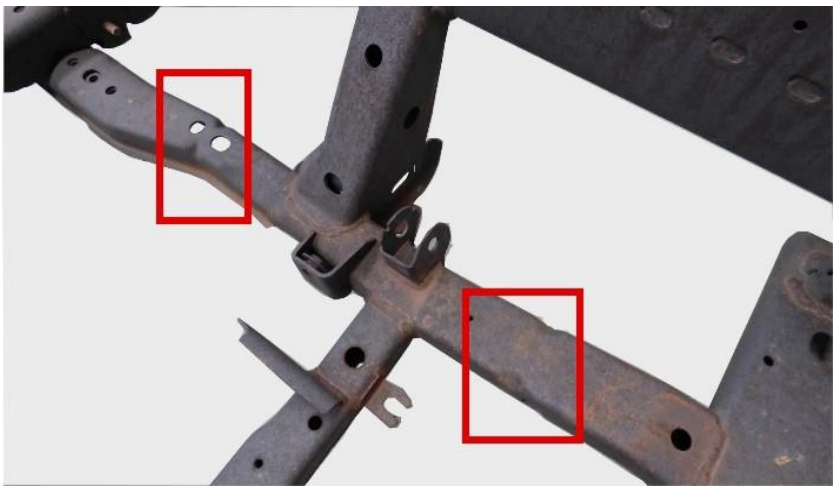
2.3.2. BODY ON FRAME PLATFORMS (CRUSH ZONES)

Inspection criteria

The frame rail should have crush zones placed at the ends of the rail, which are intended to absorb energy in collisions by bending or crushing. Crush zones can include holes, slots, convolutions, buckle initiators, notches or dimples stamped into the frame rail to initiate and control deformation due to a collision of the frame.
These fuse areas of the frame should be supplied as separate elements for easy replacement.
In low intensity collisions, this crush zones must absorb and not transmit the collision energy to the rest of the frame.

Reason

In low intensity crashes when the frame has these crush zones repairs are shorter in time and less expensive.



DESIGN AND REPAIRABILITY GUIDE

2025

RCAR