NISSAN BODY REPAIR MANUAL

This Body Repair Manual on the following pages is prepared to provide service personnel with the general knowledge necessary to perform body repairs on NISSAN vehicles. This will allow us to maintain the original quality built into all NISSAN vehicles and to provide our customers with lasting satisfaction.
This manual contains information on auto body construction, sheet metal work, welding, plastic repair, safety & health, etc. It is useful for training not only body repair technicians but also anyone who wants to learn body repair technique.

INDIVIDUAL SERVICE MANUALS

The applicable model Service Manual and this Body Repair Manual should be used together when performing body repair work. Individual Service Manuals for respective models are available at **nissan-techinfo.com** to provide the detailed repair procedures for specific NISSAN vehicle models. Repair information and procedures specific to the vehicle model and year should be referenced for each and every repair.

Individual Service Repair Manuals are available here:

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Nissan Collision Repair Position Statements are available here:

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SECTION BRM
BODY REPAIR

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Foreword

INFOID:0000000012106646

BODY REPAIR

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This manual contains information on auto body construction, sheet metal work, welding, plastic repair, safety & health, etc.. It is useful for training not only body repair technicians but also anyone who wants to learn body repair technique. The Body Repair Manuals and the Service Manuals for respective models are published separately to provide the detailed description of how to repair specific NISSAN vehicle models. The applicable manuals and this manual should be used together when performing body repair work.

FRAME REPAIR

This manual is prepared to provide service personnel with the general knowledge necessary to perform frame repairs on NISSAN vehicles. This will allow us to maintain the original quality built into all NISSAN vehicles and to provide our customers with lasting satisfaction.
It is useful for training not only body repair technicians, but also anyone who wants to learn frame repair techniques. The Body Repair Manual Fundamentals, the Body Repair Manuals and the Service Manuals for respective models are published separately to provide the detailed description of how to repair specific NISSAN vehicle models. The applicable manuals and this manual should be used together when performing frame repair work.

AUTO BODY CONSTRUCTION
BODY TYPES AND STRUCTURE

BODY TYPES AND STRUCTURE : Body Types and Structure

INFOID:0000000012106775

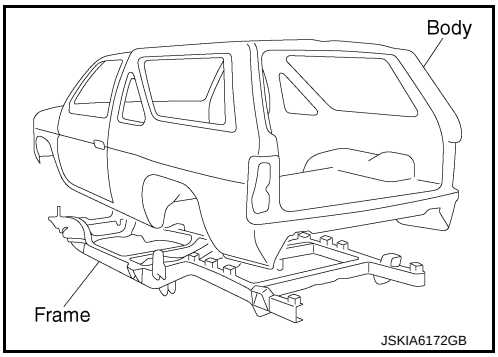
There are two principal types of body construction, Frame body and uni-body (in which the body and frame are constructed as an integral unit). Vehicles damaged by a collision must be repaired to their original shape, strength and durability. For that purpose, repair technicians have to comprehend the original body structure.

BODY TYPES AND STRUCTURE : Frame Body

INFOID:0000000012107336

The body and frame are separated from each other as shown in the figure.The Frame body type vehicle is characterized as follows:

- Noise and vibration transferred from the road to the body are reduced. This reduction is accomplished through rubber mounting between body and frame.
- Increase in vehicle weight and height.
- For details, refer to BRM-197, "GENERAL INFORMATION : General Information".



BODY TYPES AND STRUCTURE : Uni-body

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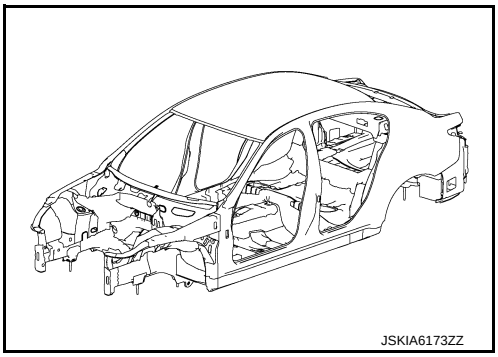
In the uni-body construction, as shown in the figure, individual metal parts are welded together to make up the body assembly and provide overall body rigidity through an integral all steel welded construction. The uni-body type vehicle is characterized as follows.

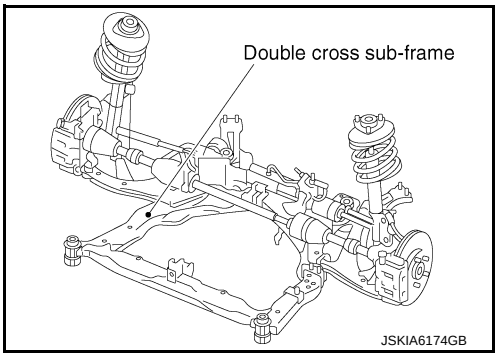
- More occupant space can be easily obtained.
- Susceptible to corrosion and damage caused by stone chipping because the underbody is close to the road and is made of thin sheet metal.



(1) FRONT BODY CONSTRUCTION

Generally, the thick side members and the front end crossmembers are arranged in a double cross pattern to support most loads. As the impact absorbing mechanism, the side member is concaved, curved, or reinforced partially to absorb energy by deforming when impact is applied.

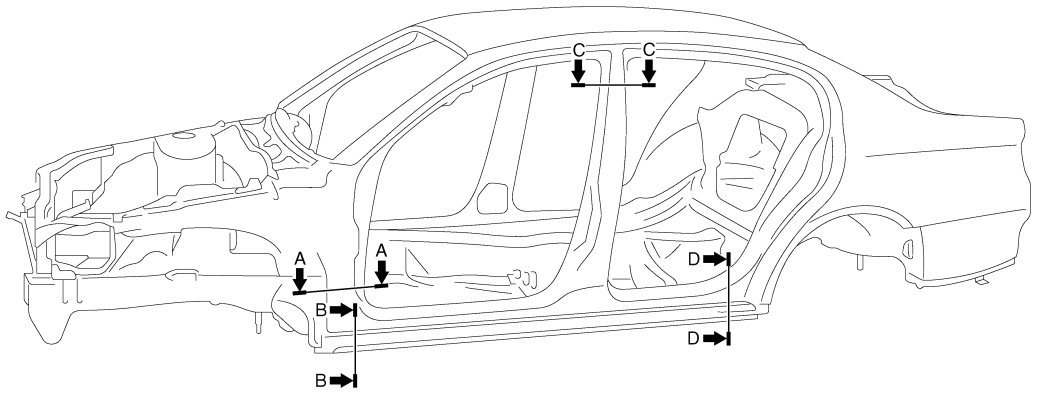
- The double cross sub-frame normally contains quiet and damping functions. In addition to these functions, the function to improve collision performance is added to the double cross sub-frame for certain vehicle types.
- The sub-frame is fixed onto the front body with bolts. Vibration and noise from the engine and suspension are not directly transmitted to the body.



(2) CENTER BODY CONSTRUCTION

The passenger compartment area occupies the major portion of the center body. The center body consists of a floor, sills, pillars, and roof panel. To minimize the passenger compartment deformation in a collision, pillar strength has been enhanced. In addition, by multiple reinforcing of the joints with roof and sills, the reinforcing structure has further been improved, compared to the closed sectional construction.

BODY CONSTRUCTION



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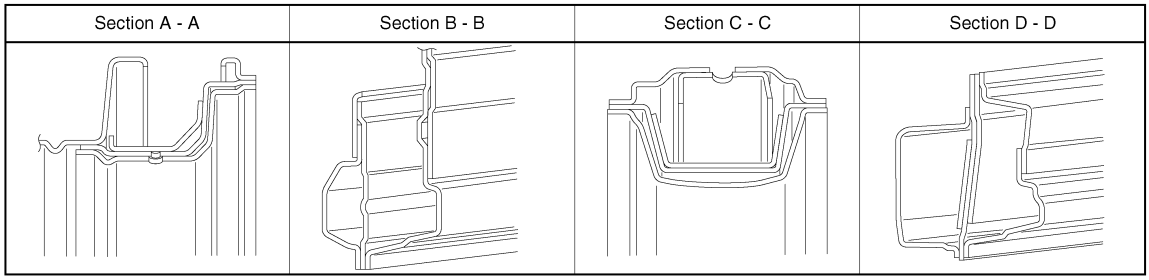

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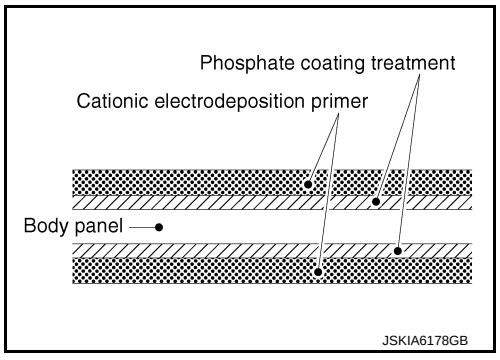
Construction of typical NISSAN uni-body vehicles are shown on the following pages.
Panel parts will be available either as assembled or individual parts so that only the damaged part need be replaced. To obtain the service parts, refer to the parts catalog for each model.

NOTE:

A phosphate coating treatment and a cationic electrodeposition primer (ED coats), which provide an excellent anti-corrosion effect, are employed on all body components.



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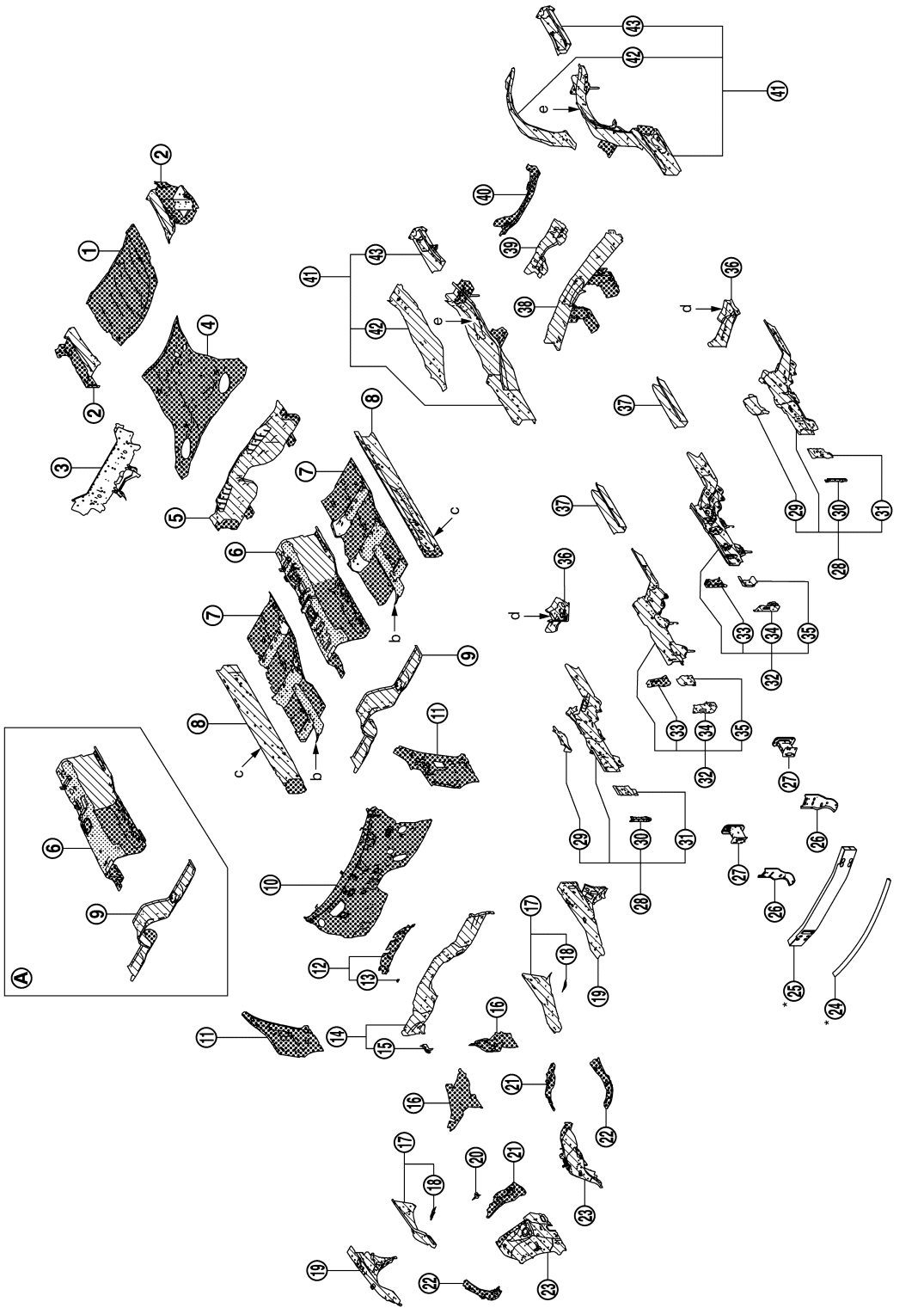
NISSAN Genuine Service Parts also are treated in the same manner. Therefore, it is recommended that GENUINE NISSAN PARTS or equivalent be used for panel replacement to maintain anti-corrosive performance built into the vehicle at the factory.

UNDERBODY COMPONENT PARTS

There are two principal types of drive positions, FF (Front engine Front drive) and FR (Front engine Rear drive). The body structure for engine mounting and suspension is different between these vehicle types. This figure shows FR type.

Example



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Ⓐ M/T models

: Both sided anti-corrosive precoated steel sections

: High strength steel (HSS) sections

: Both sided anti-corrosive steel and HSS sections

*: Aluminum portion

No.	Parts name			Tensile strength (MPa)	Both sided anti-corrosive precoated steel sections	Aluminum portion
①	Rear floor rear			Under 440	×	—
②	Rear floor rear side (RH & LH)			590	×	—
③	2nd rear crossmember (Upper)			590	—	—
④	Rear floor front			Under 440	×	—
⑤	Rear seat crossmember reinforcement assembly			590	×	—
⑥	Center front floor			440	×	—
⑦	Front floor (RH & LH)	b.	1350 MPa[caution] T=1.6 mm (0.063 in)	590	×	—
⑧	Inner sill (RH & LH)	c.	980 MPa[caution] T=1.0 mm (0.039 in)	590	×	—
⑨	Lower dash			440	×	—
⑩	Upper dash			Under 440	×	—
⑪	Side dash (RH & LH)			Under 440	×	—
⑫	Upper front cowl top assembly			Under 440	×	—
⑬	Cowl top bracket			Under 440	×	—
⑭	Lower dash crossmember			590	×	—
⑮	Lower battery support bracket			Under 440	×	—
⑯	Front cowl top assembly (RH & LH)			Under 440	×	—
⑰	Upper front hoodledge (RH & LH)			440	×	—
⑱	Front hoodledge reinforcement (RH & LH)			Under 440	×	—
⑲	Hoodledge reinforcement (RH & LH)			440	×	—
⑳	Battery support bracket			Under 440	×	—
㉑	Lower rear hoodledge (RH & LH)			Under 440	×	—
㉒	Side radiator core support (RH & LH)			Under 440	×	—
㉓	Front strut housing (RH & LH)			440	×	—
㉔	Inner center front bumper reinforcement			—	—	×
㉕	Front bumper armature assembly			—	—	×
㉖	Side apron bracket assembly (RH & LH)			Under 440	—	—
㉗	Front bumper stay (RH & LH)			Under 440	—	—
㉘	Front side member closing plate assembly (RH & LH)			590	×	—
㉙	Front side member center closing plate (RH & LH)			440	×	—
㉚	Bumper reinforcement bracket (RH & LH)			Under 440	×	—
㉛	Front side member front closing plate (RH & LH)			590	×	—
㉜	Front side member assembly (RH & LH)			590	×	—
㉝	Front side member connector assembly (RH & LH)			Under 440	×	—
㉞	Add on frame bracket (RH & LH)			440	×	—
㉟	Front side member front extension (RH & LH)			780	×	—

No.	Parts name			Tensile strength (MPa)	Both sided anti-corrosive precoated steel sections	Aluminum portion
㊱	Front side member outrigger assembly (RH & LH)	d.	980 MPa[caution] T=2.0 mm (0.079 in)	590	×	—
㊲	Front side member rear extension (RH & LH)		980 MPa[caution] T=1.2 mm (0.047 in)	—	×	—
㊳	Rear seat crossmember			590	×	—
㊴	Rear floor belt anchor reinforcement			590	×	—
㊵	2nd rear crossmember (Lower)			590	×	—
㊶	Rear side member assembly (RH & LH)	e.	980 MPa[caution] T=1.2 mm (0.047 in)	590	×	—
㊷	Rear side member rear (RH & LH)			590	×	—
㊸	Rear side member extension (RH & LH)			780	×	—

CAUTION:

If the high strength steel (ultra high strength steel) of this is broken, replace by assembly for the supply part.

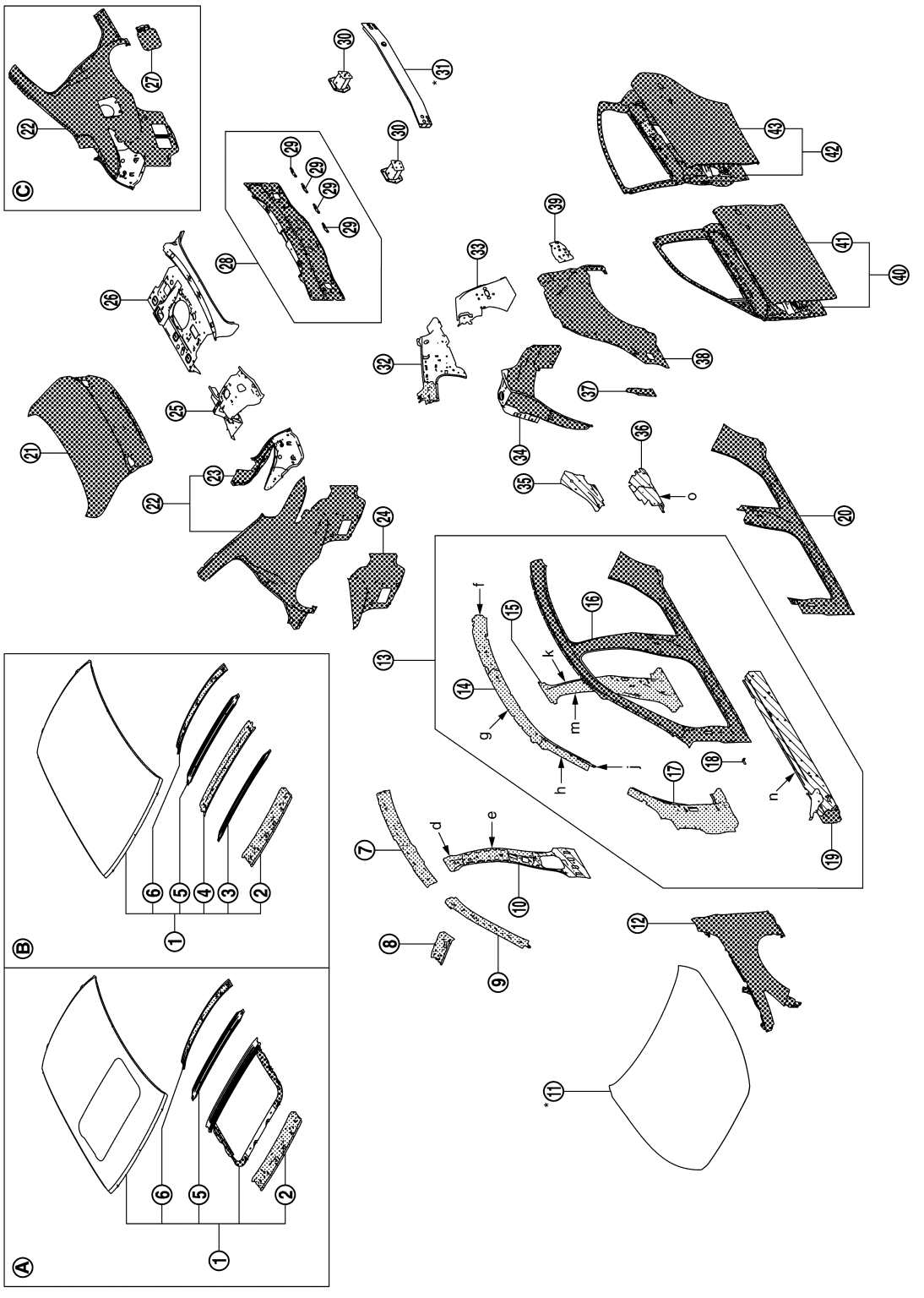
NOTE:

- For the parts without a number described in the figure, it is supplied only with the assembly part that the part is included with.
- Tensile strength column shows the largest strength value of a part in the component part.

BODY COMPONENT PARTS (I)

There are several kinds of body shapes: Sedan (2 or 4 door), Hardtop, Hatchback, Coupe, Wagon (Van) and One box type. This figure shows sedan type.

Example



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Ⓐ Sunroof models Ⓑ Without sunroof models Ⓒ Right side

: Both sided anti-corrosive precoated steel sections

: High strength steel (HSS) sections

: Both sided anti-corrosive steel and HSS sections

*: Aluminum portion

No.	Parts name			Tensile strength (MPa)	Both sided anti-corrosive precoated steel sections	Aluminum portion
①	Roof assembly			590	—	—
②	Front roof rail		1180 MPa[caution] T=1.0 mm (0.039 in)	—	—	—
③	Roof bow No.1			Under 440	—	—
④	Roof reinforcement assembly		980 MPa[caution] T=1.0 mm (0.039 in)	—	—	—
⑤	Roof bow No.2			Under 440	—	—
⑥	Rear roof rail			590	—	—
⑦	Inner side roof rail (RH & LH)			590	—	—
⑧	Front roof rail brace (RH & LH)			590	—	—
⑨	Side roof reinforcement (RH & LH)		1180 MPa[caution] T=1.2 mm (0.047 in)	—	—	—
⑩	Inner center pillar (RH & LH)	d.	1180 MPa[caution] T=1.2 mm (0.047 in)	440	—	—
		e.	1350 MPa[caution] T=1.8 mm (0.071 in)			
⑪	Hood			—	—	×
⑫	Front fender (RH & LH)			Under 440	×	—
⑬	Side body assembly (RH & LH)			Refer to No. ⑭ - ⑲		
⑭	Outer side roof rail reinforcement (RH & LH)	f.	1180 MPa[caution] T=1.0 mm (0.039 in)	—	—	—
		g.	1350 MPa[caution] T=1.4 mm (0.055 in)			
		h.	1180 MPa[caution] T=1.2 mm (0.047 in)			
		j.	980 MPa[caution] T=1.6 mm (0.063 in)			
⑮	Center pillar reinforcement (RH & LH)	k.	1180 MPa[caution] T=1.2 mm (0.047 in)	440	—	—
		m.	1350 MPa[caution] T=1.4 mm (0.055 in)			
⑯	Outer front side body (RH & LH)			Under 440	×	—
⑰	Front pillar brace (RH & LH)			590	—	—
⑱	Cowl top bracket extension (RH & LH)			Under 440	×	—
⑲	Outer sill reinforcement (RH & LH)	n.	1180 MPa[caution] T=1.0 mm (0.039 in)	590	×	—
⑳	Outer sill (RH & LH)			Under 440	×	—
㉑	Trunk lid			Under 440	×	—
㉒	Rear fender (RH & LH)			Under 440	×	—
㉓	Tail pillar assembly (RH & LH)			Under 440	—	—
㉔	Rear fender extension (RH & LH)			Under 440	×	—

No.	Parts name	Tensile strength (MPa)	Both sided anti-corrosive precoated steel sections	Aluminum portion
㉕	Side parcel shelf (RH & LH)	Under 440	—	—
㉖	Parcel shelf	Under 440	—	—
㉗	Fuel filler lid	Under 440	×	—
㉘	Upper rear panel assembly	Under 440	×	—
㉙	Rear bumper bracket	Under 440	×	—
㉚	Rear bumper stay (RH & LH)	Under 440	—	—
㉛	Inner center rear bumper reinforcement	—	—	×
㉜	Inner rear pillar (RH & LH)	590	—	—
㉝	Inner rear pillar reinforcement (RH & LH)	Under 440	—	—
㉞	Inner rear wheelhouse (RH & LH)	Under 440	×	—
㉟	Outer rear wheelhouse extension (RH & LH Upper)	590	×	—
㊱	Outer rear wheelhouse extension (RH & LH Lower) o. 980 MPa[caution] T=1.0 mm (0.039 in)	590	×	—
㊲	Inner rear wheelhouse front extension (RH & LH)	Under 440	×	—
㊳	Outer rear wheelhouse (RH & LH)	Under 440	×	—
㊴	Outer rear wheelhouse extension (RH & LH Rear)	Under 440	—	—
㊵	Front door assembly (RH & LH)	440	×	—
㊶	Outer front door panel (RH & LH)	Under 440	×	—
㊷	Rear door assembly (RH & LH)	440	×	—
㊸	Outer rear door panel (RH & LH)	Under 440	×	—

CAUTION:

If the high strength steel (ultra high strength steel) of this is broken, replace by assembly for the supply part.

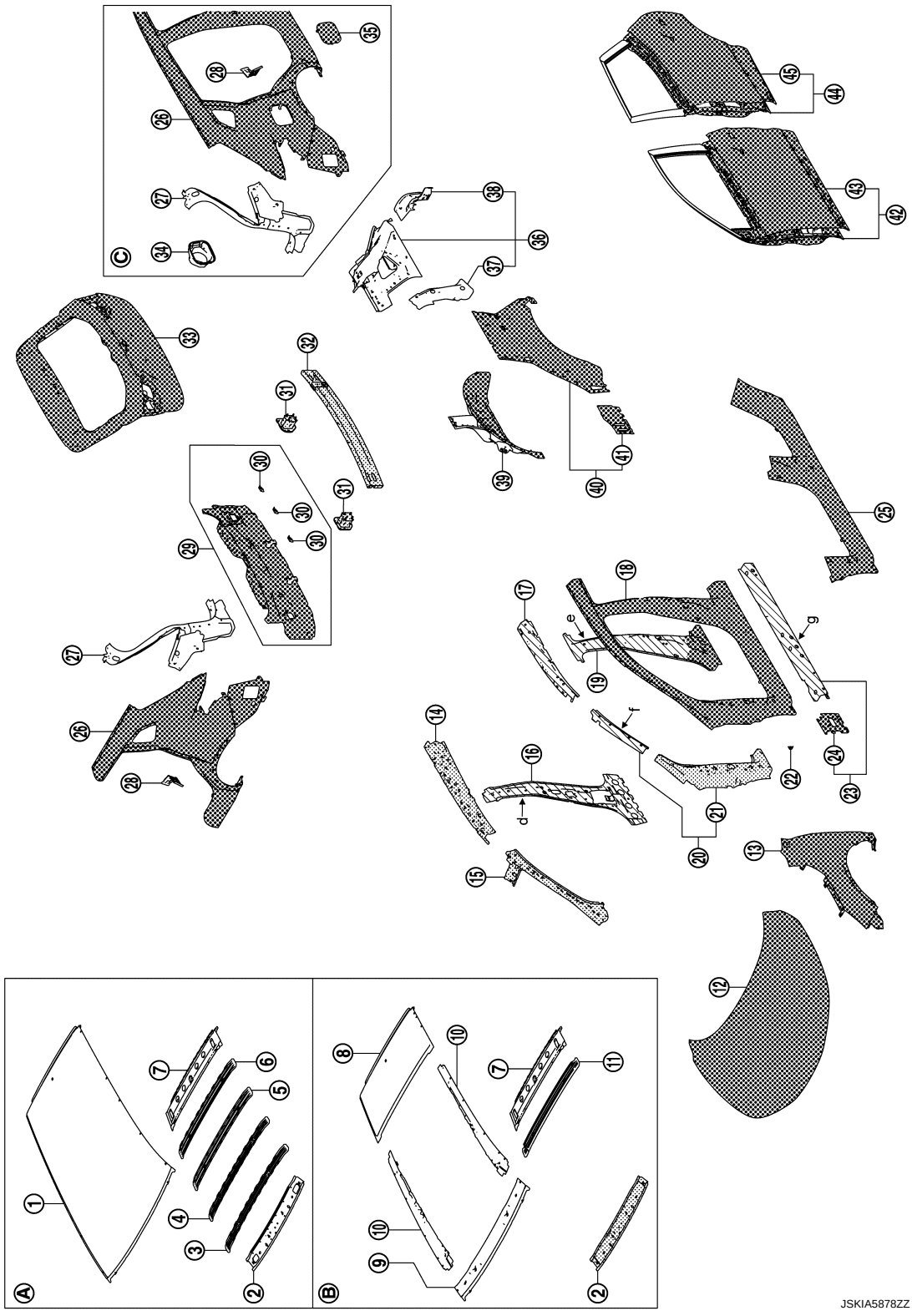
NOTE:

- For the parts without a number described in the figure, it is supplied only with the assembly part that the part is included with.
- Tensile strength column shows the largest strength value of a part in the component part.

BODY COMPONENT PARTS (II)

This figure shows 5-door Hatchback type.

Example



Ⓐ Without sunroof models Ⓑ With sunroof models Ⓒ Right side

: Both sided anti-corrosive precoated steel sections

: High strength steel (HSS) sections

: Both sided anti-corrosive steel and HSS sections

No.	Parts name			Tensile strength (MPa)	Both sided anti-corrosive precoated steel sections
①	Roof			Under 440	—
②	Front roof rail assembly			Under 440	—
③	1st roof bow			Under 440	—
④	2nd roof bow			Under 440	—
⑤	3rd roof bow			Under 440	—
⑥	4th roof bow			Under 440	—
⑦	Rear roof rail assembly			Under 440	—
⑧	Rear roof			Under 440	—
⑨	Upper front roof rail			Under 440	—
⑩	Roof extension assembly			Under 440	—
⑪	Center roof bow			Under 440	—
⑫	Hood assembly			Under 440	×
⑬	Front fender assembly (RH & LH)			Under 440	×
⑭	Inner front side roof rail assembly (RH & LH)			450	—
⑮	Upper inner front pillar assembly (RH & LH)			590	—
⑯	Inner center pillar assembly (RH & LH)	d.	980 MPa[caution] T=1.2 mm (0.047 in)	590	×
⑰	Outer side roof rail (RH & LH)		980 MPa[caution] T=1.0 mm (0.039 in)	—	×
⑱	Outer front side body (RH & LH)			Under 440	×
⑲	Center pillar hinge brace assembly (RH & LH)	e.	980 MPa[caution] T=1.2 mm (0.047 in)	Under 440	×
⑳	Front pillar hinge brace assembly (RH & LH)	f.	980 MPa[caution] T=1.4 mm (0.055 in)	590	×
㉑	Lower front pillar hinge brace (RH & LH)			590	×
㉒	Front fender bracket (RH & LH)			Under 440	×
㉓	Outer sill reinforcement assembly (RH & LH)	g.	980 MPa[caution] T=1.0 mm (0.039 in)	Under 440	×
㉔	Lower front pillar reinforcement (RH & LH)			Under 440	×
㉕	Outer sill assembly (RH & LH)			Under 440	×
㉖	Rear fender assembly (RH & LH)			Under 440	×
㉗	Rear fender extension complete (RH & LH)			Under 440	—
㉘	Striker retainer assembly (RH & LH)			Under 440	—
㉙	Upper rear panel assembly			450	×
㉚	Upper rear bumper retainer			Under 440	×
㉛	Rear bumper stay assembly (RH & LH)			600	—
㉜	Rear bumper reinforcement assembly		1180 MPa[caution] T=1.2 mm (0.047 in)	—	—
㉝	Back door assembly			Under 440	×

No.	Parts name	Tensile strength (MPa)	Both sided anti-corrosive precoated steel sections
㉞	Fuel filler base assembly	Under 440	—
㉟	Fuel filler lid assembly	Under 440	×
㊱	Inner rear pillar assembly (RH & LH)	Under 440	—
㊲	Inner rear pillar reinforcement (RH & LH)	Under 440	—
㊳	Lower inner rear pillar (RH & LH)	Under 440	—
㊴	Inner rear wheelhouse assembly (RH & LH)	Under 440	×
㊵	Outer rear wheelhouse assembly (RH & LH)	Under 440	×
㊶	Outer rear wheelhouse extension (RH & LH)	Under 440	×
㊷	Front door assembly (RH & LH)	Under 440	×
㊸	Outer front door (RH & LH)	Under 440	×
㊹	Rear door assembly (RH & LH)	Under 440	×
㊺	Outer rear door (RH & LH)	Under 440	×

CAUTION:

If the high strength steel (ultra high strength steel) of this is broken, replace by assembly for the supply part.

NOTE:

- For the parts without a number described in the figure, it is supplied only with the assembly part that the part is included with.
- Tensile strength column shows the largest strength value of a part in the component part.

BODY TYPES AND STRUCTURE : Requirements for Passenger Car Body

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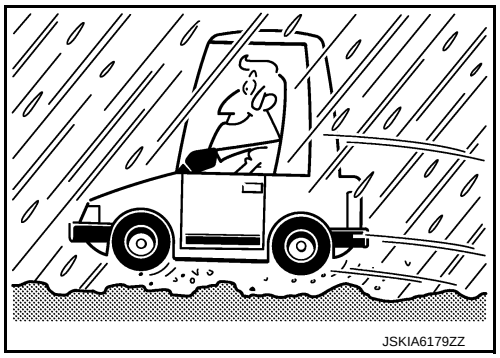
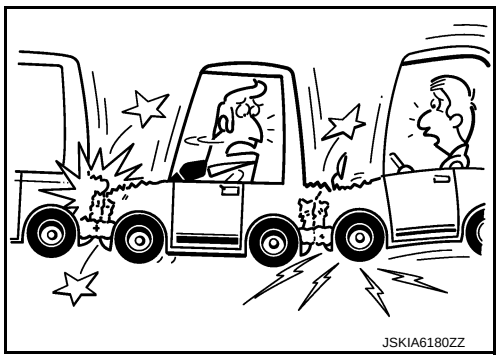
(1) PRESERVATION OF BODY SHAPE

No portion of the body should sustain damage or malfunction under normal vehicle operating conditions.



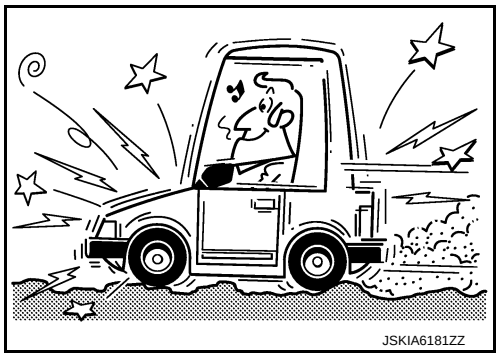
(2) OCCUPANT PROTECTION

In a collision, the body must absorb shock to reduce damage to the passenger compartment to the minimum while ensuring occupant safety.



(3) PREVENTION OF BODY VIBRATION AND NOISE

No uncomfortable vibration or noise should be generated while the car is being driven.



BODY TYPES AND STRUCTURE : To Increase Vehicle Rigidity and Strength

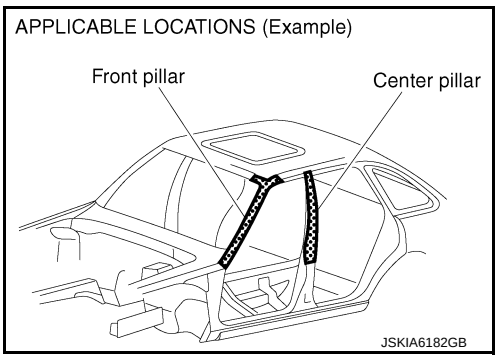
INFOID:0000000012106772

(1) URETHANE FOAM FILLER

Some vehicles have Urethane Foam Filler in body panel spaces to provide extra rigidity for the lightweight body and to reduce noise and vibration.

REQUIRED MATERIAL CHARACTERISTICS FOR SERVICE

- Density: Over 0.1 g/cm^3 (0.06 oz/cu in)
- Noticeable volumetric changes should not occur with changes in humidity and temperature.
- Material characteristics should not adversely affect ED (electrodeposition) coats.



<Urethane foam for forming agent> 3M™ Automix™ Flexible Foam 08463 or equivalent

SERVICE PARTS AVAILABILITY

- Each service part will be ED coated. These are filled with urethane foam filler after the trim mounting clips have been installed and, for the front pillar, when the drain hose has been installed.
- When these parts are replaced, Urethane foam filler must be injected into the place where it was cut away.

(2) WELD BOND

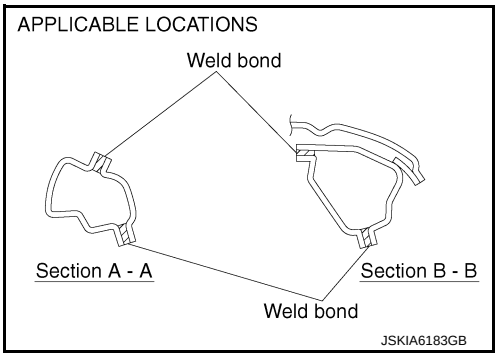
Some vehicles have Weld Bond applied to the entire perimeter of the body panels at door locations and side roof rails to increase torsional rigidity and body strength.

REQUIRED MATERIAL CHARACTERISTICS FOR SERVICE

- Material should be a 2-components epoxy adhesive.

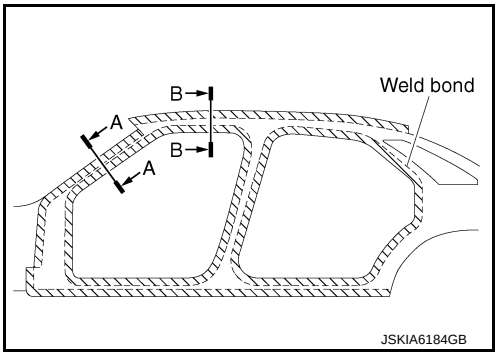
<Adhesive> CIBA-GEIGY Araldite AV 8113 / Hardner HV 8113 or equivalent

- Use in conjunction with spot welding.



SERVICE PARTS AVAILABILITY

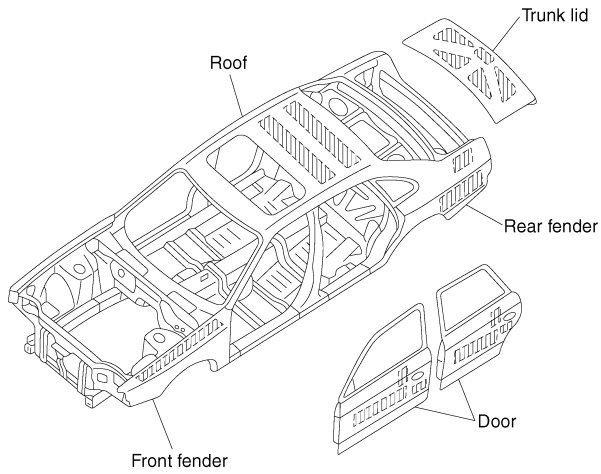
- Assembled service parts will be provided with applied weld bond.
- When any of these parts are replaced, weld bond must be applied to the mating surfaces on the panel. If these panel parts are fixed with MIG welding, avoid applying weld bond around MIG weld holes.



(3) STIFFENER

Some vehicles have stiffeners to prevent dents.

: Stiffener location (Example)



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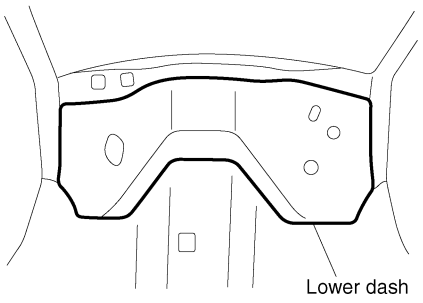
BODY TYPES AND STRUCTURE : To Reduce Noise and Vibration

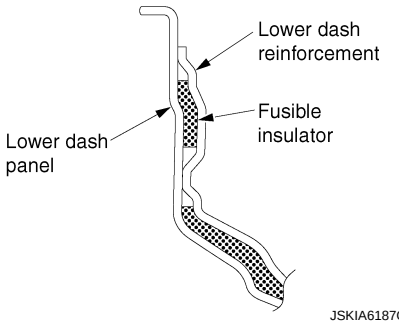
INFOID:0000000012106734

Some vehicles have the following materials to reduce noise and vibration.

(1) SANDWICH STEEL SHEET



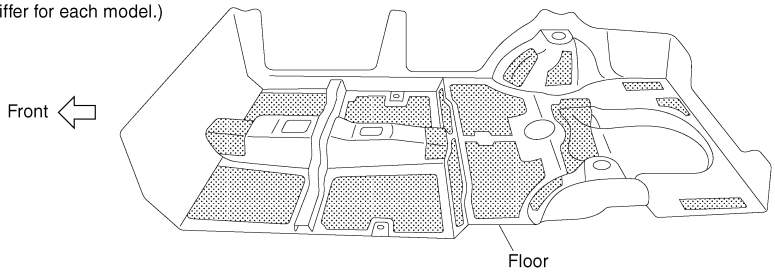
JSKIA6186GB



JSKIA6187GB

(2) FUSIBLE INSULATOR

: Applied portions of Fusible insulator.
(These portions will differ for each model.)



JSKIA6188GB

COLLISION DYNAMICS

COLLISION DYNAMICS : Collision Dynamics

INFOID:0000000012111522

The body is designed to maintain rigidity and durability during normal driving conditions. Front and rear portions of the body should absorb the maximum amount of energy in a severe collision for minimizing the influence to occupants, and the passenger compartment should not deform easily to provide safety for the occupants.
Methods to propagate the force of a collision throughout each part of the body are shown below.

COLLISION DYNAMICS : Five Elements of Force

INFOID:0000000012106803

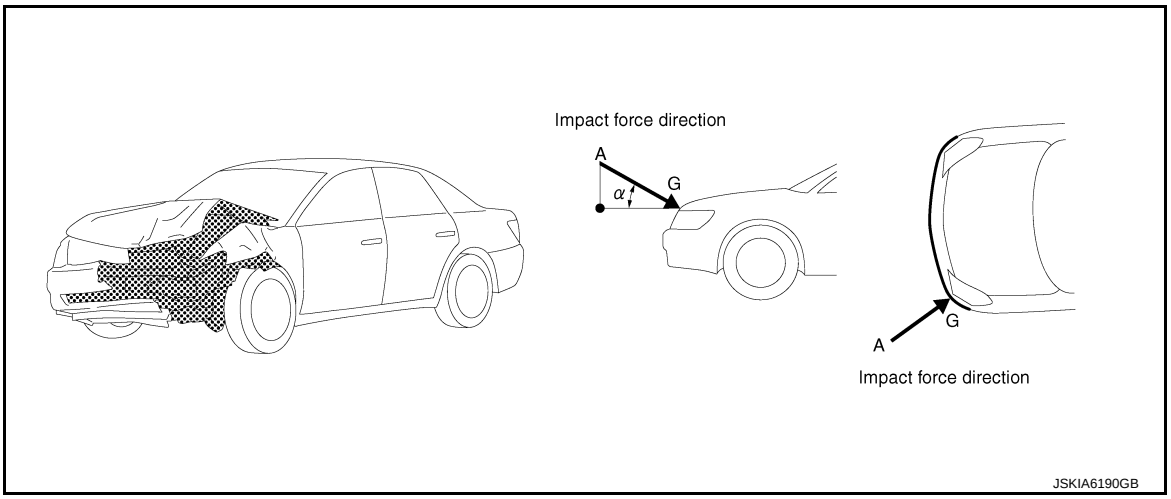
In general, direction, magnitude, and point of impact are the major elements of force. In body repair work, the following five elements should be considered.

1. Direction of force
2. Magnitude of force
3. Point of impact
4. Number of forces applied
5. Sequence of impact

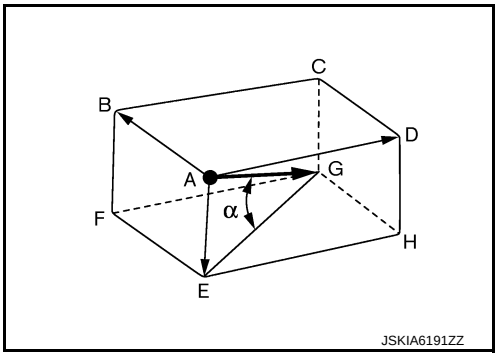
COLLISION DYNAMICS : Direction of Impact Force

INFOID:0000000012106804

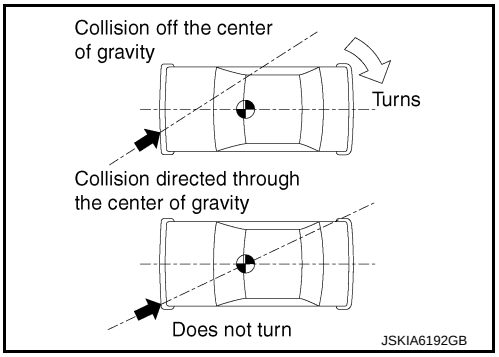
The impact force (input) of a collision is composed of three-dimensional components. Force propagation can be analyzed through careful examination of these components.
The figure shows an impact force applied to the body from the front at an angle of "α°" in the direction of (A - G).



This force can be divided into three-dimensional directions as shown in the figure. The impact force can be divided into (A - B), (A - D), and (A - E).
Each of these forces damages the corresponding panel.



If the impact force is applied away from the center of gravity, a moment of rotation is caused which absorbs the impact force. If the force aims at the center of gravity, no such moment is caused and the resultant damage will be greater.

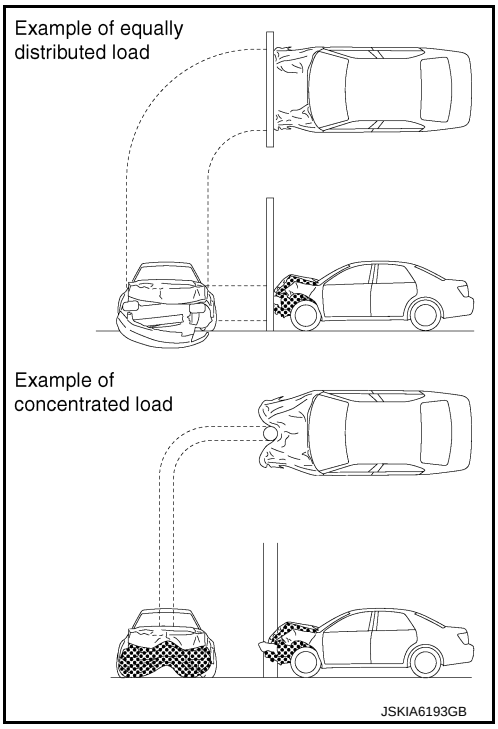


COLLISION DYNAMICS : Impact Force and Collision Area

INFOID:0000000012106798

Consider the impact force (f) per unit area in a frontal collision.
- f = F/A
- F: Impact force (input)
- A: Collision area

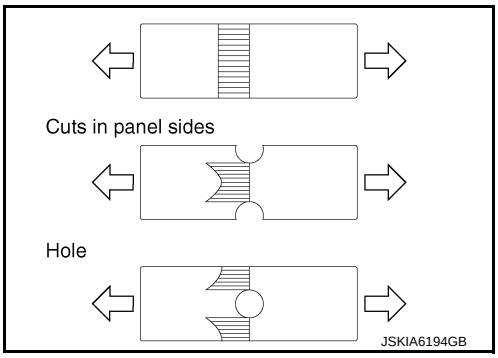
The smaller the collision area, the greater the impact force (f) per unit area. The deformation will also be larger and deeper.



COLLISION DYNAMICS : Concentration of Stress

INFOID:0000000012106799

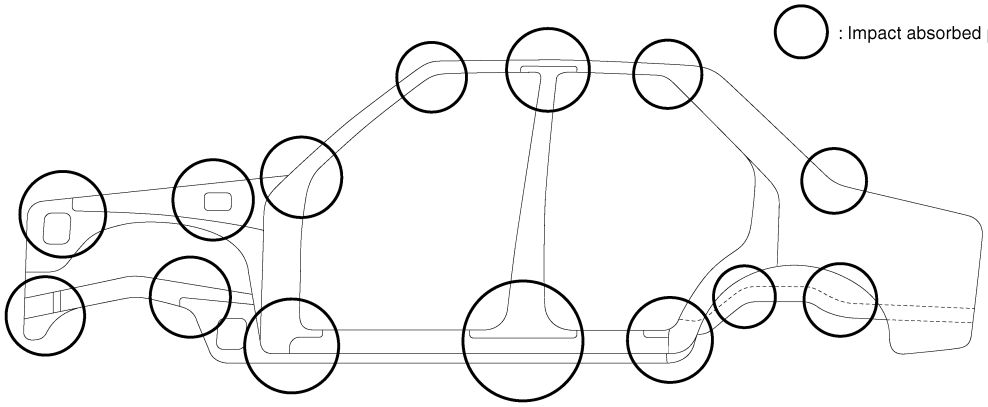
If a panel has cuts or holes, stress distribution will be uneven. As shown in the figure, stress concentrates where the sectional shape changes, thus producing deformation.
This principle is utilized in panel design. Impact force is absorbed, and further propagation of deformation is prevented.



COLLISION DYNAMICS : Propagation of Impact Force

INFOID:0000000012106800

The impact force, while absorbed somewhat at the impact absorbed area, propagates to various portions by passing through each rigid contact point.

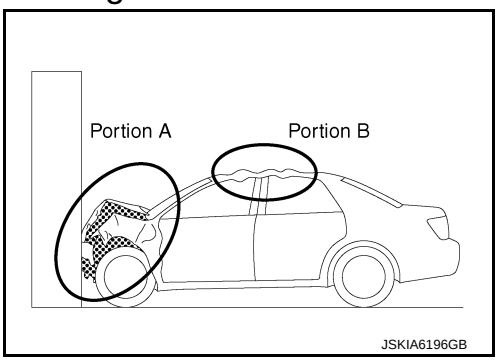


JSKIA6195GB

COLLISION DYNAMICS : Direct Damage and Indirect Damage

INFOID:0000000012106801

The body panel may be damaged indirectly by inertia.
Portion (A) in the figure is the direct damage, and portion (B) shows a type of indirect damage.
Therefore, it is necessary to closely check for both types of damage.

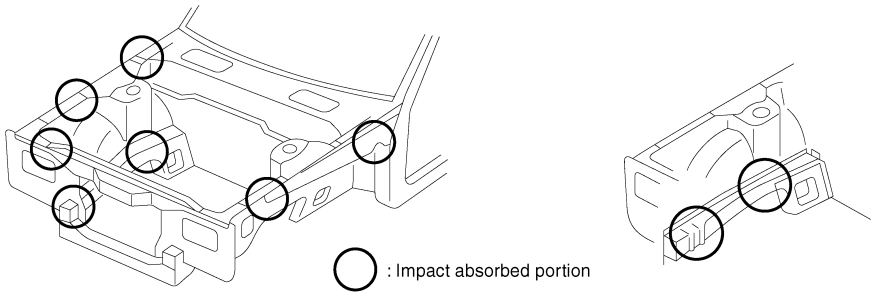


JSKIA6196GB

COLLISION DYNAMICS : Features of Impact Applied to Each Portion of Body

INFOID:0000000012106802

(1) FRONTAL COLLISION AND DAMAGE

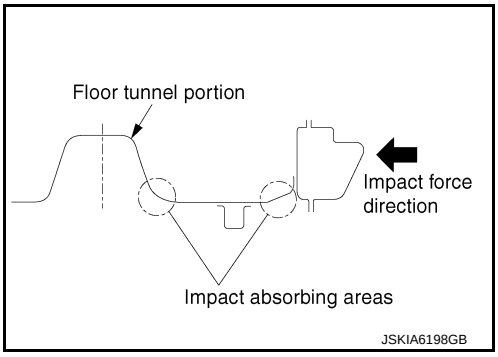


JSKIA6197GB

Impact force is absorbed at the bead and circled portions shown in the figure. If it is not absorbed completely, impact damage can propagate to the dash panel.

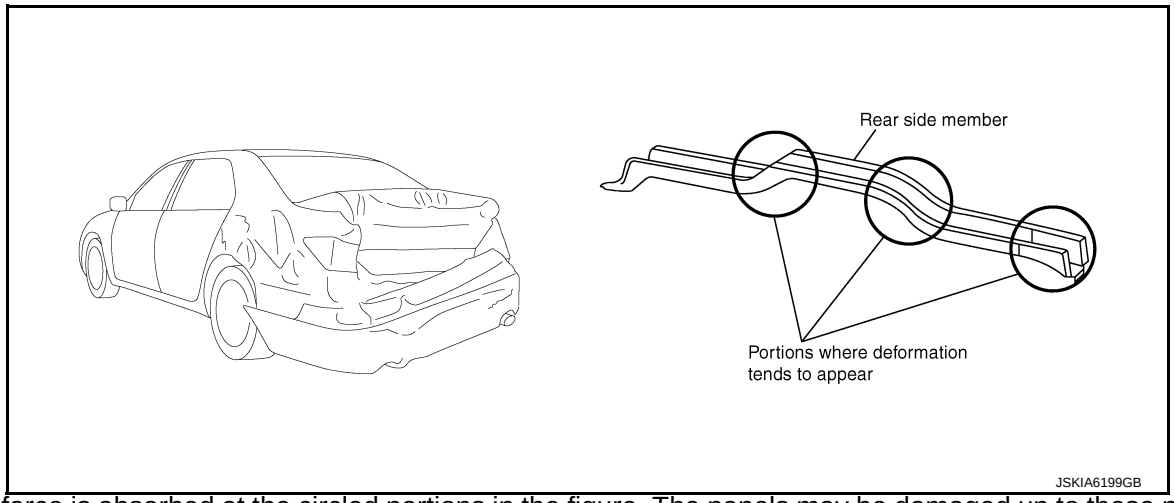
(2) SIDE COLLISION AND DAMAGE

If an impact is applied to the center of the passenger compartment, damage extends to the floor. The wheelbase also becomes misaligned.
Accordingly, wheelbase measurements, wheel alignment, and steering system checks are important.



JSKIA6198GB

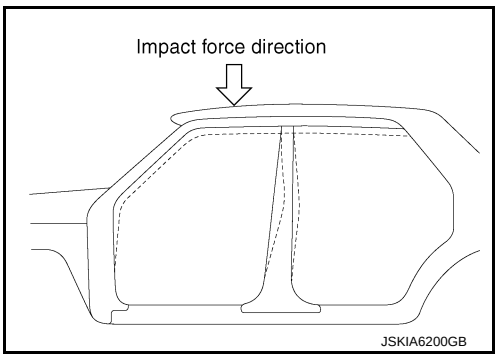
(3) REAR COLLISION AND DAMAGE



Impact force is absorbed at the circled portions in the figure. The panels may be damaged up to these portions according to the magnitude of impact.

(4) IMPACT FROM TOP AND DAMAGE

Small impact is absorbed with the roof and roof bow.
If the impact is great, it is also absorbed with the pillars.
However, broken glass and a deformed rear fender may result.



BODY ALIGNMENT

BODY ALIGNMENT : Body Alignment

INFOID:0000000012111674

The Body Repair Manual published for each model includes body alignment drawings, body center marks and panel matching marks. These are used to measure the extent of damage done (deformation extent) and to make sure that the dimensions of the body are correct after making the repair.

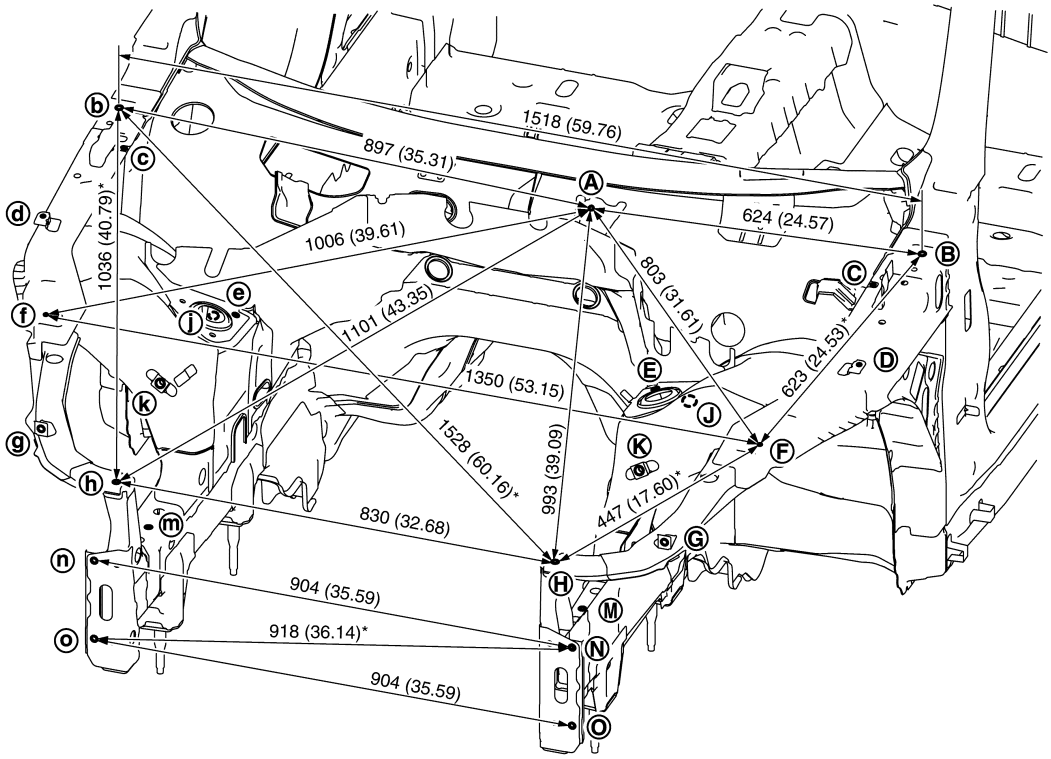
BODY ALIGNMENT : Engine Compartment

INFOID:0000000012106893

ENGINE COMPARTMENT (EXAMPLE)

These dimensions are measured by the Tram tracking gauge or steel tape.

Measurement



JSKIA3375GB

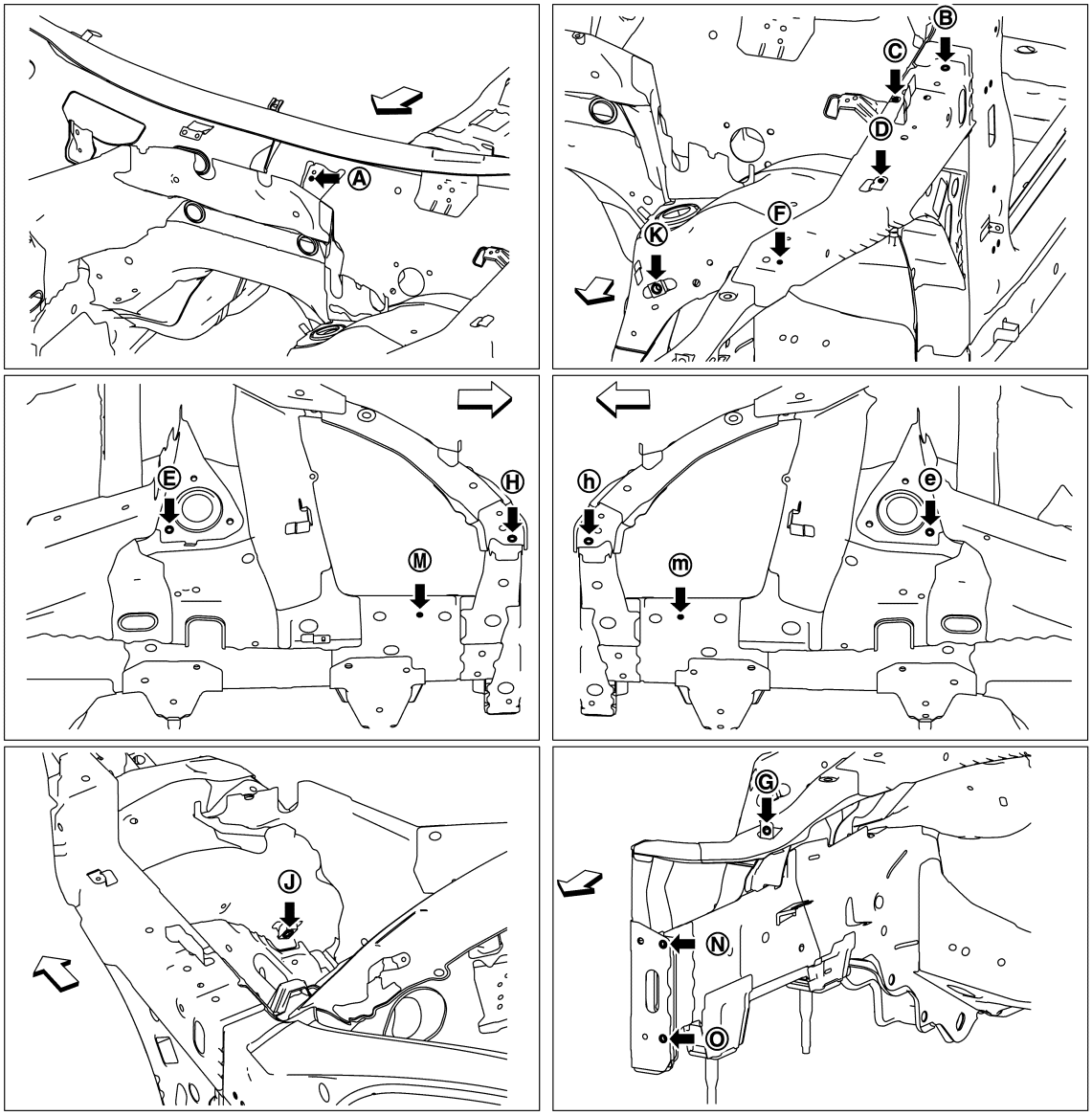
Unit: mm (in)

«The others»

Unit: mm (in)

Point	Dimension	Memo	Point	Dimension	Memo	Point	Dimension	Memo
Ⓐ – Ⓒ	580 (22.83)		Ⓑ – Ⓔ	558 (21.97)*		Ⓔ – ⓔ	786 (30.94)	
Ⓐ – ⓒ	850 (33.46)		Ⓑ – ⓔ	1227 (48.31)*		Ⓔ – ⓗ	985 (38.78)*	
Ⓐ – Ⓓ	722 (28.43)		Ⓑ – ⓕ	1561 (61.46)*		Ⓔ – ⓜ	934 (36.77)*	
Ⓐ – ⓓ	971 (38.23)		Ⓑ – Ⓙ	497 (19.57)*		Ⓕ – ⓗ	1149 (45.24)*	
Ⓐ – Ⓔ	469 (18.46)		Ⓒ – ⓒ	1416 (55.75)		Ⓖ – ⓖ	1179 (46.42)	
Ⓐ – ⓔ	659 (25.94)		Ⓒ – Ⓕ	504 (19.84)*		Ⓖ – Ⓗ	197 (7.76)*	
Ⓐ – Ⓖ	975 (38.39)		Ⓒ – ⓕ	1472 (57.95)*		Ⓖ – Ⓝ	254 (10.00)*	
Ⓐ – ⓖ	1128 (44.41)		Ⓒ – Ⓗ	912 (35.91)*		Ⓙ – ⓙ	906 (35.67)	
Ⓐ – Ⓜ	898 (35.35)		Ⓒ – ⓗ	1417 (55.79)*		Ⓚ – ⓚ	906 (35.67)	
Ⓐ – ⓜ	1017 (40.04)		Ⓓ – ⓓ	1544 (60.79)		Ⓜ – ⓜ	833 (32.80)	

Measurement Points



JSKIA3376ZZ

⇦: Vehicle front

Unit: mm (in)

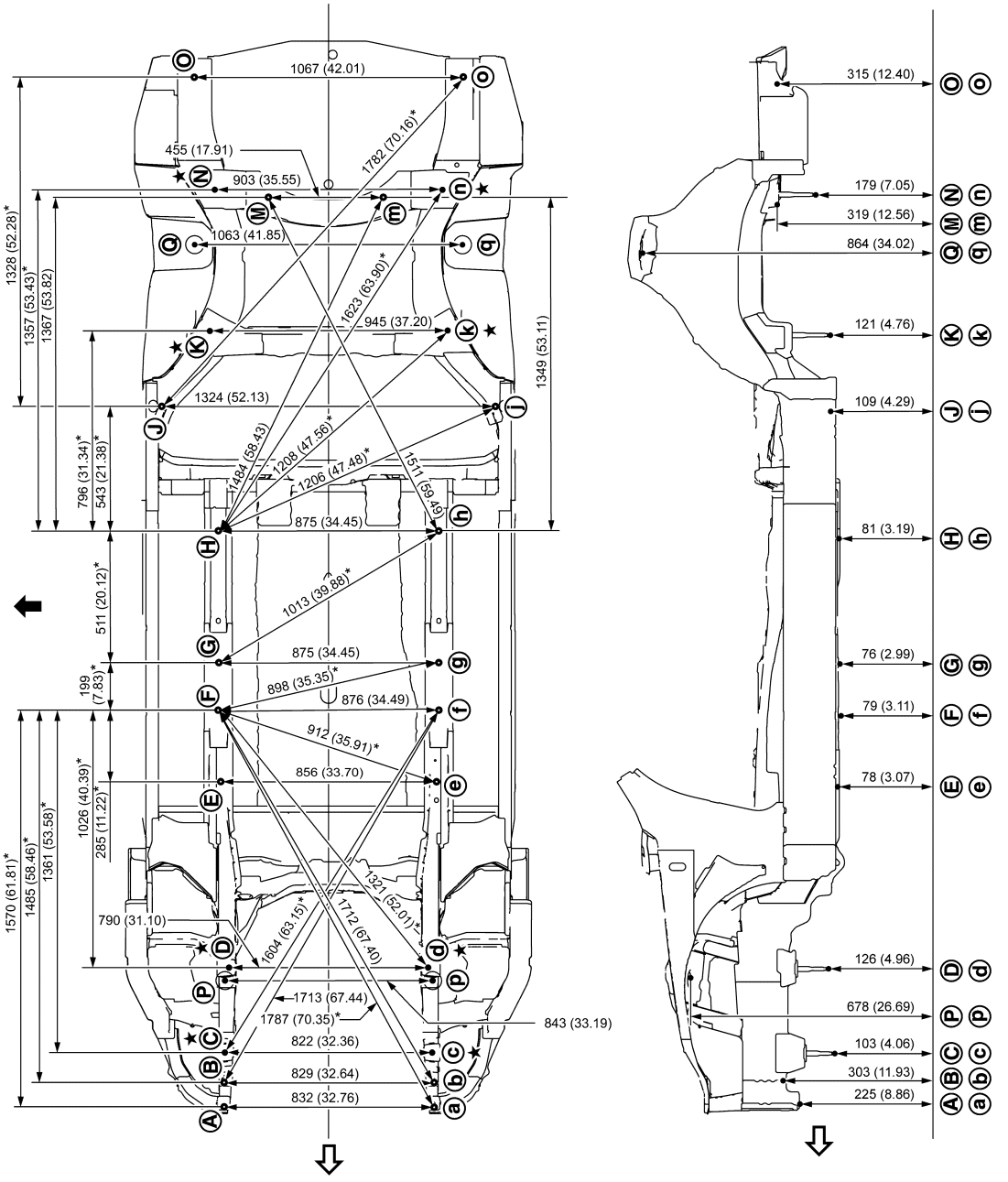
Point	Material	Point	Material
Ⓐ	Wiper mounting bracket hole center ϕ7 (0.28)	Ⓕ ⓕ	Hoodledge reinforcement hole center ϕ6 (0.24)
Ⓑ ⓑ	Hood hinge installing hole center ϕ12 (0.47)	Ⓗ ⓗ	Side radiator core support hole center ϕ12 (0.47)
Ⓒ ⓒ	Upper hoodledge hole center ϕ8 (0.31)	Ⓙ ⓙ Ⓚ ⓚ	Nut holder hole center ϕ16 (0.63)
Ⓓ ⓓ Ⓖ ⓖ	Front fender installing hole center Ⓓ ⓓ: ϕ7 (0.28) Ⓖ ⓖ: ϕ12 (0.47)	Ⓜ ⓜ	Front side member hole center ϕ7 (0.28)
Ⓔ ⓔ	Front strut installing hole center ϕ11 (0.43)	Ⓝ ⓝ Ⓞ ⓞ	Front bumper stay installing hole center ϕ11 (0.43)

BODY ALIGNMENT : Underbody

INFOID:0000000012106894

UNDERBODY (EXAMPLE)

Measurement



JSKIA3287GB

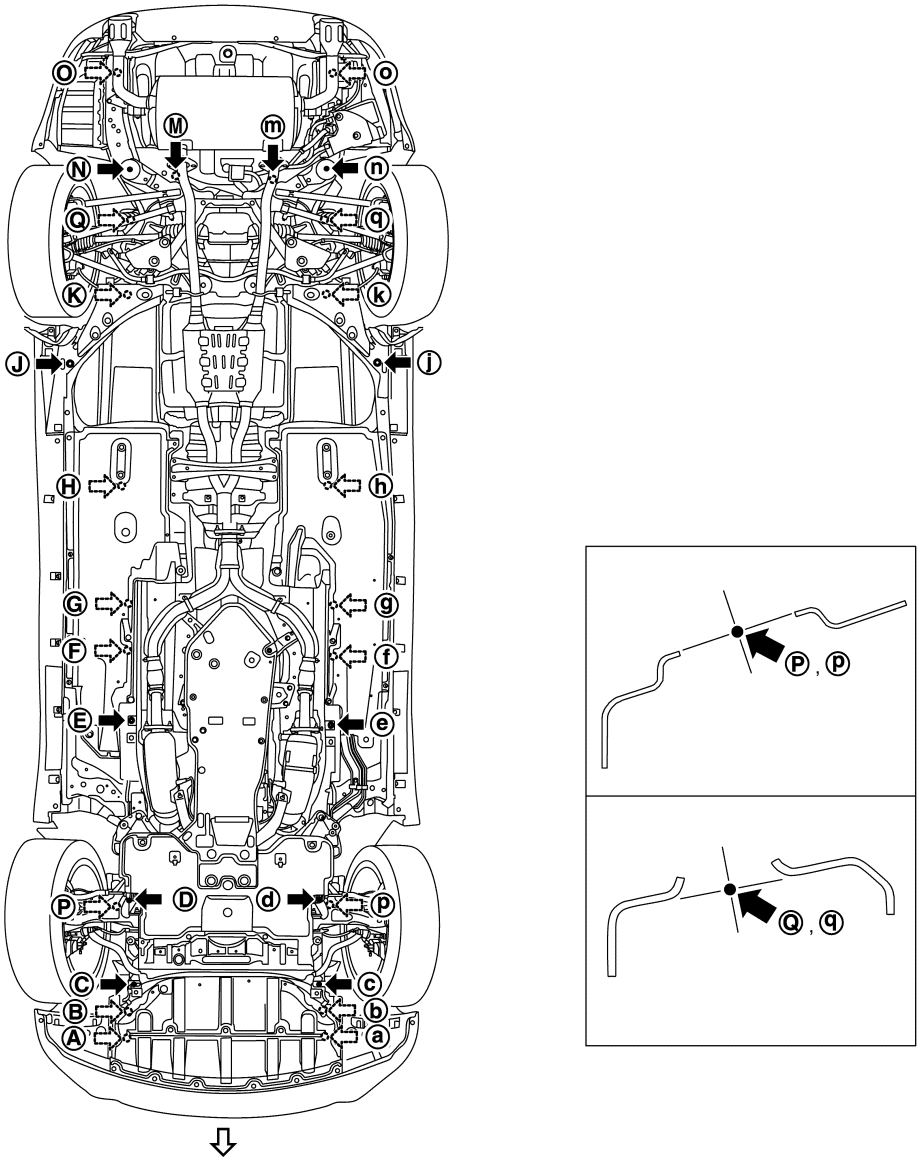
Unit: mm (in)

⇦: Vehicle front

⬅: Vehicle left side

★: Bolt head

Measurement Points



JSKIA3288ZZ

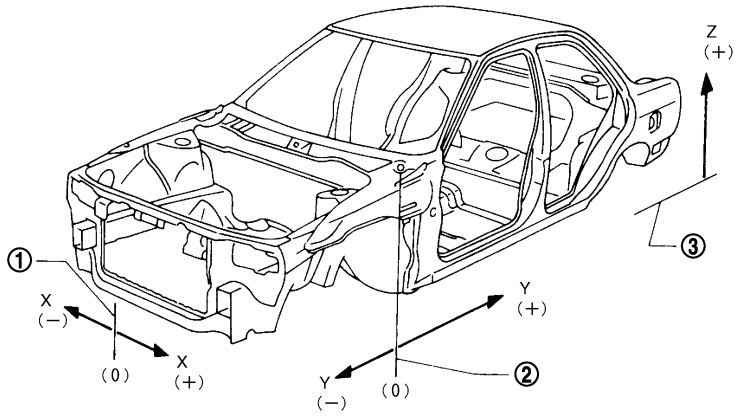
⇦: Vehicle front

Unit: mm (in)

Points	Coordinates			Remarks	Points	Coordinates			Remarks
	X	Y	Z			X	Y	Z	
Ⓐ ⓐ	±415.8 (±16.370)	–463.0 (–18.228)	224.6 (8.843)	Hole ϕ13 (0.51)	Ⓙ ⓙ	±662.0 (±26.063)	2304.0 (90.708)	108.5 (4.272)	Hole ϕ8 (0.31)
Ⓑ	416.2 (16.386)	–368.0 (–14.488)	303.2 (11.937)	Hole ϕ16 (0.63)	Ⓚ ⓚ	±472.6 (±18.606)	2603.8 (102.512)	120.8 (4.756)	Bolt head
ⓑ	–413.2 (–16.268)	–368.0 (–14.488)	303.2 (11.937)	Hole ϕ16 (0.63)	Ⓜ	238.0 (9.370)	3141.0 (123.661)	318.6 (12.543)	Hole ϕ16 (0.63)
Ⓒ ⓒ	±411.0 (±16.181)	–261.0 (–10.276)	103.3 (4.067)	Bolt head	ⓜ	–217.0 (–8.543)	3120.0 (122.834)	318.6 (12.543)	Hole 16×18 (0.63×0.71)
Ⓓ ⓓ	±395.0 (±15.551)	76.0 (2.992)	126.3 (4.972)	Bolt head	Ⓝ ⓝ	±451.5 (±17.776)	3163.9 (124.563)	179.0 (7.047)	Bolt head
Ⓔ ⓔ	±428.0 (±16.850)	815.0 (32.087)	78.4 (3.087)	Hole 16×20 (0.63×0.79)	Ⓞ ⓞ	±533.5 (±21.004)	3609.8 (142.118)	315.2 (12.409)	Hole 16×20 (0.63×0.79)

Points	Coordinates			Remarks	Points	Coordinates			Remarks
	X	Y	Z			X	Y	Z	
Ⓕ ⓕ	±438.0 (±17.244)	1100.0 (43.307)	79.0 (3.110)	Hole ϕ16 (0.63)	Ⓟ ⓟ	±421.6 (±16.598)	38.2 (1.504)	677.9 (26.689)	Hole ϕ50.1 (1.972)
Ⓖ ⓖ	±437.5 (±17.224)	1299.0 (51.142)	76.1 (2.996)	Hole ϕ16 (0.63)	Ⓠ ⓠ	±531.3 (±20.917)	2945.8 (115.976)	864.1 (34.020)	Hole ϕ71.8 (2.827)
Ⓗ ⓗ	±437.5 (±17.224)	1810.0 (71.260)	81.2 (3.197)	Hole ϕ16 (0.63)					

- Deformations of underbody due to impact are investigated with Tram tracking gauge or centering gauge.
- The coordinates of the measurement points are the distances measured from the standard line of “X”, “Y” and “Z” as follows.



JSKIA0073GB

① Vehicle center ② Front axle center ③ Imaginary base line

If you use the centering gauge for investigating the deformations, you will be able to use the dimensions of the measurement points “Z”.

- The distance between the two points is indicated by a straight line measurement. They are obtained by each ″x″, ″y″, and ″z″ coordinate as shown below.

The projected distance between holes A and B which are shown in the figure to the right can be obtained by the following method. Let Ⅰ be the plane projection view and Ⅱ be the front projection view. From the plane projection view, the distance between the holes can be obtained by constructing a triangle having side lengths of 50 and 30 units.

$L^2 = a^2 + b^2$ $L = \sqrt{a^2 + b^2}$

The projected measurement will be

$L = \sqrt{50^2 + 30^2} = \sqrt{3,400} = 58.3 \fallingdotseq 58$

View Ⅱ is a projection view of lenght L in View Ⅰ observed from a right angle. Lenght L_1 is measured directly from the drawing. If L_1 is to be computed, using a similar projection measurement method as before, let L ($=\sqrt{30^2 + 50^2}$) and 20 units be the sides of a triangle.

Then $L_1^2 = L^2 + c^2$

By substituting $L^2 = a^2 + b^2$

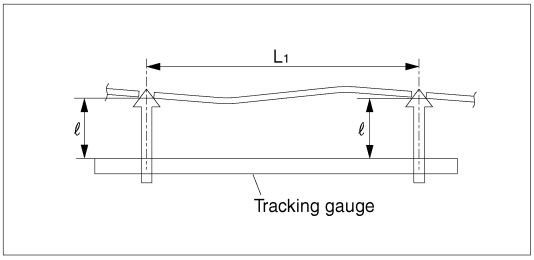
$L_1^2 = a^2 + b^2 + c^2$

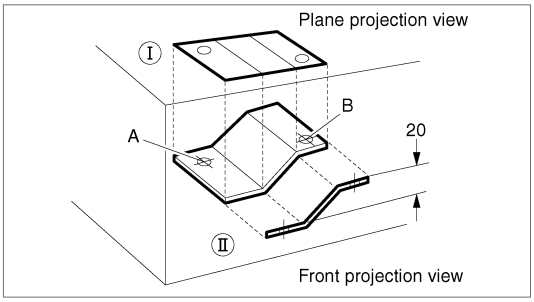
$L_1 = \sqrt{a^2 + b^2 + c^2}$

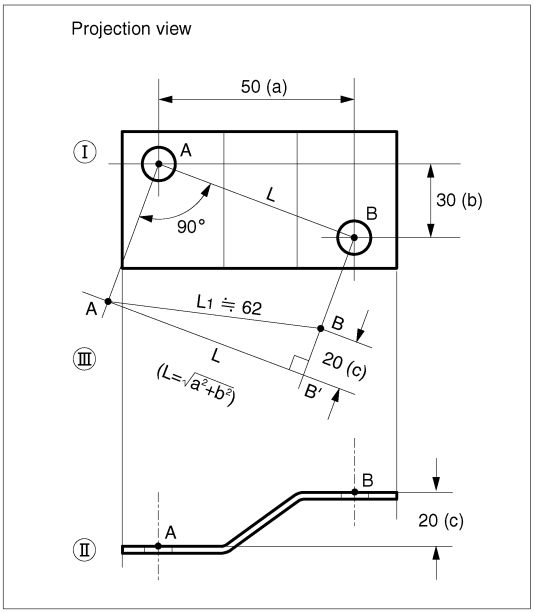
The distance of the straight line is obtained as

$L_1 = \sqrt{50^2 + 30^2 + 20^2} = \sqrt{3,800} = 61.6$

$\fallingdotseq 62$







JSKIA6831GB

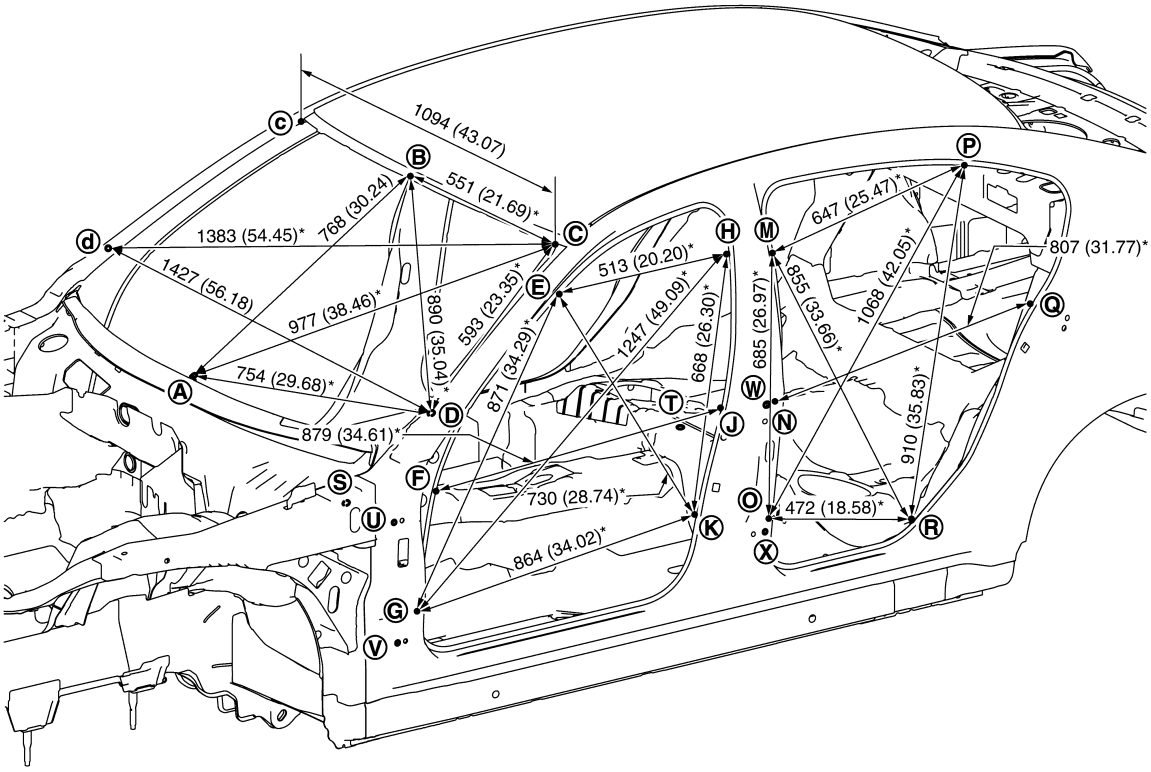
BODY ALIGNMENT : Passenger Compartment and Rear Body

INFOID:0000000012106895

These dimensions are measured by the Tram tracking gauge or steel tape.

PASSENGER COMPARTMENT (EXAMPLE)

Measurement



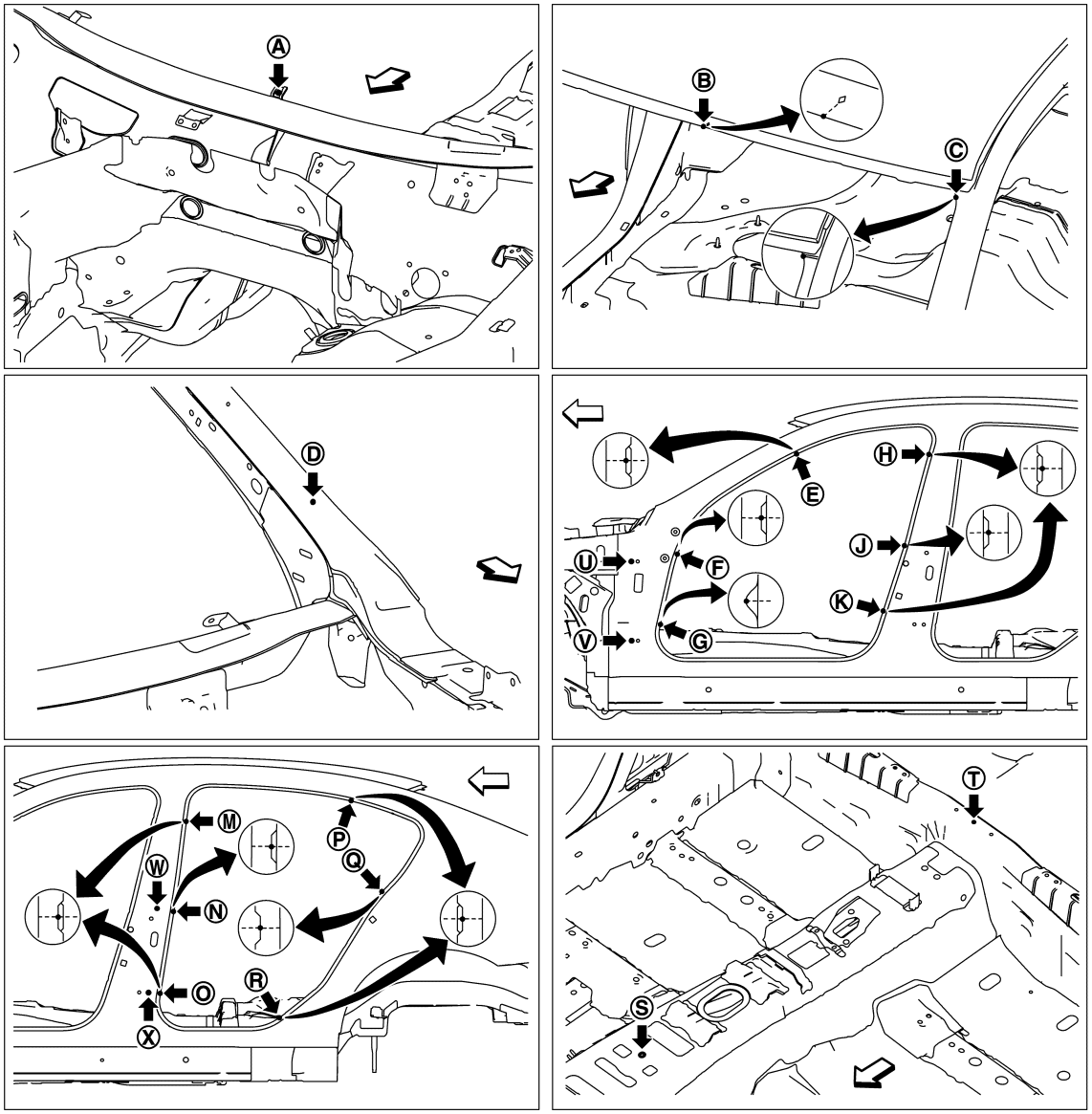
Unit: mm (in)

«The others»

Unit: mm (in)

Point	Dimension	Memo	Point	Dimension	Memo	Point	Dimension	Memo
Ⓔ - ⓔ	1232 (48.50)		Ⓜ - ⓡ	1619 (63.74)*		Ⓣ - Ⓜ	953 (37.52)*	
Ⓔ - ⓖ	1604 (63.15)*		Ⓝ - ⓝ	1450 (57.09)		Ⓣ - Ⓝ	829 (32.64)*	
Ⓔ - ⓗ	1344 (52.91)*		Ⓝ - ⓠ	1637 (64.45)*		Ⓣ - Ⓞ	785 (30.91)*	
Ⓔ - ⓚ	1529 (60.20)*		Ⓞ - ⓞ	1477 (58.15)		Ⓣ - Ⓟ	1072 (42.20)*	
Ⓕ - ⓕ	1444 (56.85)		Ⓞ - ⓟ	1682 (66.22)*		Ⓣ - Ⓠ	1003 (39.49)*	
Ⓕ - ⓙ	1693 (66.65)*		Ⓞ - ⓡ	1555 (61.22)*		Ⓣ - Ⓡ	772 (30.39)*	
Ⓖ - ⓖ	1474 (58.03)		Ⓟ - ⓟ	1144 (45.04)		Ⓤ - ⓤ	1584 (62.36)	
Ⓖ - ⓗ	1844 (72.60)*		Ⓟ - ⓡ	1590 (62.60)*		Ⓤ - Ⓦ	1164 (45.83)*	
Ⓖ - ⓚ	1705 (67.13)*		Ⓠ - ⓠ	1401 (55.16)		Ⓤ - Ⓧ	1157 (45.55)*	
Ⓗ - ⓗ	1253 (49.33)		Ⓡ - ⓡ	1485 (58.46)		Ⓥ - ⓥ	1611 (63.43)	
Ⓗ - ⓚ	1511 (59.49)*		Ⓢ - Ⓔ	994 (39.13)*		Ⓥ - Ⓦ	1226 (48.27)*	
Ⓙ - ⓙ	1450 (57.09)		Ⓢ - Ⓕ	791 (31.14)*		Ⓥ - Ⓧ	1129 (44.45)*	
Ⓚ - ⓚ	1466 (57.72)		Ⓢ - Ⓖ	761 (29.96)*		Ⓦ - ⓦ	1588 (62.52)	
Ⓜ - ⓜ	1273 (50.12)		Ⓢ - Ⓗ	1268 (49.92)*		Ⓧ - ⓧ	1623 (63.90)	
Ⓜ - ⓞ	1533 (60.35)*		Ⓢ - Ⓙ	1099 (43.27)*				
Ⓜ - ⓟ	1369 (53.90)*		Ⓢ - Ⓚ	999 (39.33)*				

Measurement Points



JSKIA3379ZZ

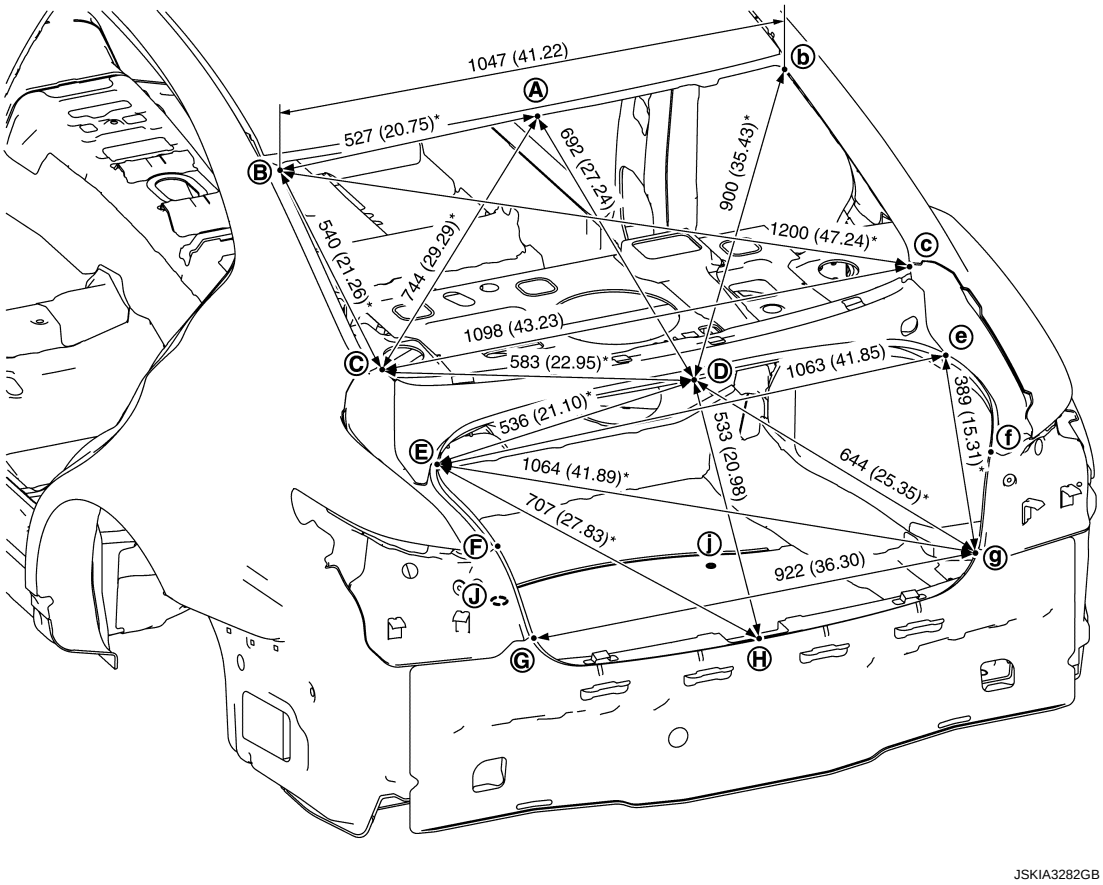
⇦: Vehicle front

Unit: mm (in)

Point	Material	Point	Material
Ⓐ	Upper dash hole center of center positioning mark ϕ8 (0.31)	Ⓗ ⓗ Ⓙ ⓙ Ⓚ ⓚ Ⓜ ⓜ Ⓝ ⓝ Ⓞ ⓞ	Center pillar indent
Ⓑ	Roof flange end of center positioning mark	Ⓟ ⓟ Ⓠ ⓠ Ⓡ ⓡ	Rear fender indent
Ⓒ ⓒ	Outer side body joggle	Ⓢ	Trans control reinforcement hole center of center positioning mark 14×12 (0.55×0.47)
Ⓓ ⓓ	Outer side body hole center ϕ4 (0.16)	Ⓣ	Rear seat crossmember reinforcement hole center of center positioning mark ϕ5 (0.20)
Ⓔ ⓔ Ⓕ ⓕ Ⓖ ⓖ	Front pillar indent	Ⓤ ⓤ Ⓥ ⓥ Ⓦ ⓦ Ⓧ ⓧ	Door hinge installing hole center Ⓤ ⓤ Ⓥ ⓥ Ⓧ ⓧ: ϕ12 (0.47) Ⓦ ⓦ: 11×9 (0.43×0.35)

REAR BODY (EXAMPLE)

Measurement



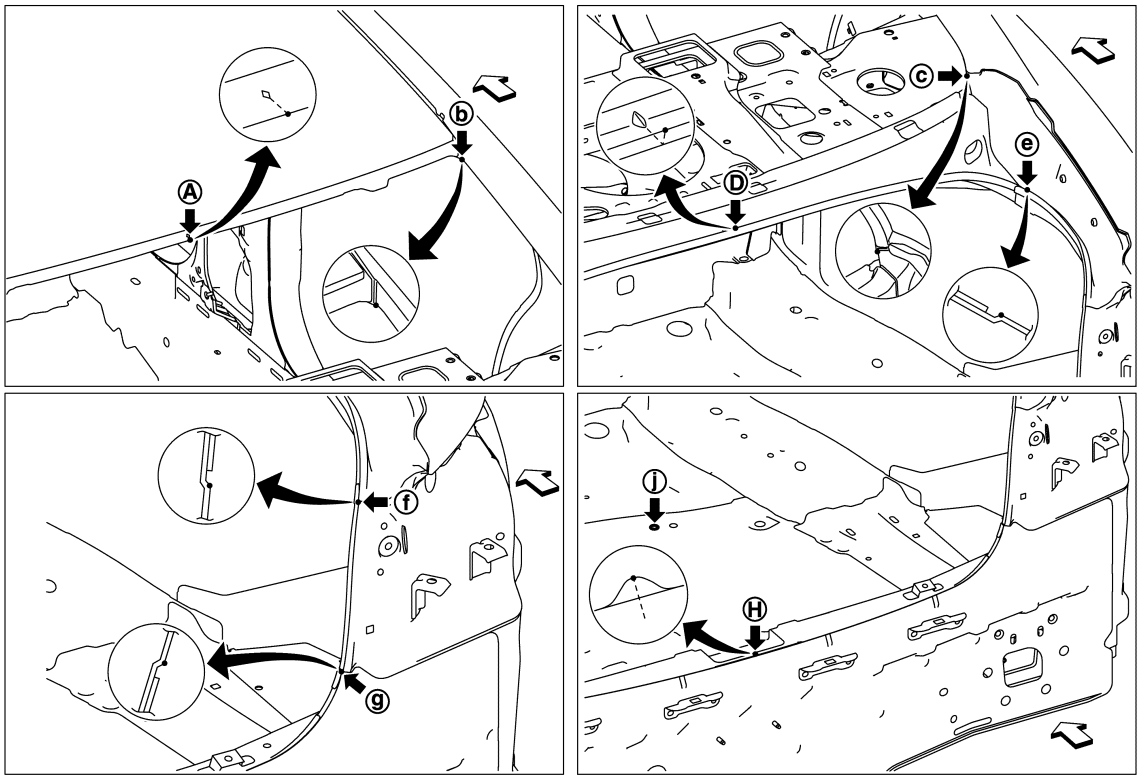
Unit: mm (in)

«The others»

Unit: mm (in)

Point	Dimension	Memo	Point	Dimension	Memo	Point	Dimension	Memo
Ⓐ – Ⓔ	916 (36.06)*		Ⓔ – Ⓙ	726 (28.58)*		Ⓖ – Ⓗ	469 (18.46)*	
Ⓐ – Ⓖ	1207 (47.52)*		Ⓔ – ⓙ	995 (39.17)*		Ⓖ – Ⓙ	750 (29.53)*	
Ⓐ – Ⓗ	1190 (46.85)		Ⓕ – ⓕ	1019 (40.12)		Ⓖ – ⓙ	981 (38.62)*	
Ⓒ – ⓔ	1108 (43.62)*		Ⓕ – Ⓗ	573 (22.56)*		Ⓗ – Ⓙ	754 (29.68)*	
Ⓓ – Ⓕ	592 (23.31)*		Ⓕ – Ⓙ	801 (31.54)*				
Ⓓ – Ⓙ	725 (28.54)*		Ⓕ – ⓙ	1041 (40.98)*				

Measurement Points



JSKIA3283ZZ

⇦: Vehicle front

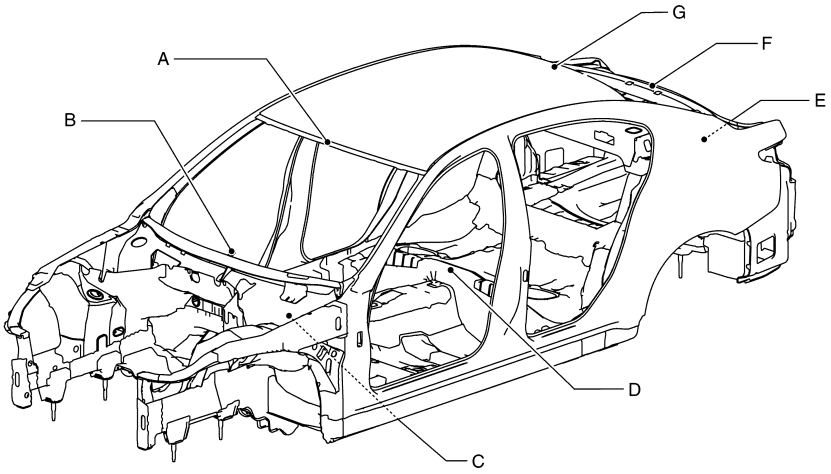
Unit: mm (in)

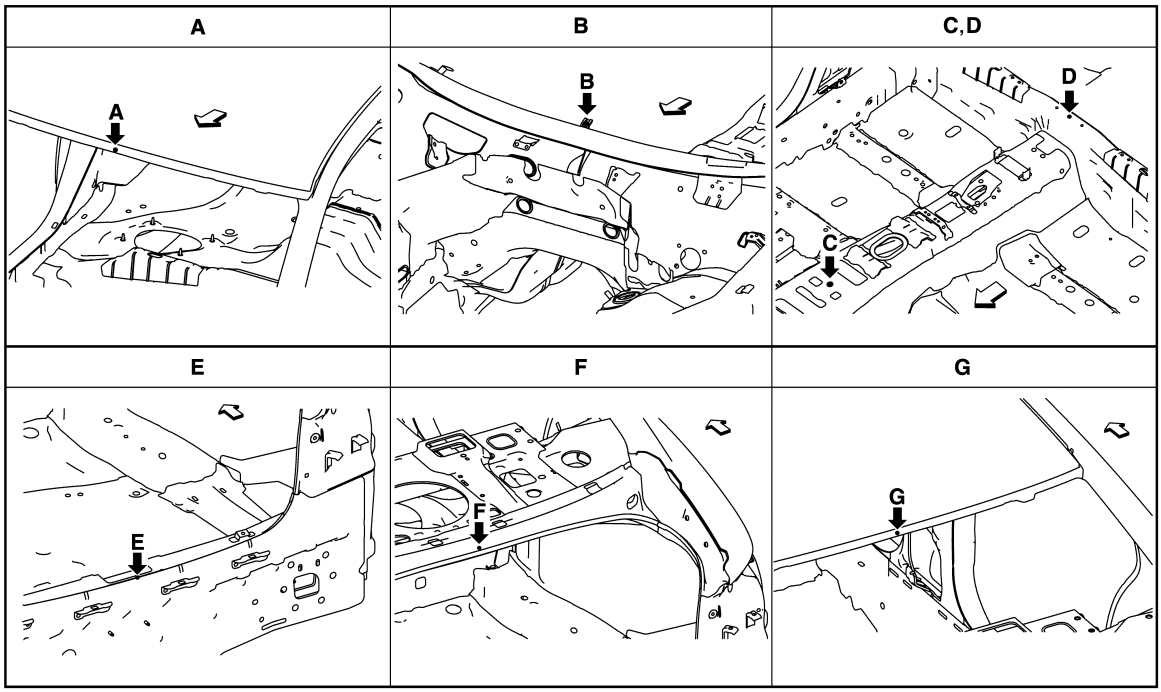
Point	Material	Point	Material
Ⓐ	Roof flange end of center positioning mark	Ⓕ ⓕ Ⓖ ⓖ	Rear combination lamp base joggle
Ⓑ ⓑ	Outer side body joggle	Ⓗ	Upper rear panel indent of center positioning mark
Ⓒ ⓒ Ⓔ ⓔ	Rear fender corner joggle	Ⓙ ⓙ	Rear floor rear hole center ϕ12 (0.47)
Ⓓ	Rear waist flange end of center positioning mark		

BODY ALIGNMENT : Body Center Marks (Example)

INFOID:0000000012106896

A mark has been placed on each part of the body to indicate the vehicle center. When repairing parts damaged by an accident which might affect the vehicle frame (members, pillars, etc.) more accurate, effective repair will be possible by using these marks together with body alignment data.





JSKIA3374ZZ

⇦: Vehicle front

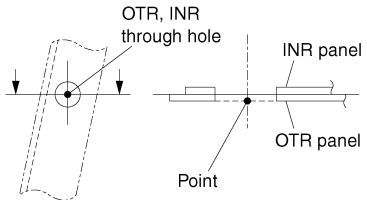
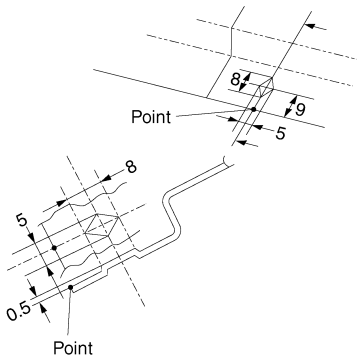
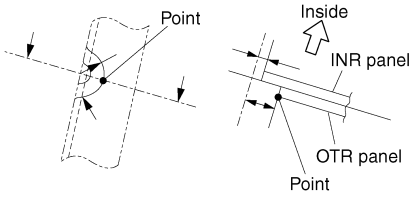
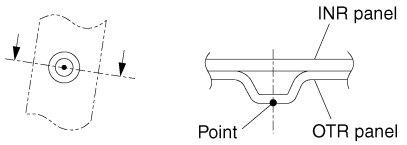
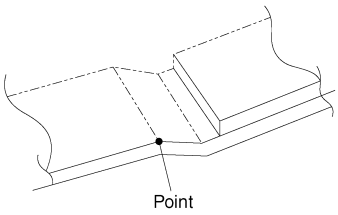
Unit: mm (in)

Points	Portion	Marks
A	Front roof	Embossment
B	Upper dash	Hole ϕ8 (0.31)
C	Trans control reinforcement	Hole 14×12 (0.55×0.47)
D	Rear seat crossmember reinforcement	Hole ϕ5 (0.20)
E	Upper rear panel	Indent
F	Rear waist	Bead
G	Rear roof	Embossment

BODY ALIGNMENT : Measurement Mark Types

INFOID:0000000012106898

These measurement marks are indicated as follows:

Types	Form and measurement point	Types	Form and measurement point
Hole Standard diameter For body ϕ4 – ϕ8 For under (Member) ϕ10 – ϕ18		Lozenge Form	
Notch			
Convex		Joggle point	

JSKIA6210GB

SUSPENSION TYPES

SUSPENSION TYPES : Suspension Types

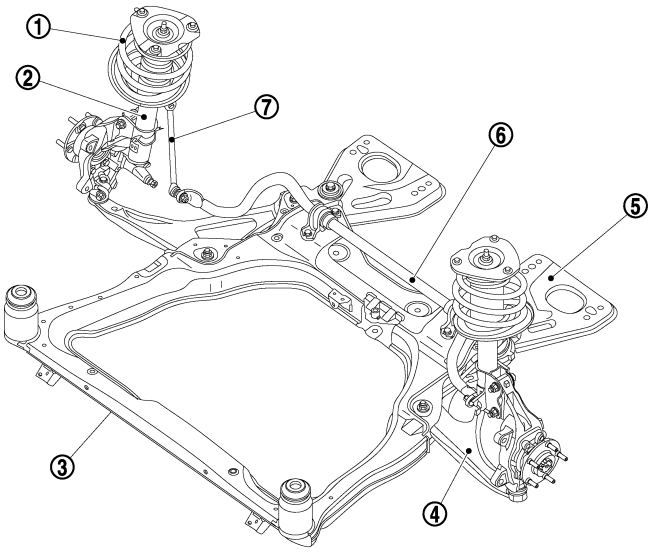
INFOID:0000000012112029

Wheel alignment inclinations must be repaired correctly to conform to design specifications. Therefore, you should understand types and installation of suspension, and should be careful when installing the suspension to repair wheel alignment inclinations. There are roughly two categories of suspensions (rigid axle type and independent type). NISSAN's principal suspension types are shown as follows.

SUSPENSION TYPES : Front Suspension

INFOID:0000000012106900

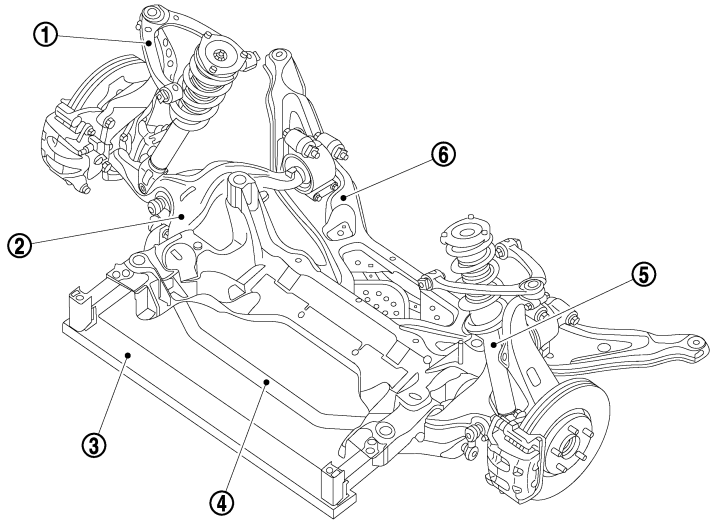
(1) FF TYPE (Front engine - Front drive)



JSKIA6211ZZ

Strut type suspension	
No.	Parts name
1.	Coil spring
2.	Strut
3.	Front suspension member
4.	Transverse link
5.	Front suspension member stay
6.	Stabilizer bar
7.	Stabilizer connecting rod

(2) FR TYPE (Front engine - Rear drive)



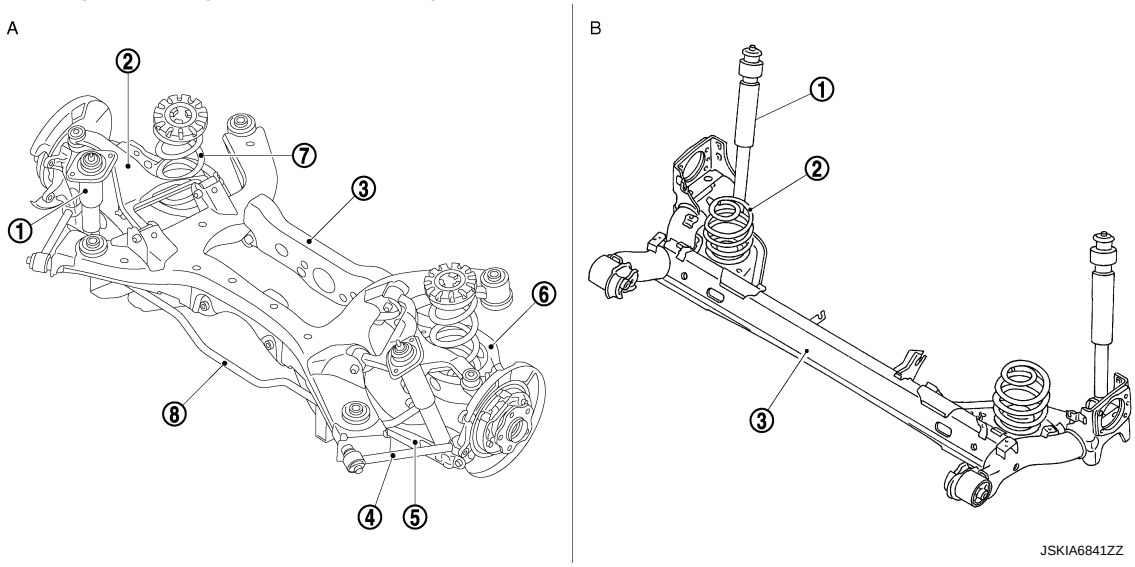
JSKIA6212ZZ

Double wishbone type suspension	
No.	Parts name
1.	Upper link
2.	Transverse link
3.	Front suspension member
4.	Stabilizer bar
5.	Shock absorber
6.	Front cross bar

SUSPENSION TYPES : Rear Suspension

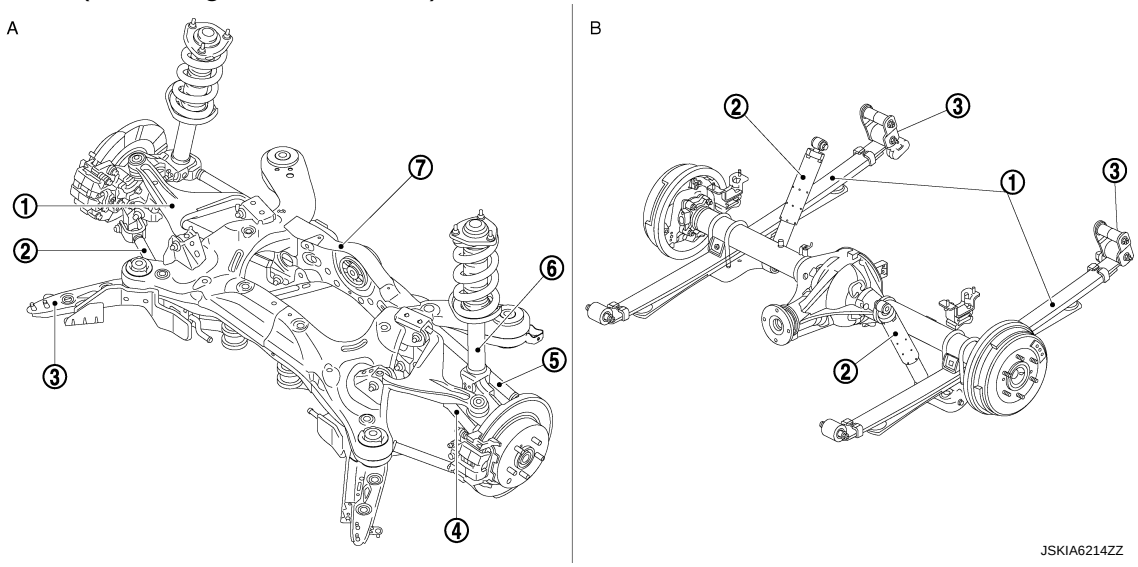
INFOID:0000000012106901

(1) FF TYPE (Front engine - Front drive)



A: Multi-link type suspension		B: Torsion beam type suspension (rigid axle)	
No.	Parts name	No.	Parts name
1.	Shock absorber	1.	Shock absorber
2.	Suspension arm	2.	Coil spring
3.	Rear suspension member	3.	Rear suspension beam
4.	Radius rod	—	—
5.	Front lower link		
6.	Rear lower link		
7.	Coil spring		
8.	Stabilizer bar		

(2) FR TYPE (Front engine - Rear drive)



A: Multi-link type suspension		B: Leaf spring type suspension (rigid axle)	
No.	Parts name	No.	Parts name
1.	Suspension arm	1.	Leaf spring
2.	Front lower link	2.	Shock absorber
3.	Rear suspension member stay	3.	Shackle
4.	Rear lower link	—	—
5.	Toe control link		
6.	Shock absorber		
7.	Rear suspension member		

WHEEL ALIGNMENT

WHEEL ALIGNMENT : Wheel Alignment

INFOID:0000000012112036

Wheel alignment refers to the positioning of each of the four wheels with respect to the body. Correct wheel alignment provides:

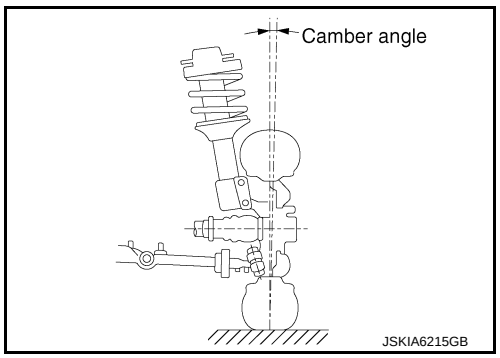
- Light steering wheel handling
- Positive steering wheel operation
- Proper stability of steering wheel
- Reduced tire wear

When repairing a damaged vehicle, particularly one with a strut suspension, an error in body alignment will directly affect wheel alignment. Therefore, correct adjustment of body alignment is very important.

WHEEL ALIGNMENT : Camber Angle

INFOID:0000000012106902

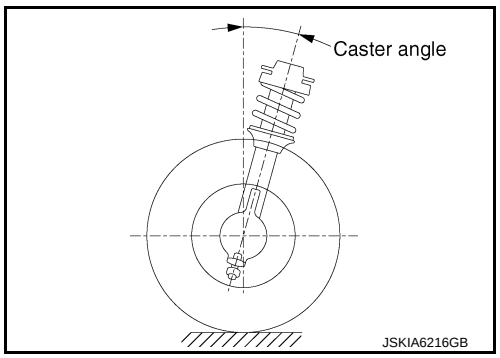
Tilting of the wheels from the vertical is called the camber angle.



WHEEL ALIGNMENT : Caster Angle

INFOID:0000000012106903

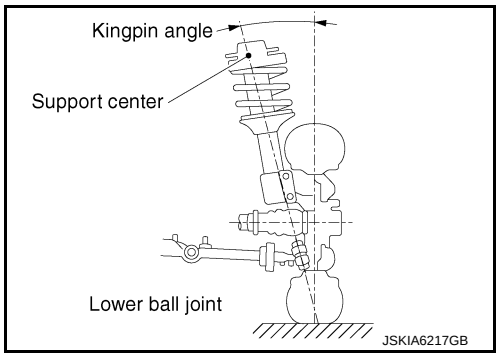
Rearward tilting of the strut when viewing the front wheel from the side.
(As shown in the figure, when caster is tilted rearward, the front wheels are pulled backward by the tires contact to the road. This reduces sideways vibration in the front wheels and also makes it easier for the wheels to recover their forward position after being turned. This “caster effect”, helps keep the vehicle stable in the straight ahead position and improves steering correction.)



WHEEL ALIGNMENT : Kingpin Angle

INFOID:0000000012106904

Inward tilting of the strut when viewing the front suspension from the front.



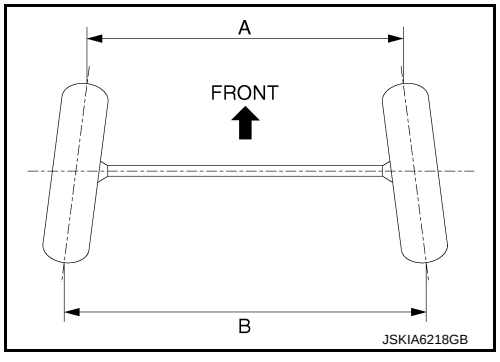
WHEEL ALIGNMENT : Toe

INFOID:0000000012106905

Toe refers to the turning in of the front wheels.

TOE : B - A
B - A : + X mm ⇒ TOE-IN
B - A : - X mm ⇒ TOE-OUT

Its purpose is to prevent slipping and scuffing of the tires on the road.



WHEEL ALIGNMENT : Non-standard Conditions Caused by Improper Wheel Alignment

INFOID:0000000012106906

(1) IMPROPERLY ADJUSTED CAMBER
- Heavy steering wheel operation
- Slow steering wheel return
- Uneven tire wear

(2) IMPROPERLY ADJUSTED CASTER
- Excessive caster: Heavy steering wheel operation
- Insufficient caster: Slow steering wheel return
- Imbalance between left and right: Car may be pulled to the side with the smaller caster angle

(3) IMPROPERLY ADJUSTED KINGPIN INCLINATION
- Heavy steering wheel operation
- Heavy shock loads transmitted to steering wheel
- Slow steering wheel return

(4) IMPROPERLY ADJUSTED TOE
- Heavy steering wheel operation
- Car may be pulled to one side
- Uneven tire wear

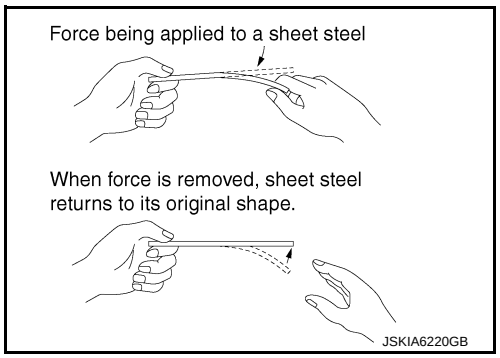
BODY MATERIALS
SHEET STEEL
SHEET STEEL : Properties of Sheet Steel

INFOID:0000000012106981

It is important to understand the properties of sheet steel for successful body repair work.Body sheet steel contains a small amount of carbon (low carbon steel) to provide shock resistance and durability. The body is constructed by pressing and welding this sheet steel.

(1) ELASTICITY

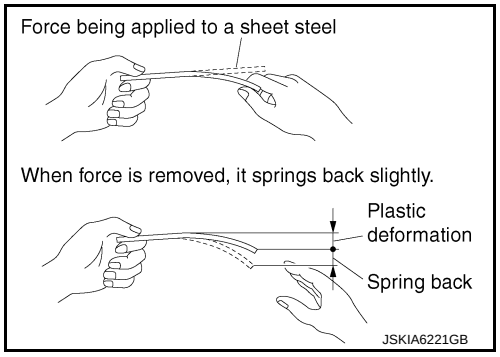
When the door panel or fender is pressed lightly, the panel surface will bend slightly. However, this deformation recovers as soon as the pressure is released. This type of deformation is called elastic deformation, and this property of a substance to return to its original shape is called elasticity.



(2) PLASTICITY

If the surface of a door or fender is hit with a hammer, the surface will be dented and the original shape will not be recovered. This type of deformation is called plastic deformation, and this property is called plasticity.

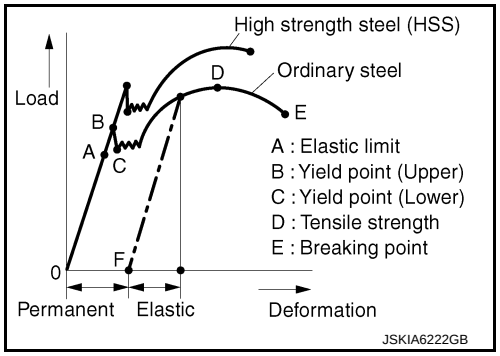
If the bend load exceeds the range of elastic deformation and then is released, the sheet steel will exhibit a tendency to return to its original form. This is called spring back.



The figure shows the relationship between the load and strain of ordinary or high strength steel.

If the load is lower than point (A), the steel will return to its original shape when the load is removed.

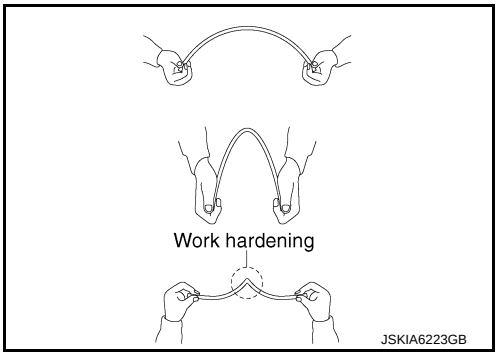
If the load exceeds point (A), even if the load is removed, the deformation (0 - F) will remain.



(3) WORK HARDENING

When sheet steel is bent or stretched, its hardness will increase. This is called work hardening. Plastic deformation always accompanies this phenomenon.

Try to bend sheet steel beyond the limit of plastic deformation in one direction. Then, bend it back in the opposite direction. The portion bent first will be deformed and hardened. If this operation is repeated many times, the steel will break at the hardened portion.
If the same portion is repeatedly hit with a hammer during body repair work, it will harden, and finally crack. To avoid this, always consider work hardening and do not strike the same portion repeatedly.



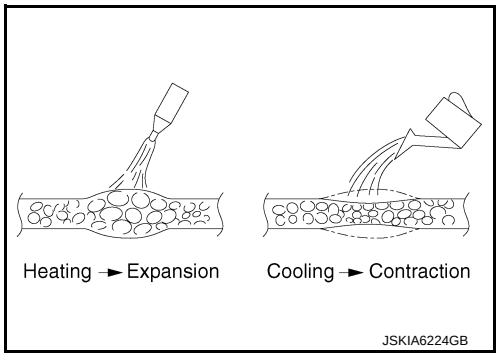
SHEET STEEL : Thermal Effects on Steel

INFOID:0000000012106980

Sheet steel will exhibit expansion, contraction, softening, and hardening phenomena when it is affected by heat.

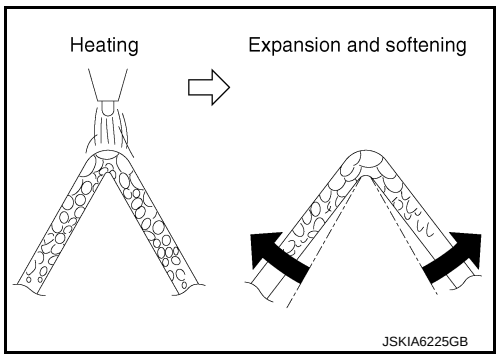
(1) EXPANSION AND CONTRACTION

When heated, sheet steel expands. When cooled, it contracts. This property is utilized in the panel shrinking technique.



(2) SOFTENING AND HARDENING

When heated, sheet steel expands and becomes soft.
Heating can be used to reduce the hardness of work hardened steel.



(3) HEAT TREATMENT METHOD FOR SHEET STEEL

- Quenching sheet steel
  Sheet steel is heated to approximately 800°C (1,472°F) and then cooled suddenly in water or oil. The sheet steel becomes hard.
- Annealing sheet steel
  Work hardened sheet steel is heated to approximately 700°C - 800°C (1,292°F - 1,472°F) and then cooled gradually.
  The hardness of the sheet steel is reduced to its original level.
- Tempering sheet steel
  Quenched sheet steel is hard, but it may be fragile. To toughen the sheet steel, it is heated to approximately 600°C (1,112°F) and then cooled gradually.
- Normalizing sheet steel
  If sheet steel is heated locally by welding and uneven strength is suspected, the sheet steel can be heated to approximately 800°C - 900°C (1,472°F - 1,652°F) and then cooled gradually.
- As sheet steel is heated, its color changes gradually. Finally, at approximately 1,500°C (2,732°F), it begins to melt.
  The table below shows the relationship between sheet steel color and temperature.

Color	Temperature °C (°F)
Dark red	600 (1,112)
Red	700 (1,292)
Light red	850 (1,562)
Yellowish red	900 (1,652)
Yellow	1,000 (1,832)
Light yellow	1,100 (2,012)
White	1,200 (2,192)
Bright white	1,250 (2,282) or over

SHEET STEEL : Types of Sheet Steel

INFOID:0000000012106979

(1) COLD ROLLED SHEET STEEL

Block steel is heated and hot rolled. It is then cold rolled into sheets.
There are several kinds of cold rolled sheet steel, such as bake hard steel and specular reflection steel.
The yield strength of bake hard steel is increased by heating after ED painting to prevent dents.
Specular reflection steel is used to provide a vivid painting surface. This type of steel can be welded and hammered for repairing the same as the standard cold rolled sheet steel.

Features:
- Cold rolled sheet steel features higher ductility and better pressing ability.
- It also features a smooth surface and uniform sheet thickness.
- Cold rolled sheet steel is used for the inner and outer body panels.

(2) HOT ROLLED SHEET STEEL

Block steel is heated and rolled by rollers.

Features (in comparison with cold rolled sheet steel):
- Strength is approximately the same.
- Lower cost
- Rough surface finish
- Lowest limit of thickness is 1.4 mm (0.055 in).
- Mainly used for inner body panels, frame and reinforcement

(3) HIGH STRENGTH SHEET STEEL (HSS)

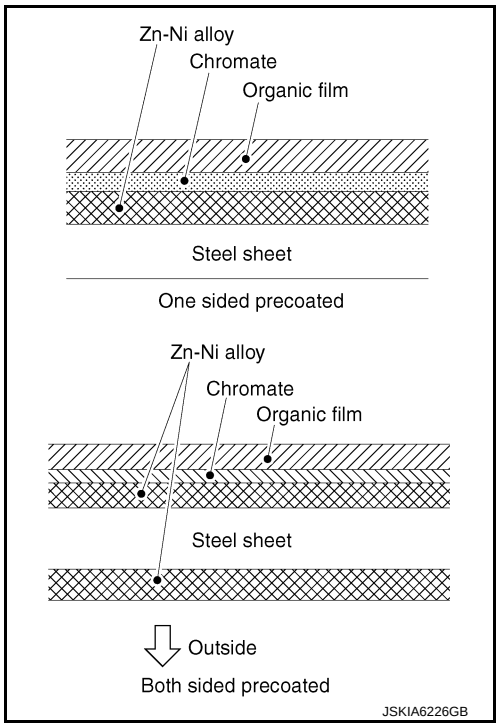
High strength sheet steel is produced by adding small amounts of additives to ordinary steel.
This high strength sheet steel features greater tensile strength than ordinary sheet steel. Therefore, thickness can be reduced without reducing panel strength.

WHY HIGH STRENGTH SHEET STEEL IS USED
- To reduce body weight
  Thickness can be reduced, hence body weight can be reduced.
- To improve durability and strength
  High strength sheet steel is selectively used in sections normally subjected to stress to improve car durability.
- To improve strength against collision
  High strength sheet steel is used in structural portions of the body to guard the occupant in collisions. For example, the high strength sheet steels are used as shown in the figure of the uni-body.

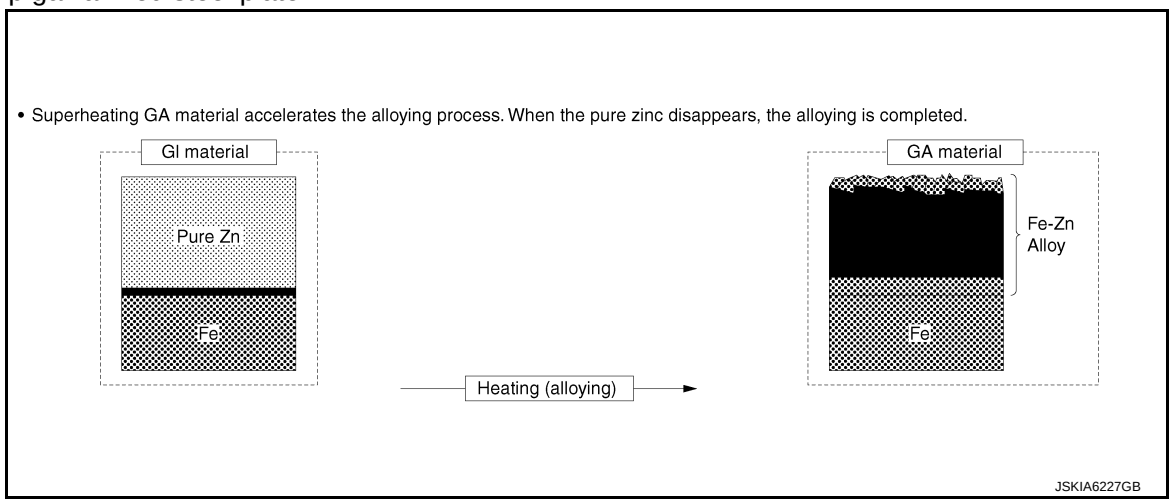
(4) ANTI-CORROSIVE PRECOATED STEEL

Anti-corrosive precoated steel is coated with zinc, tin, nickel, aluminum, etc., to insulate the surface against air and moisture, thereby preventing rust formation.
Durasteel is anti-corrosive precoated steel and is one of most important materials.

- DURASTEEL
  In order to improve repairability and corrosion resistance, a new type of anti-corrosive precoated steel sheets have been adopted, taking the place of conventional zinc-coated steel sheets.
  This durasteel is electroplated and has a zinc-nickel alloy under organic film, which provides excellent corrosion resistance.
  Durasteel is classified as either one-sided precoated steel or both sided precoated steel. The both sided precoated steel provides excellent corrosion resistance.



- For example, the anti-corrosive precoated steels are used as shown in the figure of the uni-body.
- GA, GI material
  Hot-dip galvanized steel plate



ALUMINUM

ALUMINUM : Aluminum

INFOID:0000000012112295

Aluminum alloys contain very small amounts of metal elements such as copper, magnesium, silicon, etc. and have a strength almost equal to steel plates. Its specifications are shown below. Aluminum alloys are beginning to attract much attention as a material for automobiles.

ALUMINUM : Lightweight

INFOID:0000000012106975

When steel components are rebuilt using aluminum alloys their weight is reduced by approximately 1/2.
The specific gravity of aluminum is 1/3 that of steel. However, in order to maintain equivalent rigidity, their thickness must be increased by approximately 1.4 times. Hence, their weight becomes 1.4/3, 1/2.

Specific gravity of iron : 7.83
Specific gravity of aluminum : 2.70

ALUMINUM : Corrosion Resistance

INFOID:0000000012106972

When aluminum is exposed to air, it forms an oxidizing film that has a corrosion resistant characteristic.

ALUMINUM : Excellent Heat Conductor

INFOID:0000000012106973

Heat conductivity of aluminum alloy is approximately 2 times that of iron. It absorbs heat quickly and also cools quickly.

ALUMINUM : Excellent Electrical Conductor

INFOID:0000000012106974

Electrical conductivity of aluminum alloy is approximately 2 times that of iron. It is a very economical conductor.

ALUMINUM : Anti-magnetic

INFOID:0000000012106969

Aluminum has an anti-magnetic characteristic.

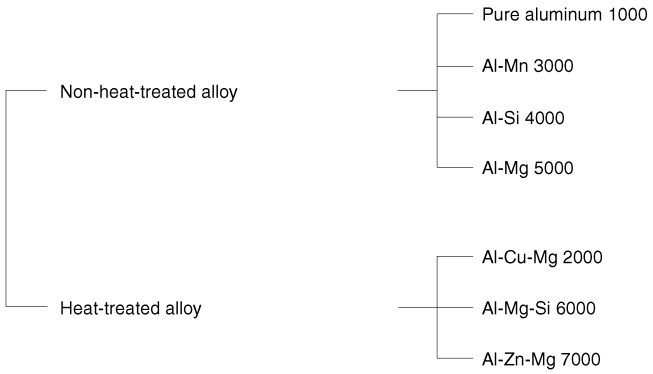
ALUMINUM : Recyclable

INFOID:0000000012106970

Because of its low melting point, it can be easily recycled. Furthermore, the energy required to produce recycled aluminum is only 1/28th the energy required when processing from ore. The quality of recycled aluminum is almost indistinguishable from the original aluminum.

ALUMINUM : Structure of Aluminum Alloy (Used for Vehicle Body Parts)

INFOID:0000000012106971



JSKIA6228GB

TYPES OF PLASTIC

TYPES OF PLASTIC : Classification of Plastic

INFOID:0000000012106982

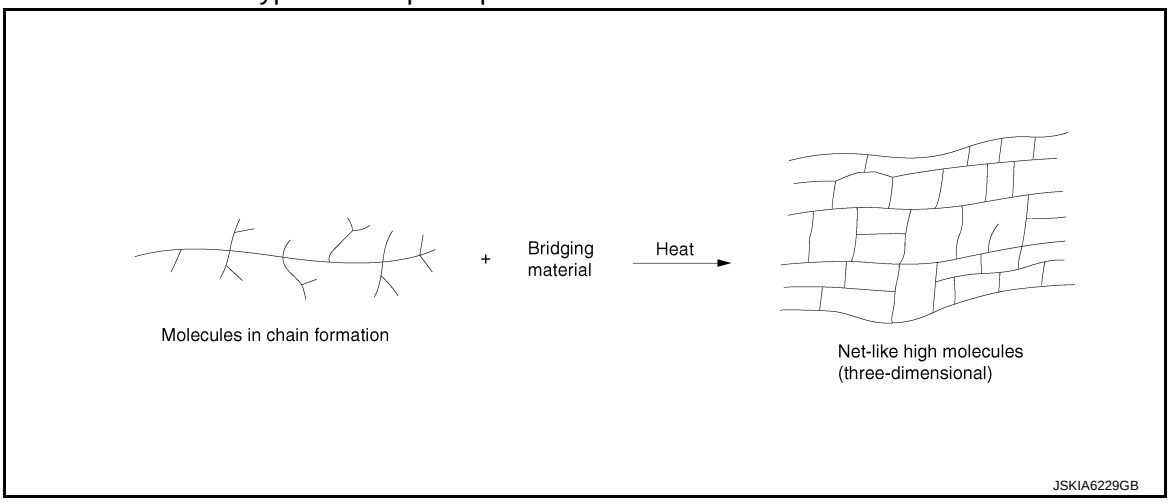
Presently, there are many different types of plastics which have been put to practical use. According to their physical properties and formation processes, plastics can be generally classified as shown below.

- Thermoplastics and Thermosetting Plastics
- Crystalline Plastics and Amorphous Plastics
- Monomer and Polymer (block polymer, graft polymer, etc.)

For this fundamental presentation, thermosetting plastics and thermoplastics are explained in detail.

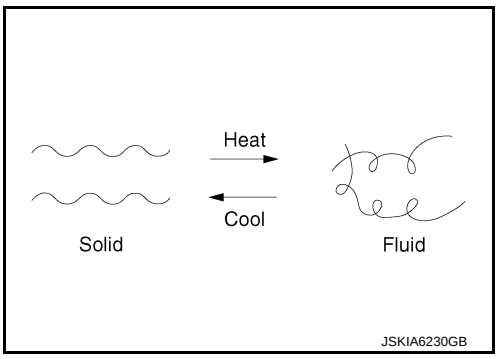
(1) THERMOSETTING PLASTICS

- Thermosetting plastics can be formed into sheets at high temperatures. After undergoing a setting process they cannot be softened again by reheating.
- Thermosetting plastics are formed from a material of relatively small molecules in chain formation. By adding bridging material and heating the material, it changes into the liquid phase. When more heat is added the chemical reaction is accelerated, and the material transforms into net-like three-dimensional high polymer. The material maintains its hardness property at high temperatures.
- Once the material is hardened, it cannot return to its original liquid phase even when reheated, and therefore various processes cannot be accomplished. On the other hand, its mechanical strength is little effected by temperature variations. A typical example is phenol resin.



(2) THERMOPLASTICS

Thermoplastics are formed by lines of high polymers. When heated to a high temperature, they liquidize, and when cooled they solidify. Plastics that repeat this process are called thermoplastics.
A typical example of this kind is polypropylene.
The figure shows the variations of molecular structure.



(3) PLASTIC COMPOUND MATERIALS

Various fillers are added to plastics to increase heat resistance, anti-shock, and dimensional stability.
These are called plastic compound materials. A typical example of this type is FRP (fiber reinforced plastic). Glass fibers are added to epoxy resin or unsaturated polyester to increase the mechanical strength of the material.
Recently, a stronger FRTP (fiber reinforced thermoplastic) has been developed, where short mineral or glass fibers are added to the plastics. FRTP does not require bridging material, and it can be processed by injection molding.

TYPES OF PLASTIC : Characteristics

INFOID:0000000012106962

Every year, more and more plastic components are being used in automobile production. This is because plastic has the following advantages over metal.

(1) LIGHTWEIGHT

The specific gravity is smaller than steel plates. Lighter weight directly affects fuel savings.

(2) FREEDOM OF DESIGN

Complex design configurations which cannot be formed with steel plates can be formed with plastic material. Examples where this can be applied are bumpers and instrument panels.

(3) CORROSION RESISTANT

On steel plates, when surface paints are scratched, corrosion will penetrate into the plate surface. This problem will not occur on plastic materials.

(4) ENERGY ABSORBING CHARACTERISTICS

Plastic foams are used in bumper systems as energy absorbers.

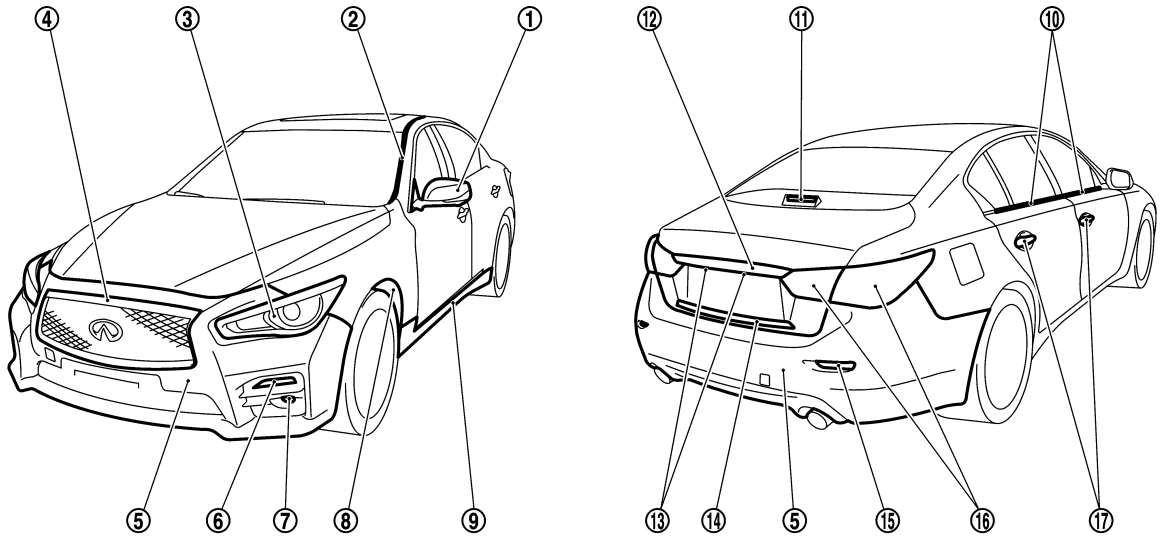
(5) MINIMAL REPAIR COST

Flexible plastic panels used as outer plates are more shock resistant and more stable when compared to steel plates.
Therefore, in case of a minor accident, steel plates will show permanent damage whereas a plastic panel will return to its original shape. For this reason, repair costs are expected to be reduced.

(6) EXCELLENT ELECTRICAL INSULATION, SOUND VIBRATION CONTROL, AND HEAT INSULATION CHARACTERISTICS

TYPES OF PLASTIC : Location of Plastic Parts (Example)

INFOID:0000000012106961



JSKIA3380ZZ

Component			Material	Component			Material
①	Door mirror	Cover	ABS	⑧	Front fender protector		PP
		Base	PA	⑨	Sill cover		PP + EPM
	With camera	Housing	ABS	⑩	Door outside molding		PVC + Stainless
		finisher	ABS	⑪	High mount stop lamp	Lens	PC
	Without camera	Housing	ASA			Housing	PC + ABS
		finisher	ASA	⑫	Trunk lid finisher	Outer	ABS
	Side turn signal lamp	Lens	PMMA			Inner	ASA
		Housing	ABS	⑬	License plate lamp	Lens	PC
②	Side roof molding		PVC + Stainless			Housing	PC
	Lower side molding		ASA	⑭	Trunk lid molding		ABS
③	Front combination lamp	Lens	PC	⑮	Reflex reflector	Lens	PMMA
		Housing	PP			Housing	ABS
④	Front grille		ABS	⑯	Rear combination lamp	Lens	PMMA
⑤	Bumper fascia		PP + EPM			Housing	ABS + ASA
⑥	Front turn signal lamp	Lens	PC	⑰	Door outside handle	Grip body	PC + PET
		Housing	PC			Grip finisher	ABS
⑦	Front fog lamp	Lens	PC				
		Housing	PBT + ASA + Glass fiber				

The location of plastic parts will be shown in the Body Repair Manual for each model.

TYPES OF PLASTIC : Handling Precautions for Plastics (Example)

INFOID:0000000012106657

- When repairing and painting a portion of the body adjacent to plastic parts, consider their characteristics (influence of heat and solvents) and remove them if necessary, or take suitable measures to protect them.
- Plastic parts should be repaired and painted using methods suitable to the materials.

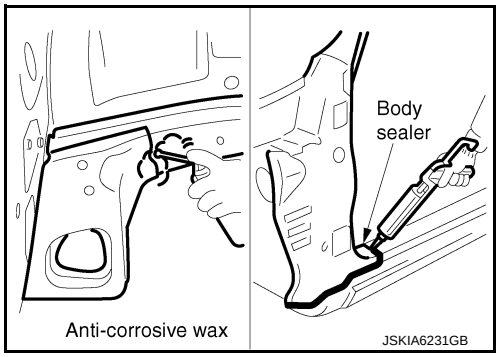
Abbreviation	Material name	Heat resisting temperature °C (°F)	Resistance to gasoline and solvents	Other cautions
PE	Polyethylene	60 (140)	Gasoline and most solvents are harmless if applied for a very short time (wipe up quickly).	Flammable
PVC	Poly Vinyl Chloride	80 (176)	Same as above.	Poison gas is emitted when burned.
EPM/EPDM	Ethylene Propylene (Diene) copolymer	80 (176)	Same as above.	Flammable
TPO	Thermoplastic Olefine	80 (176)	Same as above.	Flammable
PP	Polypropylene	90 (194)	Same as above.	Flammable, avoid battery acid.
UP	Unsaturated Polyester	90 (194)	Same as above.	Flammable
PS	Polystyrene	80 (176)	Avoid solvents.	Flammable
ABS	Acrylonitrile Butadiene Styrene	80 (176)	Avoid gasoline and solvents.	
PMMA	Poly Methyl Methacrylate	85 (185)	Same as above.	
EVAC	Ethylene Vinyl Acetate	90 (194)	Same as above.	
ASA	Acrylonitrile Styrene Acrylate	100 (212)	Same as above.	Flammable
PPE	Poly Phenylene Ether	110 (230)	Same as above.	
PC	Polycarbonate	120 (248)	Same as above.	
PAR	Polyarylate	180 (356)	Same as above.	
PUR	Polyurethane	90 (194)	Same as above.	
POM	Poly Oxymethylene	120 (248)	Same as above.	Avoid battery acid.
PBT+PC	Poly Butylene Terephthalate + Polycarbonate	120 (248)	Same as above.	Flammable
PA	Polyamide	140 (284)	Same as above.	Avoid immersing in water.
PBT	Poly Butylene Terephthalate	140 (284)	Same as above.	
PET	Polyester	180 (356)	Same as above.	
PEI	Polyetherimide	200 (392)	Same as above.	
FRP	Fiber reinforced plastics	170 (338)	Gasoline and most solvents are harmless.	Avoid battery acid.

RUST PREVENTION

RUST PREVENTION : Rust Prevention

INFOID:0000000012112296

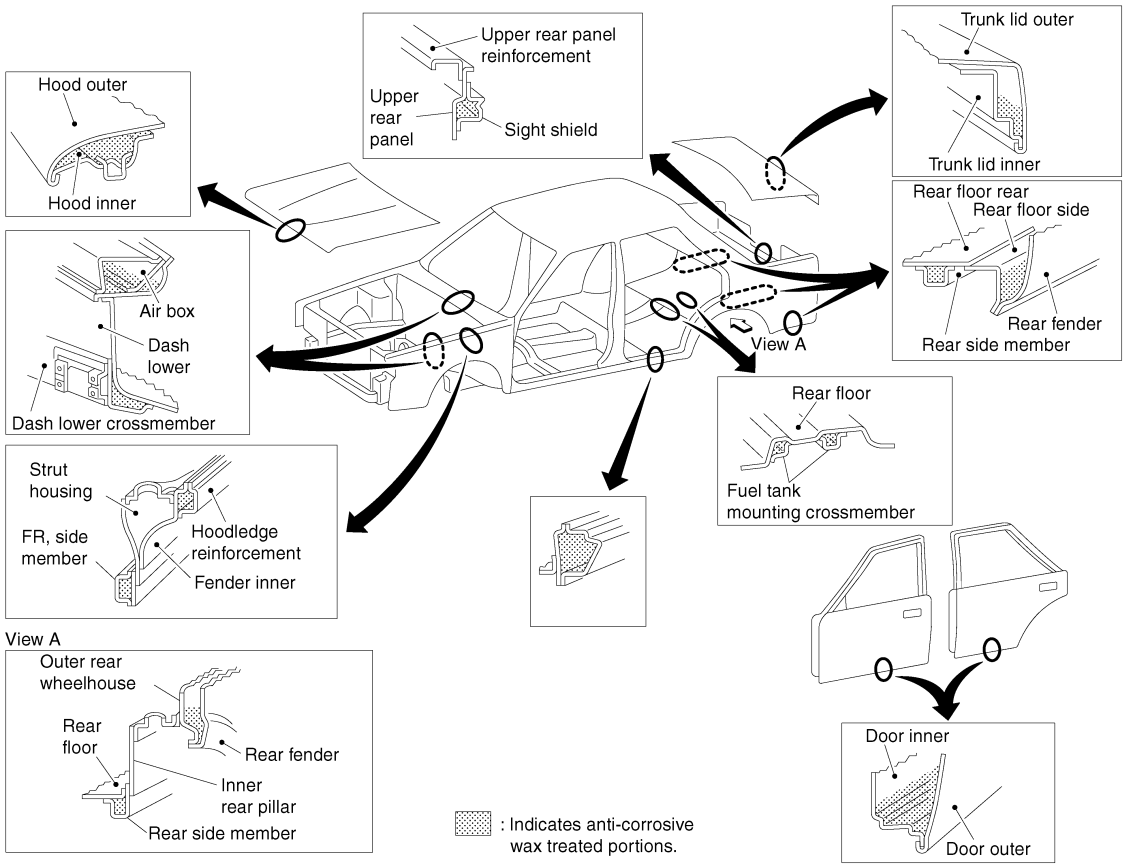
If sheet steel comes into contact directly with air or water, it will rust.
To prevent this, automobile manufacturers use various anti-corrosive techniques to extend the life of the body.
When repairing the body, it is necessary to take this point into consideration.
The original rust prevention materials of a panel are removed when the panel is cut, welded, or hammered.
Therefore, rust prevention materials must be applied after completing such work.



RUST PREVENTION : Anti-corrosive Wax

INFOID:0000000012106986

The recessed portions of the body, which cannot be painted easily when doing repair work, must be coated with anti-corrosive wax. Shown below is an example of coating with anti-corrosive wax.

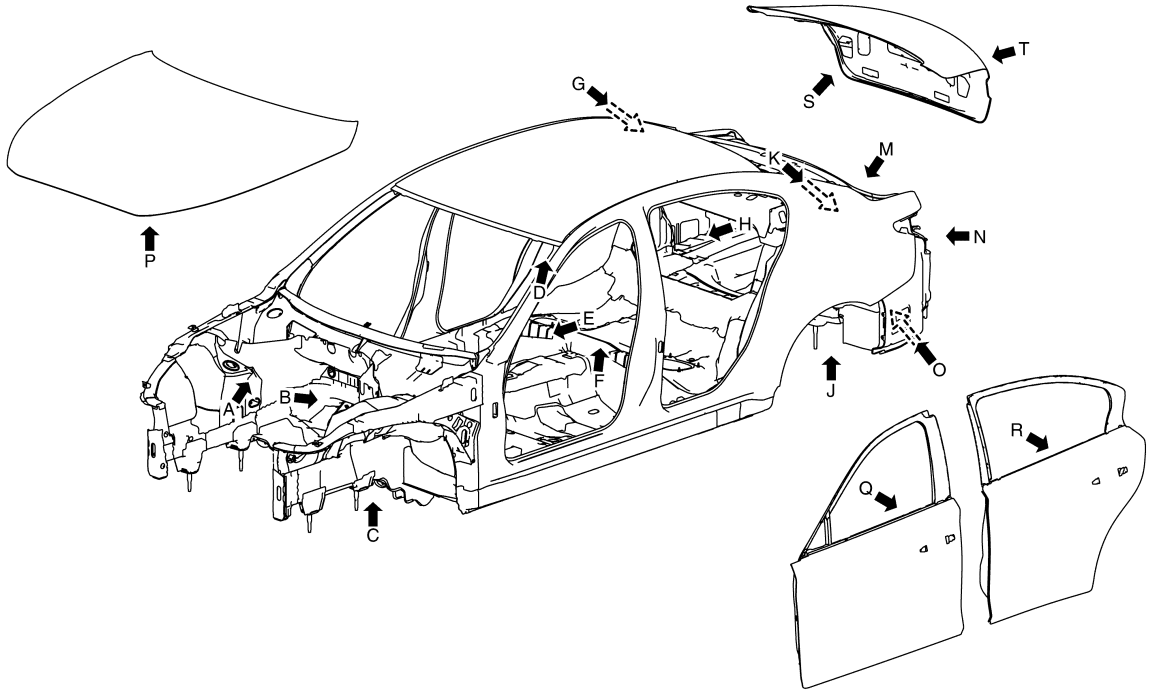


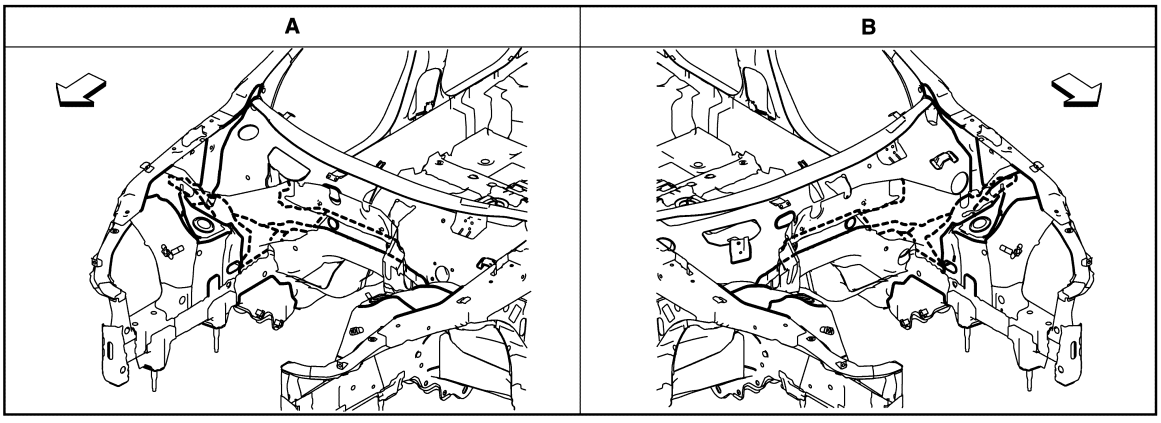
RUST PREVENTION : Sealing

INFOID:0000000012106983

The car body is assembled by welding various types of sheet steel. The assembled or mated portions of these panels are generally susceptible to rusting as well as to dust and water entry. To prevent rusting of such portions, sealing compound and edge seal tape are used. When repairing the body, it is necessary to seal original vehicle areas. An example of sealed portions is shown below.

Example





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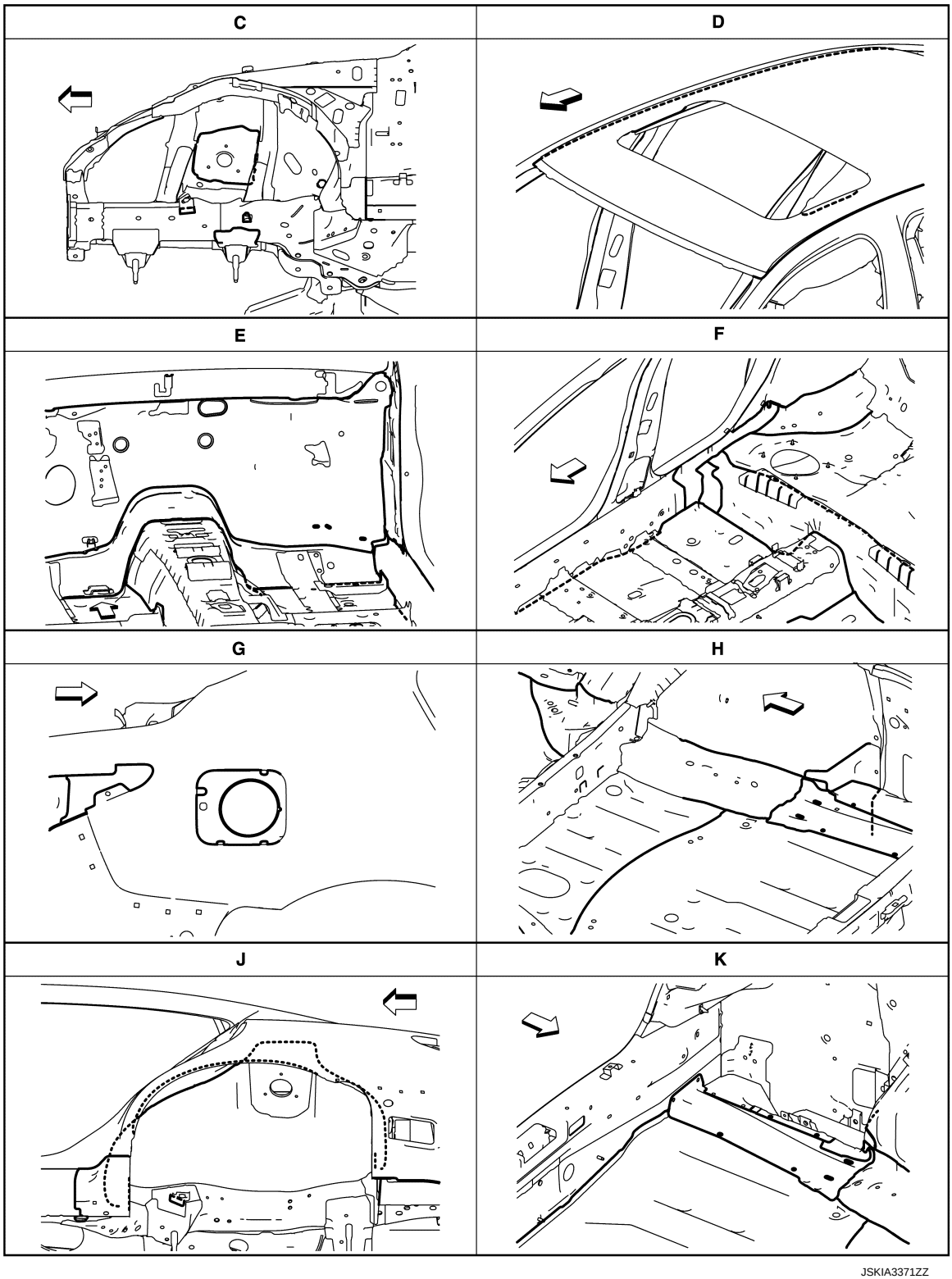
⇦: Vehicle front

▬: Sealed portions



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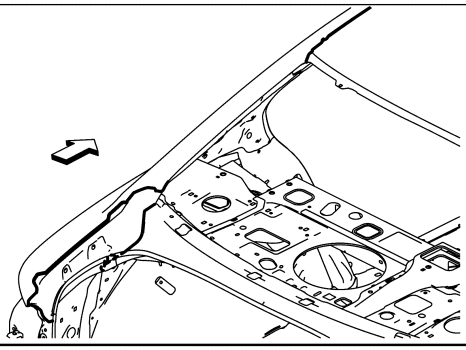
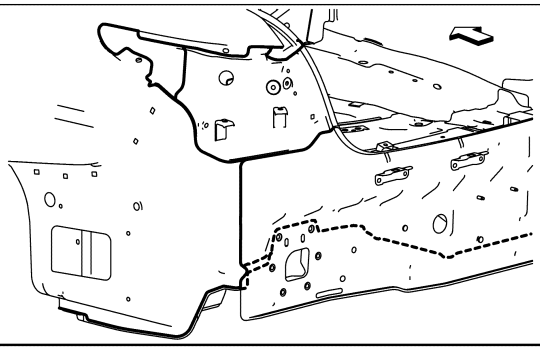
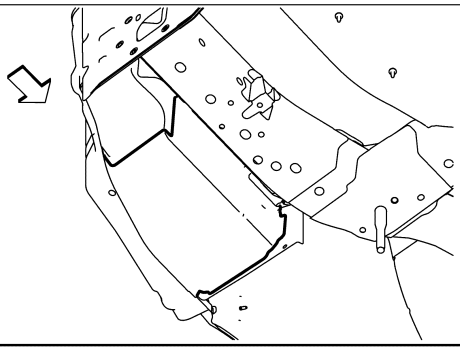
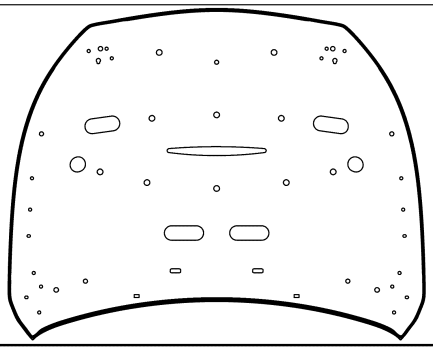
⇦: Vehicle front
▬: Sealed portions

M	N
	
O	**P**
	
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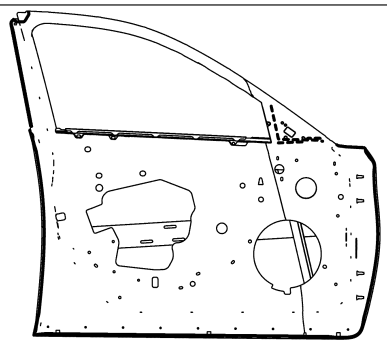
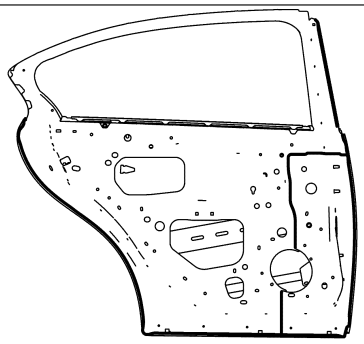
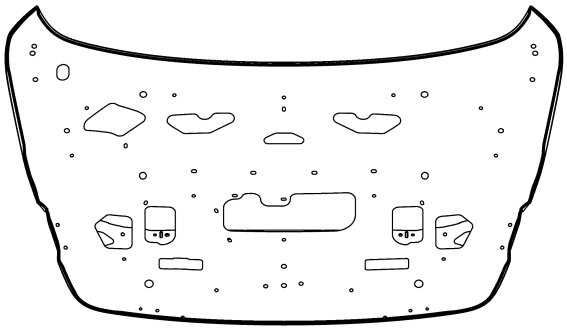
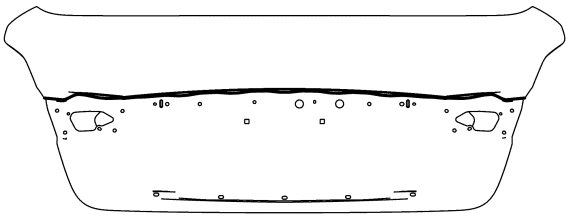
	
S	**T**
	

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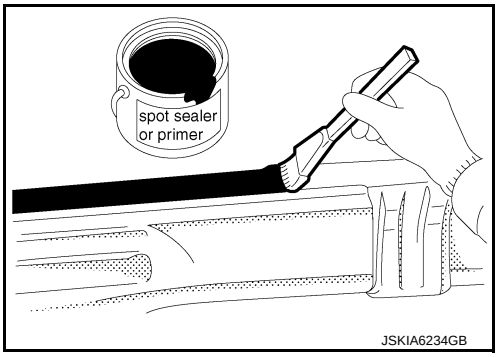
⇦: Vehicle front

▬: Sealed portions

RUST PREVENTION : Spot Sealer, Weld Through Primer and Adhesive Sealer

INFOID:0000000012106984

When spot welding panels, spot sealer must be applied to the mating surfaces to prevent rust formation.
When MIG welding panels, electrify weld through primer (metallic solution) must be applied to the mating surfaces to prevent rust formation. When hinges such as hood or door etc., are removed or replaced, adhesive sealer must be applied to the mating surfaces of the hinge. These are also important in body repair work.



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RUST PREVENTION : Undercoating and Stone Guard Coat

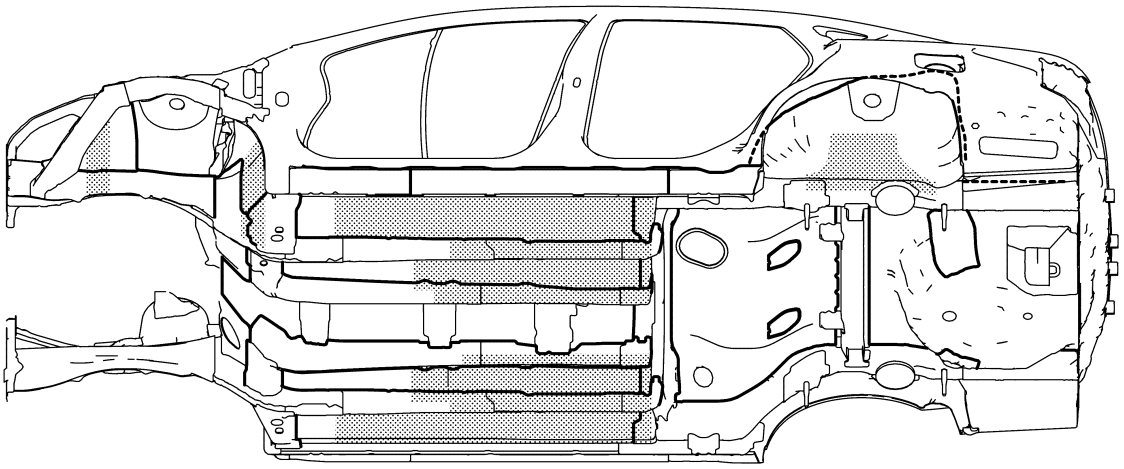
INFOID:0000000012106985

- The undersides of the floor and wheelhouse are undercoated to prevent rust, vibration, noise and stone chipping.
  Therefore, when such a panel is replaced or repaired, apply undercoating to that part. Use an undercoating with the following properties: rust preventive, soundproof, vibration-proof, shock-resistant, adhesive, and durable.

Precautions in undercoating

1. Do not apply undercoating to any place unless specified (such as the areas above the muffler and catalytic converter which are subjected to heat).
2. Do not undercoat the exhaust pipe, other parts which become hot, and rotary parts.
3. Apply bitumen wax after applying undercoating.

Example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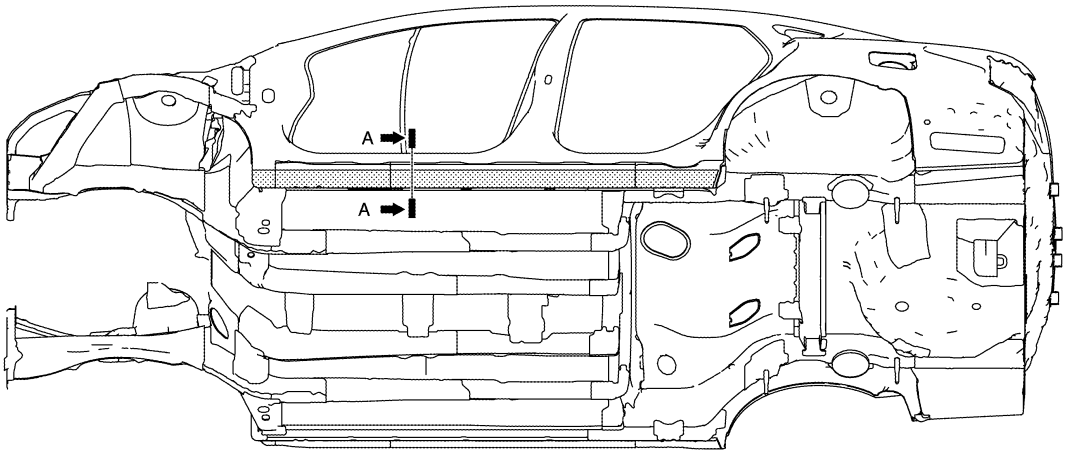
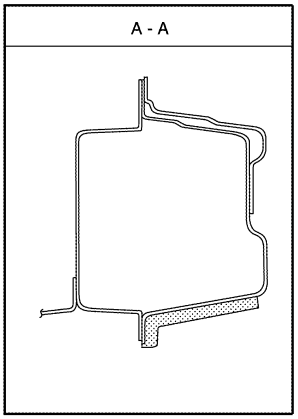
: Undercoated areas
: Sealed portions

- In order to prevent damage caused by stones, the lower outer body panels (fender, door, etc.) have an additional layer of stone guard coat over the ED primer coating. Thus, when replacing or repairing these panels, apply undercoat to the same portions as before. Use a coat which is rust preventive, durable, shock-resistant and has a long shelf life.

Example





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: Stone guard coated portions

SHEET METAL WORK

SHEET METAL WORK TOOLS

SHEET METAL WORK TOOLS : Sheet Metal Work Tools

INFOID:0000000012113014

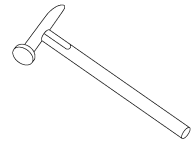
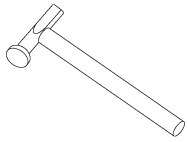
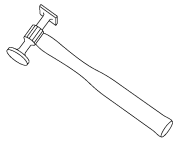
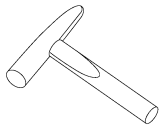
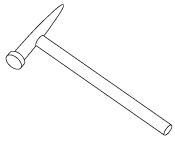
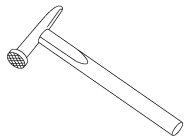
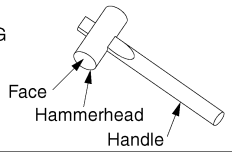
This section explains various tools used in body repair work.

SHEET METAL WORK TOOLS : Hammers

INFOID:0000000012107281

A hammer is used to correct dents, projections or other deformations. Various shapes have been designed according to their purposes.

(1) TYPES AND FEATURES OF HAMMERS

A 	A	Cross peen hammer	For shaping the panel together with dollies and spoons
B 	B	Straight peen hammer	For shaping the panel together with dollies and spoons
C 	C	Bumping hammer	For shaping the panel together with dollies and spoons
D 	D	Roughing hammer	For rough-shaping the panel in combination with straightening equipment, or when great force is required
E 	E	Pick hammer	For correcting small dents
F 	F	Shrinking hammer	For shrinking stretched panels
G 	G	Wooden hammer	For shrinking or correcting the panel without stretching

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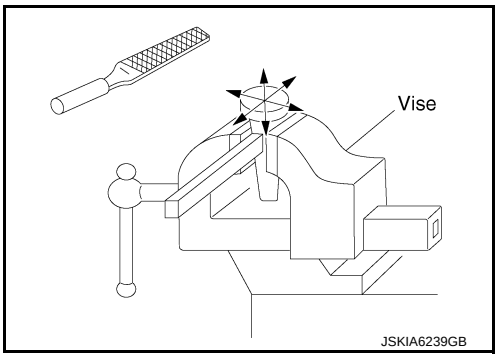
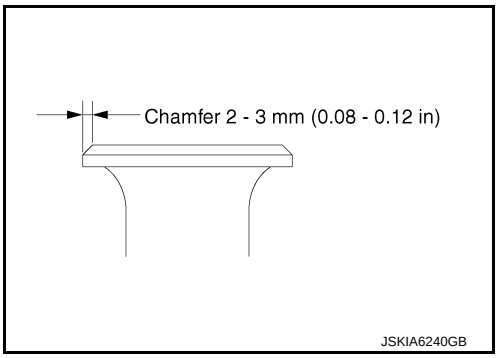
(2) SELECTION AND MAINTENANCE OF HAMMERS

It is necessary to choose lighter or heavier hammers according to application or purpose.
Hammer weight should be selected according to the user's physical strength.
Hammer maintenance is important. In particular, the hammer face must always be kept clean. A distorted or damaged hammer face will lead to distorted panels.
Accordingly, hammers for sheet metal work must not be used to hit other objects such as a chisel. Do not mix sheet metal hammers with ordinary hammers.
Repairing the face of a sheet metal hammer is explained below.

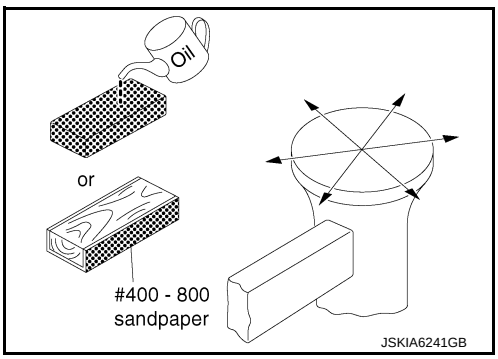
(a) Clamp the hammer in a vise with the hammer face up.
If the hammer face is deformed, use a hand file to smooth it.
(b) File the face in all directions.Do not file in only one direction.



(c) Chamfer the edge of the face to prevent it from nicking or distoring the sheet metal.



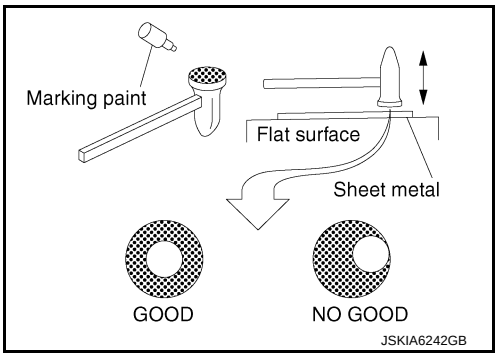
(d) After smoothing the hammer face, polish it with an oil stone or #400 - #800 abrasive paper wrapped around a wooden block. Polish the face in all directions.



(e) To check the finish, apply marking paint to the hammer face. Hit a piece of flat sheet metal on a flat surface.

GOOD : The paint comes off the center to the face.

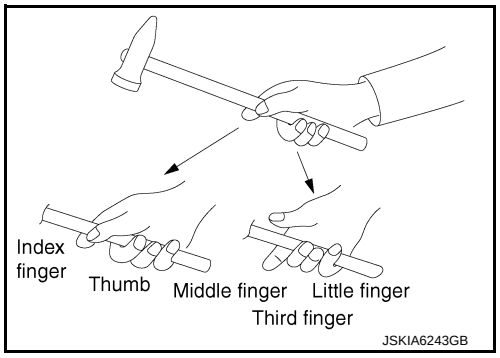
NO GOOD : The paint comes off at a section other than the center or the face. Grind the surface again.



(3) HOLDING AND HITTING WITH THE HAMMER

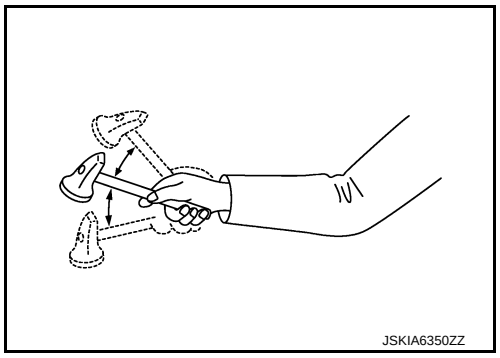
(a) Holding the hammer

- Hold the hammer handle tightly with the middle, third and little fingers so that it will not slip when it is swung.
- Hold the sides of the hammer handle lightly with the thumb and index finger to prevent sideways movement.

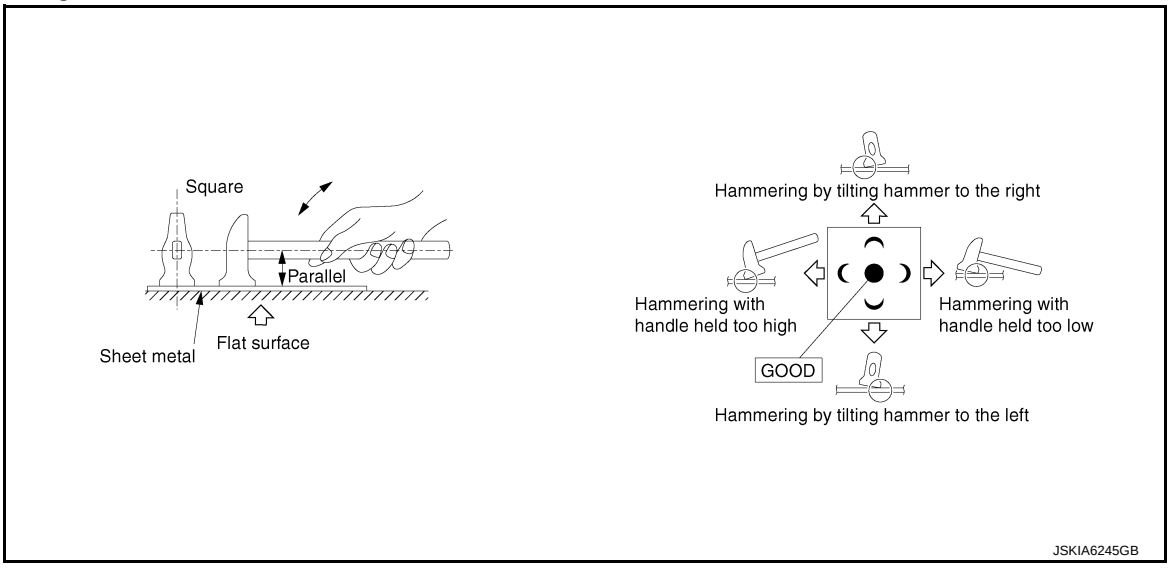


(b) Hammering

- For rough straightening work, strike strongly.
  For ordinary correcting work, swing the hammer using the wrist. In this case, the arm serves as a guide to determine the hammer direction.



- The hammer face should be flush with the panel surface when hitting. If the hammer edge strikes the surface, it will nick the panel.
- Hammering should be approximately 100 hits a minute, and should be kept constant. An irregular hammering rhythm will lead to an uneven hammering force. Sheet metal will stretch when it is hammered. Irregular hammering also makes sheet metal correction more difficult.



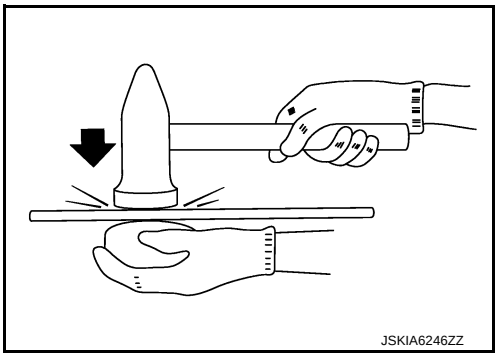
SHEET METAL WORK TOOLS : Dollies

INFOID:0000000012107280

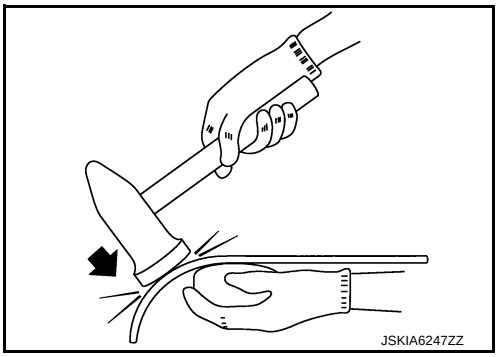
Dollies are used in combination with a hammer. They are a 1 kg - 2 kg (2 lb - 4 lb) steel blocks, heavier than a hammer, with various curves and planes.

(1) USE OF DOLLIES

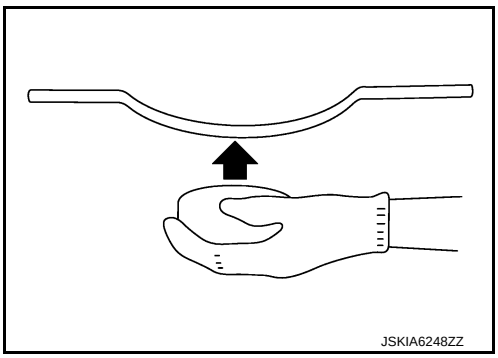
(a) Place the dolly on the underside of the deformed sheet metal. Strike the deformed section of the sheet metal with the hammer to stretch it.



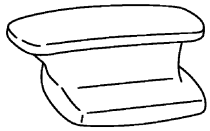
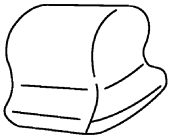
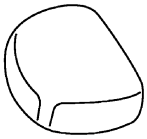
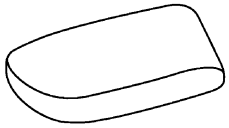
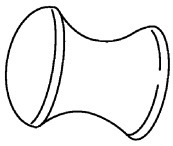
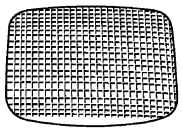
(b) Move the hammer and dolly as necessary, and direct the hammer blows so as to bend the sheet metal.



(c) If ordinary hammering is impossible due to limited space, substitute a dolly for the hammer, and strike the dented portion with the dolly.

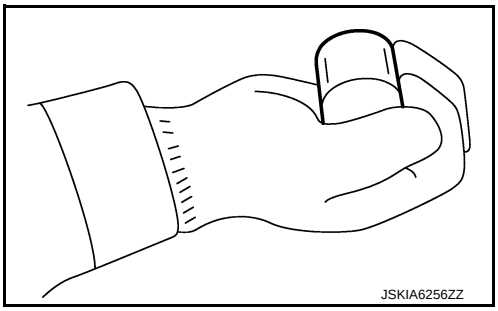


(2) TYPES AND FEATURES OF DOLLIES

 JSKIA6249ZZ	General purpose dolly	This is also called a rail dolly. It has both wide and narrow curved faces.
 JSKIA6250ZZ	Utility dolly	This type of dolly features various curved surfaces and has wide applicability to automobile body repair work. It can be handled easily in narrow spaces.
 JSKIA6251ZZ	Heel dolly	One side is flat and the other side is curved slightly. This is suitable for correcting flat and slightly curved surfaces.
 JSKIA6252ZZ	Toe dolly	This dolly is formed by two flat surfaces and a connecting curved surface. It can be used in narrow places.
 JSKIA6253ZZ	Round dolly	Both sides are curved. This dolly is used for repairing small dents.
 JSKIA6254ZZ	Wedge dolly	This dolly has a curved surface which changes gradually from sharp to gentle. Its sharp end can be inserted into narrow portions.
 JSKIA6255ZZ	Shrinking dolly	The surface is like a file. This dolly is used in combination with a shrinking hammer.

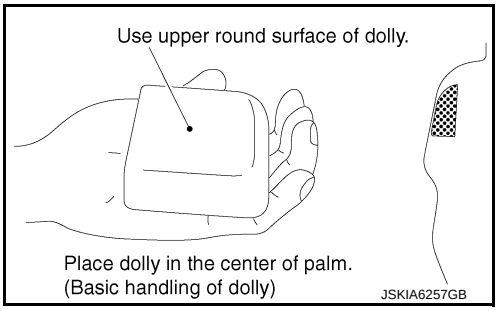
(3) SELECTION AND MAINTENANCE OF DOLLIES

Ideally, a dolly whose curved surface just fits the curvature of the panel should be used. However, this is often difficult. In most cases, a dolly whose curvature is slightly smaller than that of the panel should be selected.
Generally speaking, four types of dollies (general purpose, utility, heel and toe dollies) are sufficient for ordinary panel work. However a special dolly can be designed for unique shaping.
The size and weight of the dolly must be easy to handle.
The maintenance procedures and cautions described for the hammer also apply to the dolly.
The entire surface of the dolly must be free from damage.

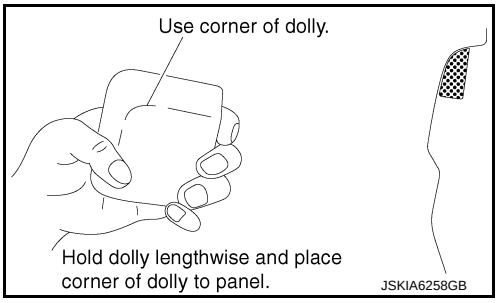


(4) HOW TO HOLD THE DOLLY

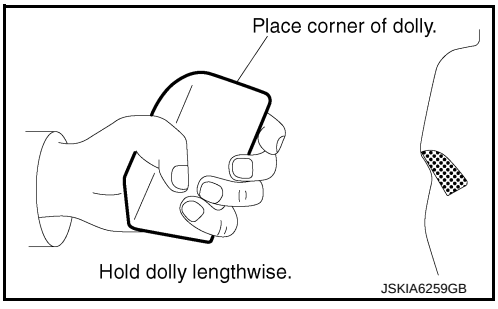
Basic handling of the dolly.
(a) TOP:
Place the dolly in the palm of your hand.
Holding it lightly, place the curved surface against the curved surface of the panel.



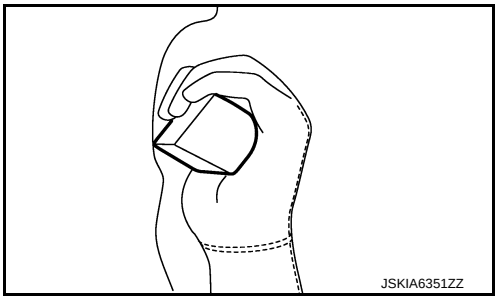
(b) CORNER:
Hold the dolly lengthwise, and place the corner in the sharply bent portion of the panel.



(c) EDGE:
Hold the dolly so that the edge faces upward.
Place this edge to the press line of the panel.



(d) CORRECTING THE PRESS LINE:
To correct a concave press line in a narrow space on the back of the panel, use a dolly as shown in the figure and strike the press line with it.

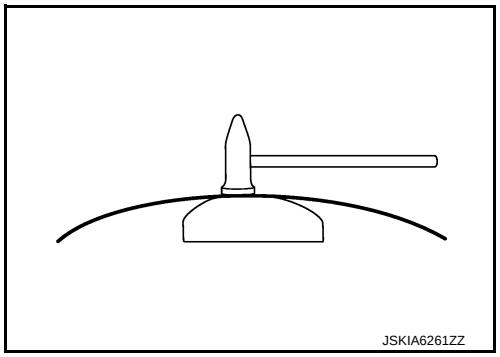


SHEET METAL WORK TOOLS : How to Use Hammer and Dolly

INFOID:0000000012107279

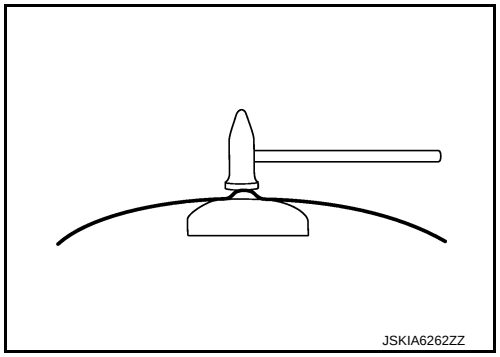
(1) HAMMER-ON-DOLLY

This is also known as dinging on the dolly. The dolly is held directly under the area being struck with the hammer. Hammering smoothes the dented metal between the dolly and hammer. This method causes the sheet metal to stretch.

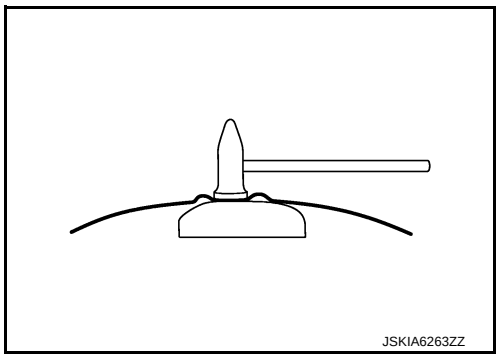


Hammering on a dolly is most effective for repairing shallow dents.

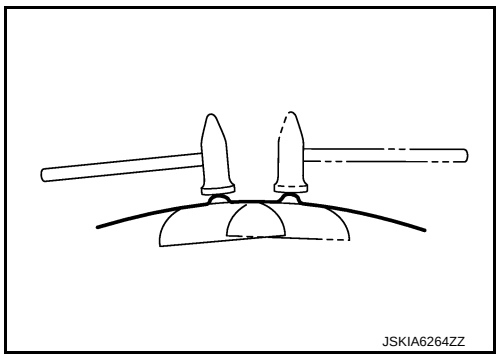
(a) The hammer strikes the sheet metal, causing the dolly to bounce against the metal surface. Thus the damaged portion is worked out from both inside and outside.



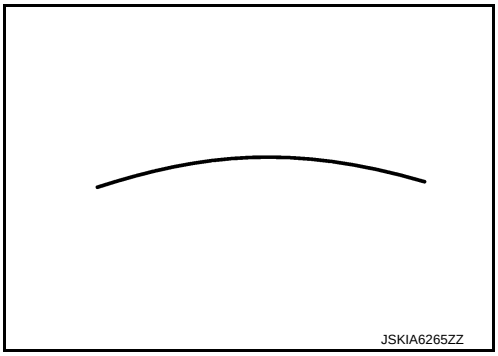
(b) The sheet metal stretches between the hammer and dolly, and deformation is distributed around the strike area.



(c) Continuously move the dolly under the shifting deformation so that it can be struck properly.



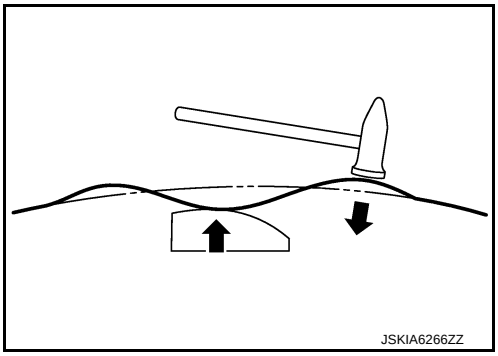
(d) The sheet metal gradually stretches and returns to its original shape.


JSKIA6265ZZ

(2) HAMMER-OFF-DOLLY

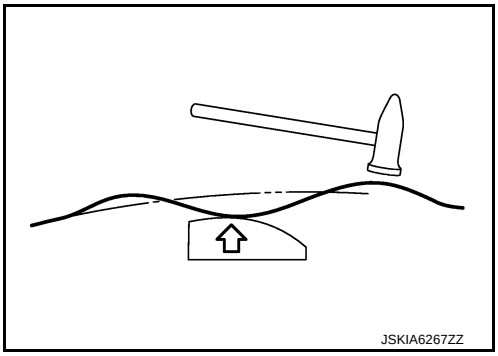
This is also known as dinging off the dolly.

Place the dolly directly under a dent, and hammer against the edge of the dent. The hammer drives one area downward while the reaction of the dolly drives the adjacent area upward.

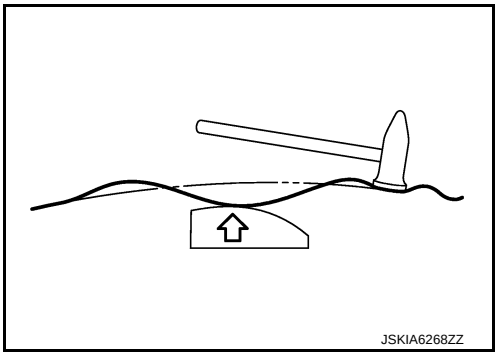

JSKIA6266ZZ

An example of the hammer-off-dolly operation is given below.

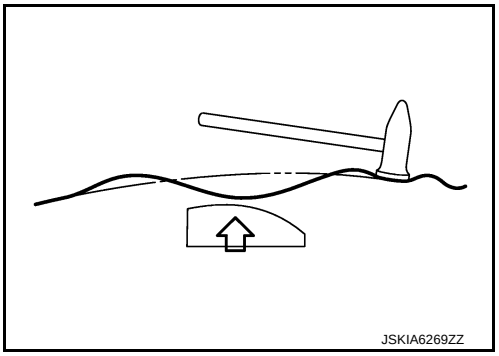
(a) Place the dolly under the deepest dent, and hammer the highest portion of the top surface.


JSKIA6267ZZ

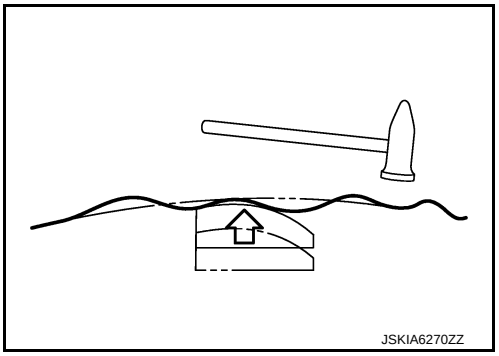
(b) The raised portion of the surface lowers as it is struck with the hammer.


JSKIA6268ZZ

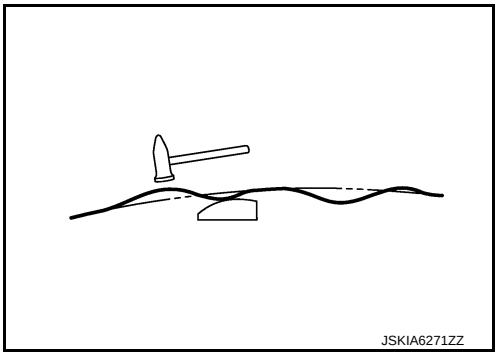
(c) Hammer blows are transmitted to the dolly, creating a reaction force.



(d) This reaction force pushes the dent.



(e) Repeat steps (a) - (d) until the surface is smooth.

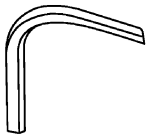


SHEET METAL WORK TOOLS : Spoons

INFOID:0000000012107278

Spoons are made of steel, and one or both ends are flat. Spoons are used as dollies in narrow spaces or as pry bars.

(1) TYPES AND FEATURES OF SPOONS

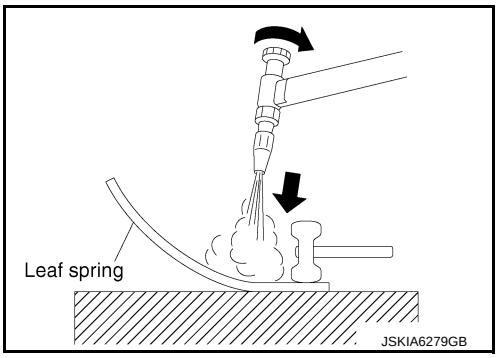
 JSKIA6273ZZ	General purpose spoon	This spoon has a gently curved surface and sharply curved ends. It is widely used in automobile body repair work.
 JSKIA6274ZZ	Long spoon	This spoon has a long handle and thin, rigid faces. It is used primarily for prying.
 JSKIA6275ZZ	Curved spoon	The handle of this spoon is comparatively short. It has a wide curved blade. This spoon is used for smoothing.
 JSKIA6276ZZ	Flat spoon	This spoon has a short handle and a wide, flat blade. When the spoon is placed on the panel and hammered, the force disperses over a wide area.
 JSKIA6277ZZ	High crown spoon	This spoon has a wide hooked blade. It is used for repairing narrow body panel spaces such as inside of outer sill panel.
 JSKIA6278ZZ	Sickle-shaped spoon	This spoon has a wide, gently curved surface with a thin end. It can be inserted into very narrow gaps between panels.

(2) SELECTION AND MAINTENANCE OF SPOONS

Select spoons suitable for the particular panel shape and internal structure. Spoons can be made from leaf springs.

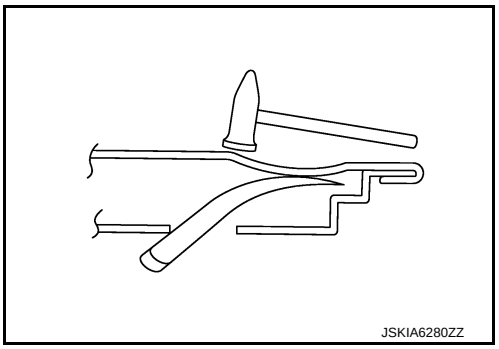
Cut the leaf spring to the desired shape. Heat it with a gas torch and shape it into a spoon by bending or stretching with a hammer. Then grind and polish. (See Hammer Maintenance, refer to BRM-59, "SHEET METAL WORK TOOLS : Hammers".)

The precautions described for the hammer and dolly also apply to spoons. Do not damage the surface which comes into direct contact with the panel during repair work.

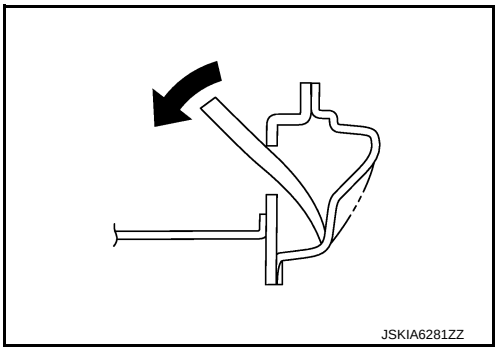


(3) HOW TO USE SPOONS

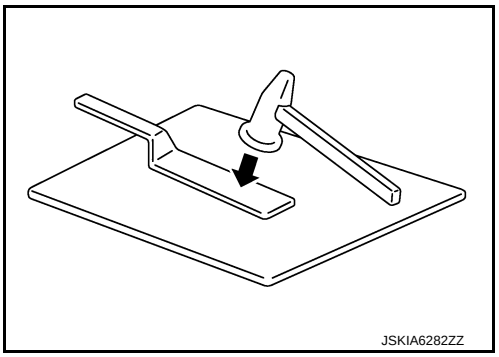
(a) Insert the spoon into tight spaces such as inside of door, and use as a dolly.



(b) Place a spoon between two panels and pry out the concave portion.

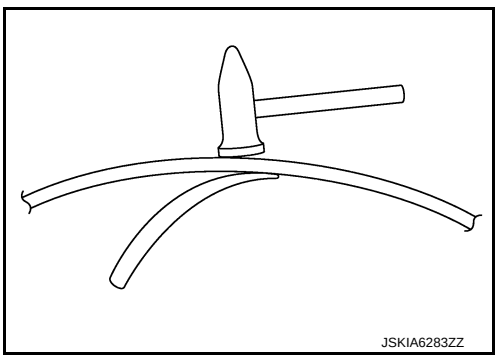


(c) Hammer directly on the spoon to disperse the force of the hammer blows.



(d) The figure to shows an example of incorrect spoon usage. There is no fulcrum point for the spoon.

If a spoon is used in this way, insufficient force is applied to the mating face, and the spoon cannot act as a dolly.

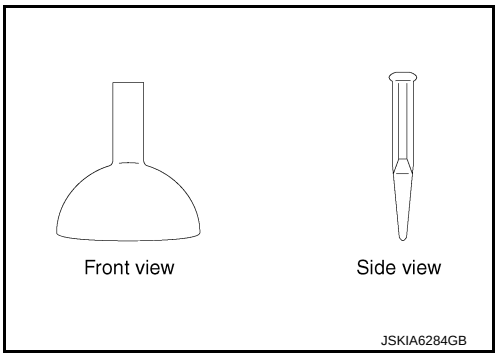


SHEET METAL WORK TOOLS : Scribing Chisels

INFOID:0000000012107276

Chisels are generally used to cut sheet metal.
They are also used in body repair work. There are numerous types of chisels. This section, however, describes scribing chisels used exclusively for bending sheet metal or for shaping panel press lines.

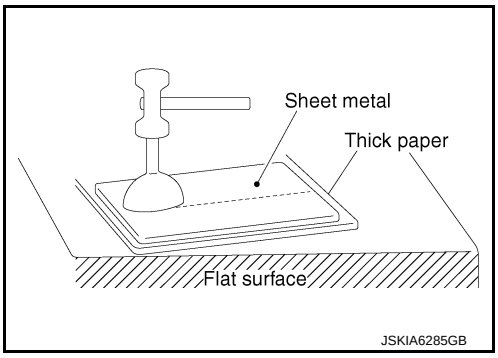
This type of chisel must have a smoothly rounded edge as shown in the figure. If the edge is sharp, the body panel will be nicked.



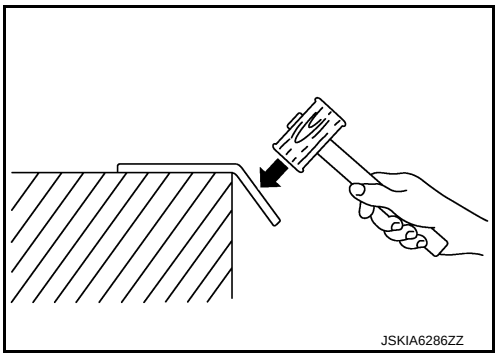
HOW TO USE SCRIBING CHISELS

(a) For bending sheet metal

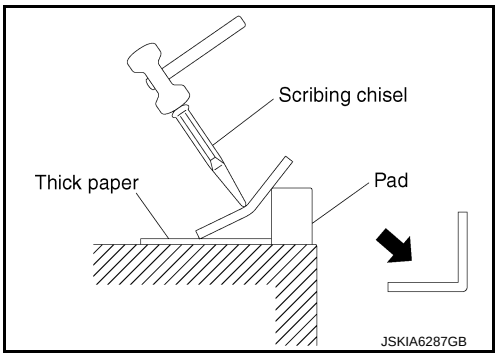
- First scribe a line on the sheet metal.
  Place thick paper or cardboard under the sheet metal.
  Place the scribing chisel on the line and hammer it.



- Place the sheet metal on a flat, angled surface scribed-side down, and bend the sheet metal with a wooden hammer.

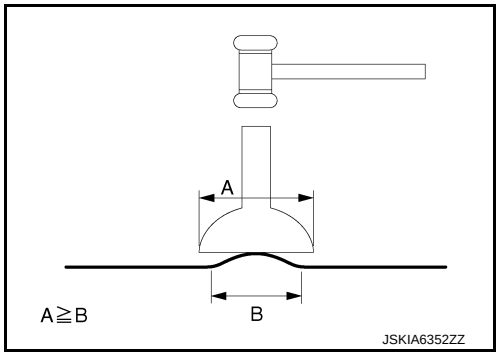


- Using a hammer and the scribing chisel, neatly bend the sheet metal squarely. Do not bend all at once.
  Bend the sheet metal gradually by gently hammering against the chisel head.

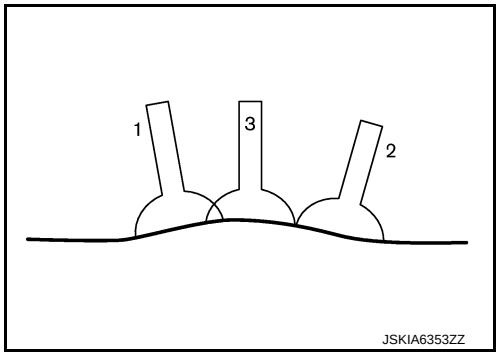


(b) Shaping the press line

- If the dent in the press line is smaller than the width of the chisel, apply the chisel to the center of the dent. Hammer to flatten. Hammer gently so that the dent can be removed gradually.



- If the dent is larger than the width of the chisel, do not strike the dent in the center. Apply the chisel at the edges of the dent.

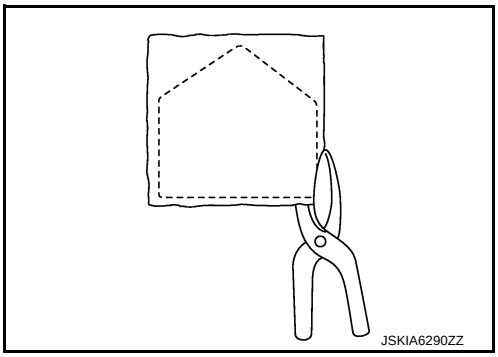


SHEET METAL WORK TOOLS : Types and Uses of Tinman's Shears

INFOID:0000000012107275

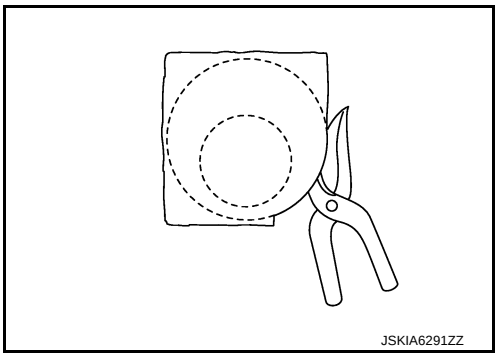
(1) STRAIGHT BLADE SHEARS

For cutting straight lines.



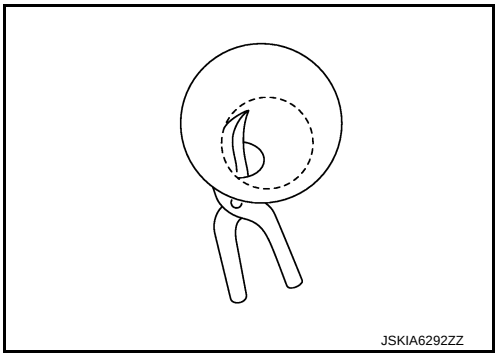
(2) CURVED BLADE SHEARS

The blades are smoothly curved. Suitable for straight or curved cutting.



(3) SCOOPED BLADE SHEARS

The entire blade is bent to one side. Suitable for cutting along a sharply curved line.



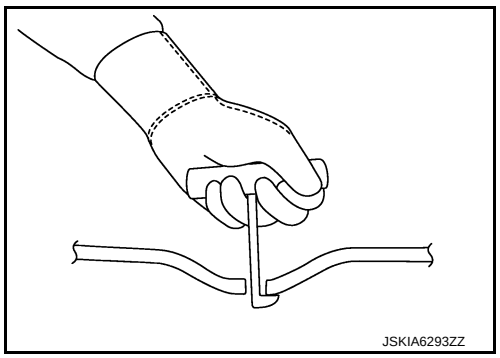
SHEET METAL WORK TOOLS : Tools for Pulling

INFOID:0000000012106661

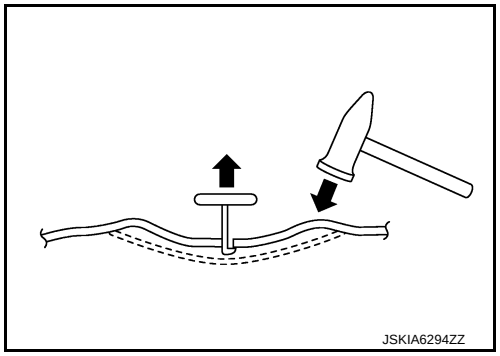
If it is impossible to gain access to the damaged area, dents can be pulled out and repaired.

(1) HAND HOOK

Small holes are drilled in the dented portion, and a hand hook is inserted into the hole. The dented panel is pulled out with the hook. This method is used to repair small panel dents.

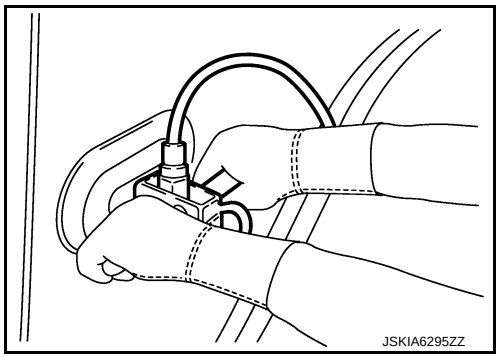


When using a hand hook, fit the end snugly against the panel. Do not pry up or use too much force. Pull the hook lightly while tapping with a hammer at the edge of the dent.
The drilled hole must be refilled with body putty after completing the work.



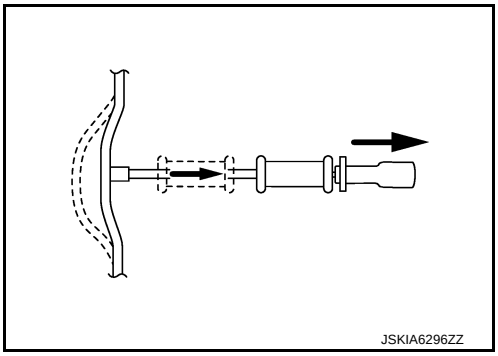
(2) VACUUM PULLER

The vacuum puller is suitable for pulling out large dents if the dented surface is comparatively smooth.

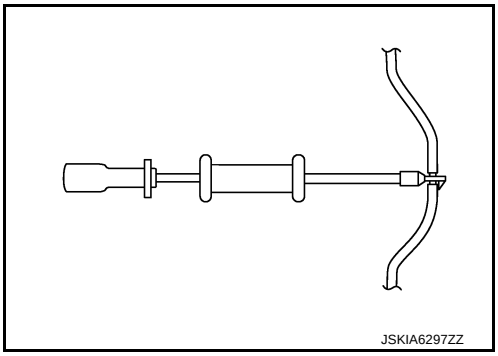


(3) SLIDING HAMMER

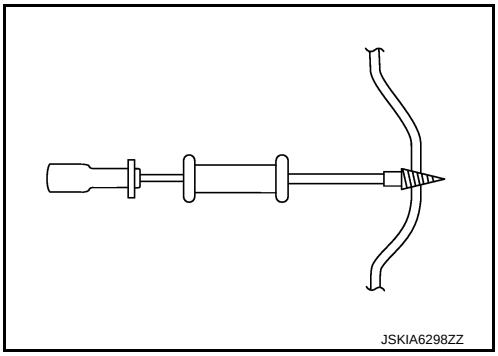
The sliding hammer is used for repairing large, deep dents. Since it provides greater force than an ordinary hammer, it is used to repair dents in thick panels.



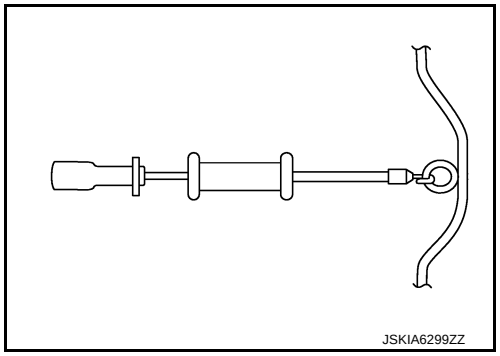
(a) A hook similar to the hand hook is attached to the end of the sliding hammer. Pulling holes are drilled in the panel. A limited force is allowed for pulling. The panel must be pulled carefully to avoid tearing.



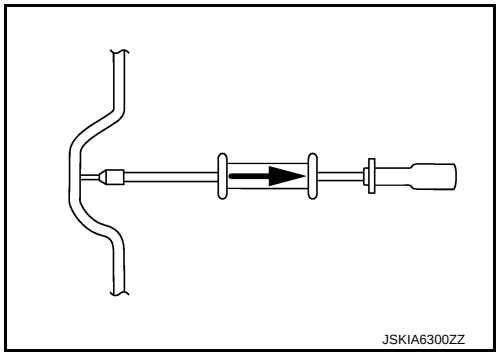
(b) A tapping screw is attached to the end of the sliding hammer. It is then screwed into the panel. A greater pulling force is possible than with the hook.



(c) Instead of a hole, a metal pin or washer is welded to the panel. Great force can be used for pulling.


JSKIA6299ZZ

(d) When the dent is deep and narrow, pull it with a single blow.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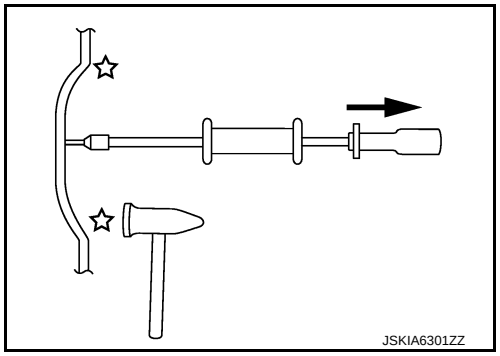
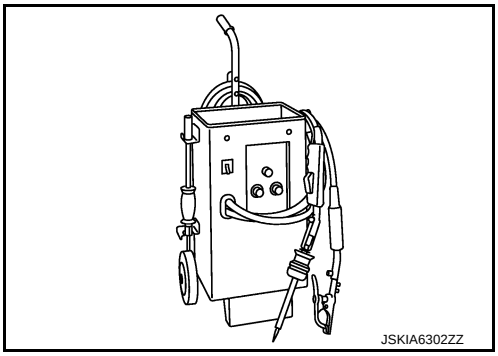
(e) When the panel dent is shallow and wide, hold the end of the sliding handle. Repair the dent by gradually tapping the edge of the dent.


JSKIA6301ZZ

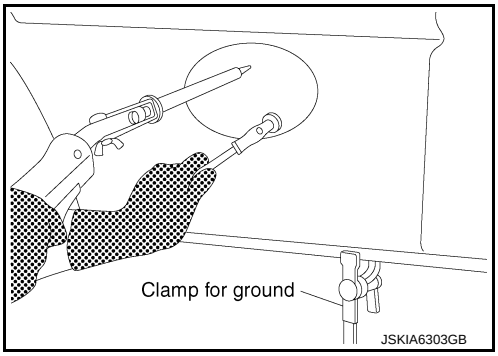
(4) STUD WELDER (BODY REPAIR STATION)

A pin or washer is welded directly to the body panel dent without drilling. The panel dent area is then pulled outward with the sliding hammer. Because no drilling is required, panel strength is unaffected. Corrosion problems are also reduced.



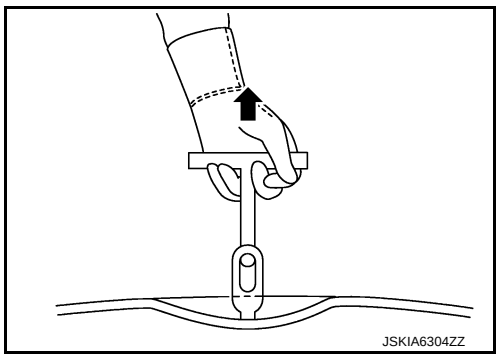
Because the stud welder welds pins directly, the paint must be removed from the dent surrounding area and the area where body ground is established.

As shown in the figure, the ground can be established at the flange area or in the dent surrounding area using a magnet.

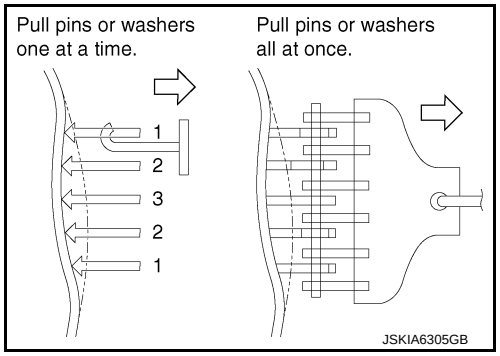


(5) WELDED PIN OR WASHER

A pin or washer is welded to the dent without drilling. It is then pulled to repair the dent.

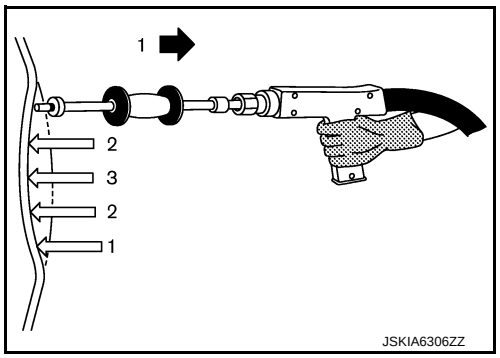


Several pins or washers are welded to the dent. They are then pulled together or separately to repair the dent.



(6) SPOT HAMMER WELDING

The sliding hammer tips are welded to the dent.
They are then pulled separately to repair the dent.
After the tips are pulled, they are twisted to separate them from the panel.



SHRINKING THE SHEET METAL

SHRINKING THE SHEET METAL : Shrinking The Sheet Metal

INFOID:0000000012113015

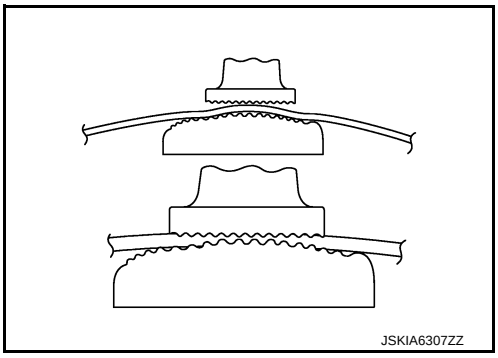
Plastic deformation may cause reduced panel thickness and the panel may stretch. Even when it is repaired using a hammer and dolly, the panel tends to bulge, losing its original shape.
In such cases, it must be shrunk to its original shape. This is called shrinking the sheet metal.

SHRINKING THE SHEET METAL : Shrinking Methods

INFOID:0000000012107282

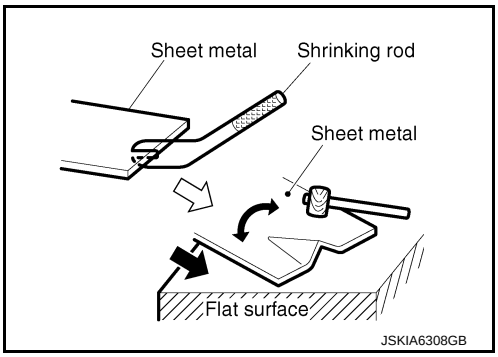
(1) HAMMER AND DOLLY

A shrinking hammer and shrinking dolly are used by the hammer-on-dolly method. Many tiny dents are formed on the panel surface. This method is suitable for shrinking comparatively small areas of panel deformation.



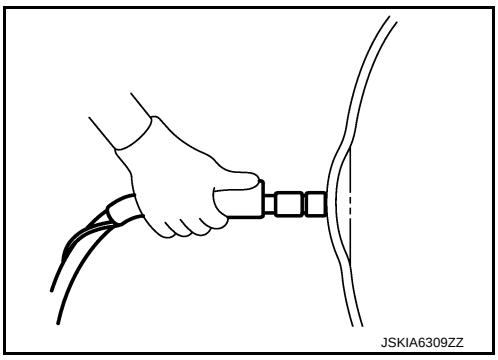
(2) SHRINKING ROD

This method is used to shrink stretched sheet metal edges. The sheet metal is inserted into the shrinking rod slit and bent in a “V” shape. The convex area of the sheet metal is then worked flat with a wooden hammer.
Hammer blows should begin at the edge and should gradually move outward to shrink the sheet metal.



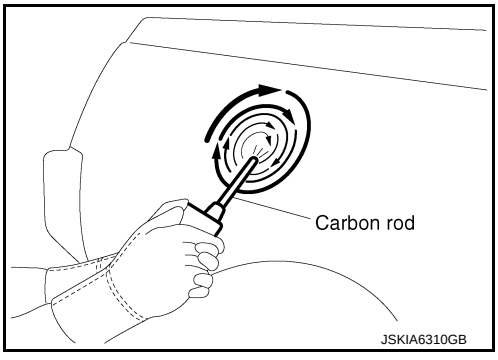
(3) ELECTRIC WELDING MACHINE

The body panel is connected to the negative power supply terminal and the tip is connected to the positive terminal. Then, an electric current is supplied to heat the panel. The shrinking principle is the same as that of gas welding. This method features no hammering and greater workability than gas welding and is suitable for repairing local panel deformations.



(4) CARBON ROD

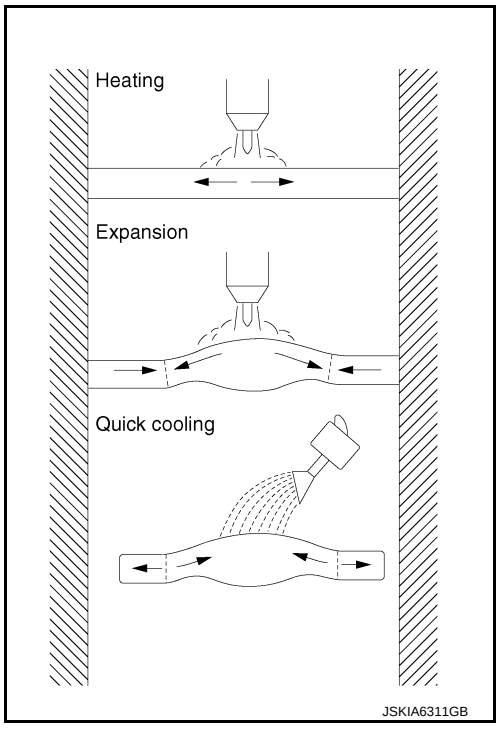
The panel is connected to the negative power supply terminal and a carbon rod is connected to the positive terminal. The panel is heated so that heat is conducted from the outside to the center of the dent. Wet rags are then applied to cool it quickly, thus shrinking the panel. This method is suitable for repairing wide, shallow panel deformations.



(5) GAS WELDING (OXY-ACETYLENE TORCH)

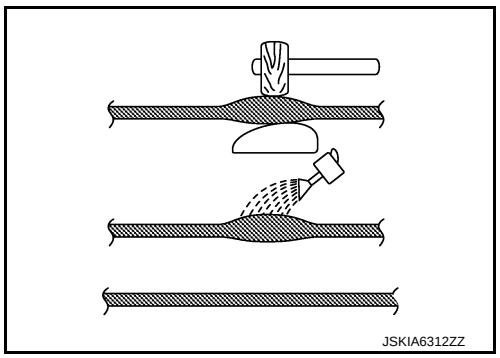
(a) Heating and expansion

As the sheet metal is heated with a gas welding torch, it stretches. However, stretching is restricted in the unheated surrounding portion. As a result, the heated portion bulges.



(b) Sudden cooling

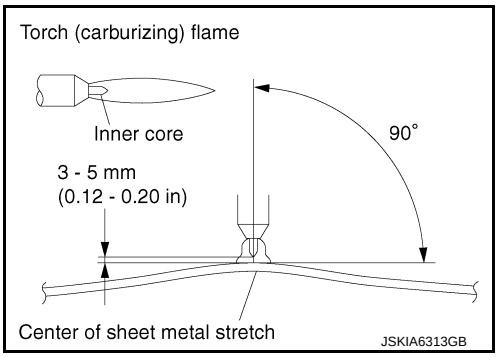
When the bulge is cooled suddenly, it shrinks.
This shrinking is accelerated by tapping with a wooden hammer.



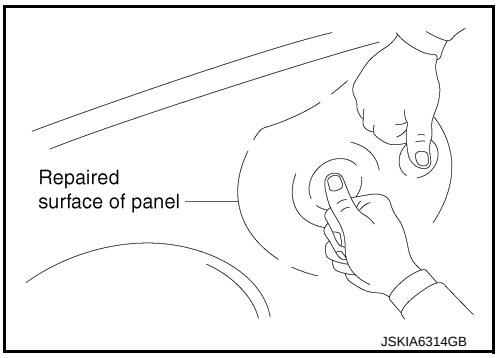
SHRINKING THE SHEET METAL : How to Heat Sheet Metal

INFOID:0000000012107283

- Use a carburizing flame when shrinking sheet metal with a gas welding torch.
- Hold the torch at a right angle to the center of the sheet metal.
- Maintain a distance of 3 mm - 5 mm (0.12 in - 0.20 in) between the inner core and sheet metal.
- Heat the sheet metal to approximately 800°C (1,472°F) (until the heated portion turns red). Increase the temperature if sheet metal stretching is insufficient.



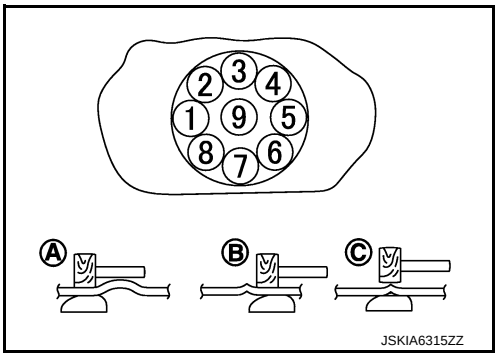
- Locate the stretched portion of the panel.
  Press the surface being repaired in several places.
  The point where the largest elastic dent is formed is the center, where the stretch is the maximum. The highest portion of the panel being repaired can also be considered the most stretched portion.



- The area heated with a welding torch must be approximately 3 mm - 5 mm (0.12 in - 0.20 in) in diameter if the panel shape is complex, and approximately 6 mm - 15 mm (0.24 in - 0.59 in) in diameter if it is flat.
- Small stretch
- Apply a dolly to the back of the heated panel. Tap the panel with a wooden hammer using the hammer-ondolly method in the sequence shown in the figure.

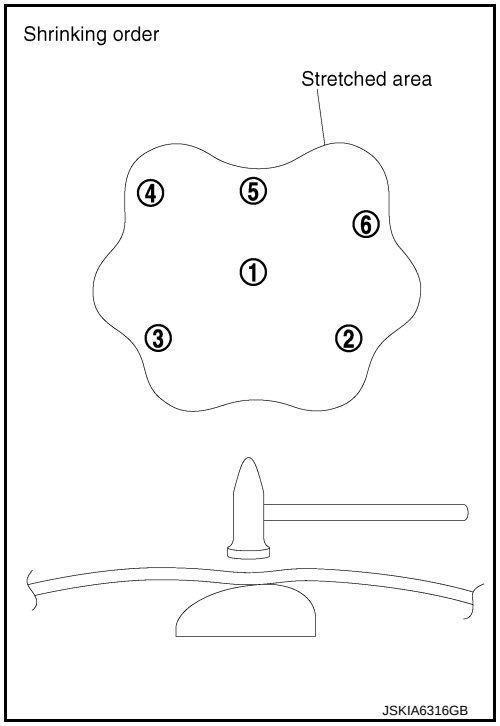
  (A) and (B) → 1 - 8

  (C) → 9



- Excessive stretch
  Shrink the panel, starting with the most stretched portion, and proceed toward the edge of the dent so that the dent surface is lower than the original surface.

  Using a gas welding torch makes the panel concave.
  To correct this, strike the concave portion using the hammer-on-dolly method to stretch the panel bit by bit until the original surface is restored.



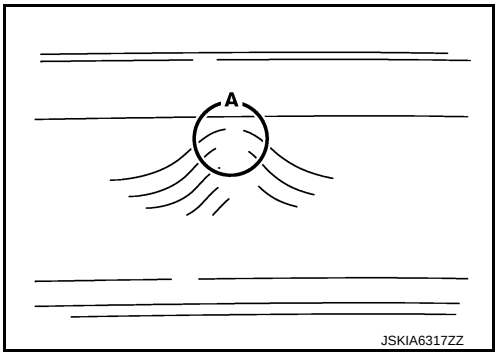
- Apply wet cloths to the shrunken portion of the panel to cool it quickly.

CORRECTING A DEFORMED PANEL

CORRECTING A DEFORMED PANEL : Determining Panel Damage

INFOID:0000000012107284

Panel damage must be examined carefully to select the most suitable repair method.
(A) In the figure is the plastic deformed area and the surrounding portions are elastic deformed areas.
Correction of (A) will automatically remove the elastic deformation.



Removing the cause of the dent can simplify the entire repair operation. Plastic deformation can be recognized by sharp bending, a nick, or cracked or peeled paint.

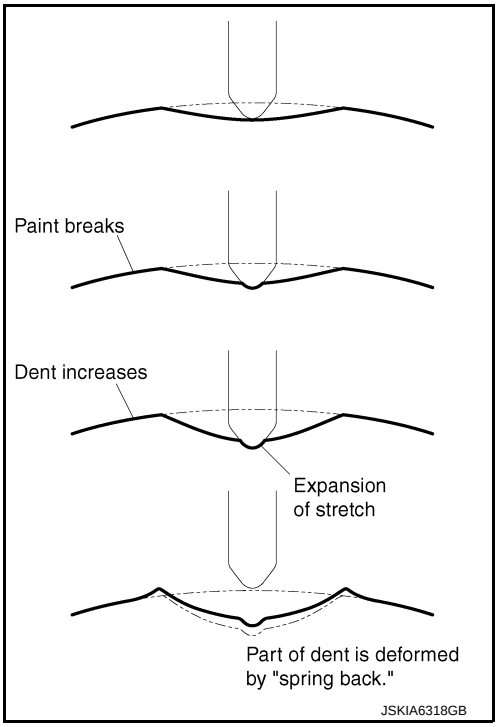
SHEET METAL DEFORMATION ANALYSIS

(a) When external force is applied, sheet metal deformation begins. Elastic deformation is generated around the point where the external force is applied.

(b) As the external force increases, areas surrounding the dent yield to the pressure, and local cracking or small breaks in the paint occur. This indicates plastic deformation.

(c) If the external force continues to increase, breaks around the dent enlarge, and the sheet metal at the center of the dent stretches.

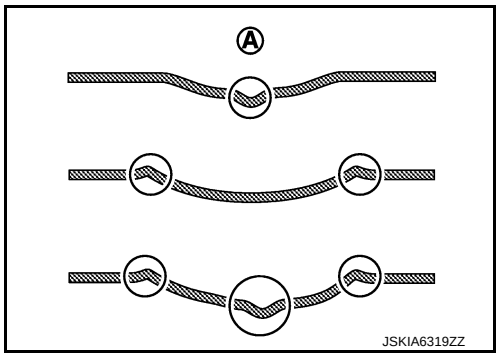
(d) When the external force is removed, the “spring back” causes the plastic deformed portion of the dent to swell above the original surface.



CORRECTING A DEFORMED PANEL : Basic Types of Damage

INFOID:0000000012107285

- Plastic deformation forms at the center of portion (A) of the dent. The surrounding area remains in elastic deformation.
- Plastic deformation occurs at one or several portions around the dent. Other areas remain in elastic deformation.
- Both plastic and elastic deformation are generated throughout the damaged panel.



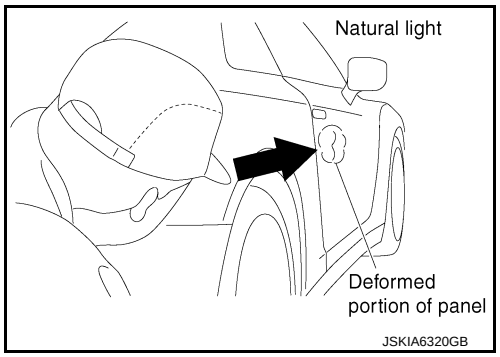
CORRECTING A DEFORMED PANEL : Examination of Panel Damage

INFOID:0000000012107286

It is difficult to find minor deformation or panel irregularity, particularly, at the final stage of repair. This section explains how to determine if a vehicle has minor panel deformation.

(1) VISUAL CHECK

Check the affected portion of the panel by carefully examining the deformation in the light reflected on the surface.

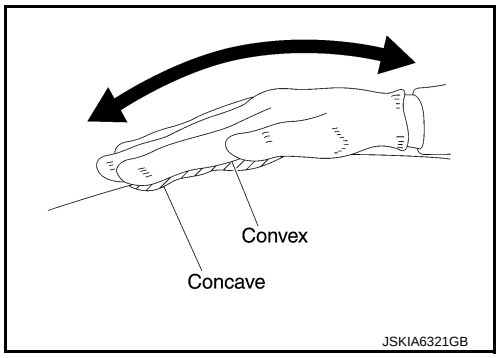


(2) TOUCH CHECK

Lightly place a hand on the surface of the panel and move it forward/backward and right/left to judge by touch with the palm of a hand. Slide and move a hand from an undamaged surface to a damaged part, all the way to the undamaged surface on the other side.

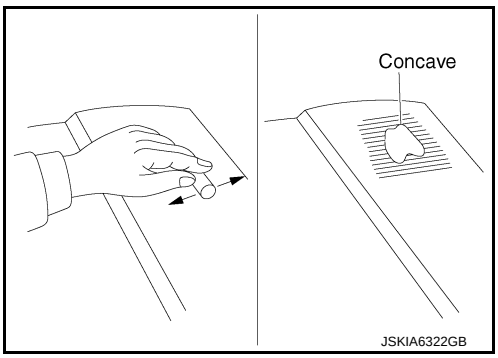
NOTE:

Wearing work gloves makes it easier to tell the difference.

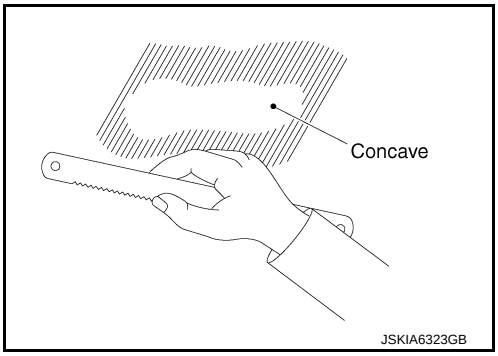


(3) CHECK WITH TOOLS

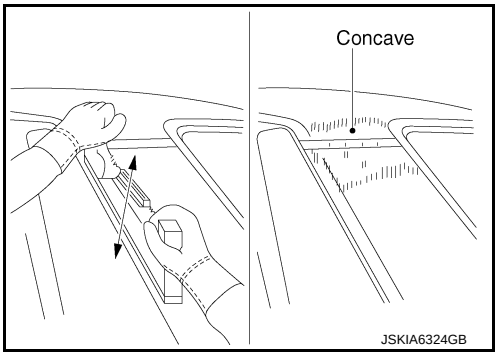
- Use of chalk: Rub the panel surface with a piece of chalk held lengthwise.
  Dents or concave areas in the panel will remain uncolored.



- Use of hacksaw blade: Scrape the panel surface with the blade teeth.
  Dents or concave areas will not be scratched.



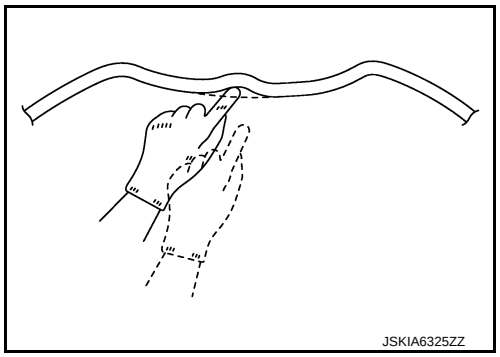
- Use of body file: Scrape a body file lightly on the panel.
  Dents or concave areas will not be scratched.
  The body file should not be used for grinding.
  Thickness and strength of the panel will be reduced.



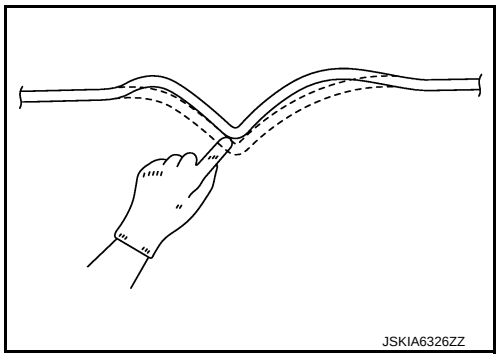
CORRECTING A DEFORMED PANEL : Elastic VS. Plastic Deformation

INFOID:0000000012107287

- Elastic deformation: If pressed, the deformed portion will move or further deform.



- Plastic deformation: If pressed, the deformed portion will remain unchanged, and other portions will move.

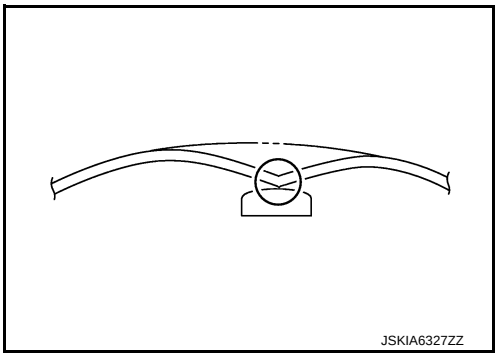


CORRECTING A DEFORMED PANEL : Basic Repair Procedure

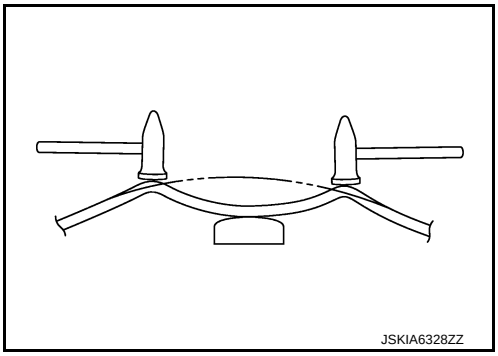
INFOID:0000000012107288

(1) WHEN PLASTIC DEFORMATION OCCURS AT THE CENTER OF THE DAMAGED PORTION

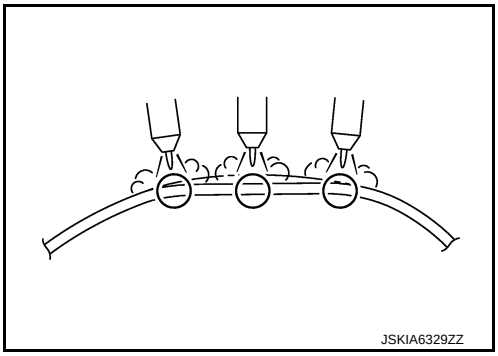
(a) Using a hammer or dolly, strike the lowest portion of the dent from behind until it becomes flat.



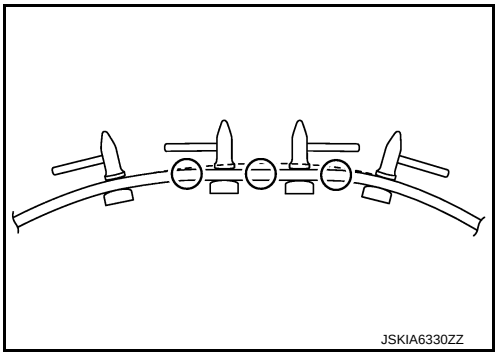
(b) Using the hammer-off-dolly method as shown in the figure, raise the concave portion and lower the convex portion.
Then smooth the surface a little lower than the original. Using a wooden hammer and dolly, correct the irregularities in the panel.



(c) Existence of plastic deformation can be determined by the stretched panel. The original surface can be restored by shrinking that portion with a gas welding torch.



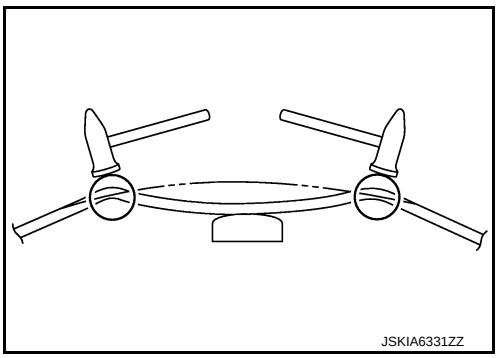
(d) Use a hammer and dolly by the hammer-on-dolly method. Stretch the panel while striking the outer area of the damaged portion. The entire panel surface should be formed somewhat higher than the original surface. Note that, in this case, the stretched portion of the panel must not be hit with the hammer.



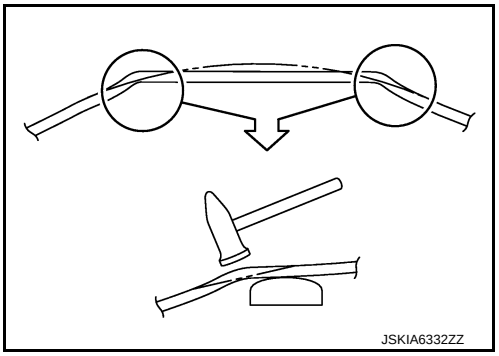
If the concave portion is shallow and if the working face of the wooden hammer matches it, the repair work can be completed quickly by directly shrinking the portion with a gas welding torch.

(2) WHEN PLASTIC DEFORMATION EXISTS AROUND THE DAMAGED PORTION

(a) Apply the dolly to the elastic deformation area behind the panel. Hit the plastic deformation area with a hammer so that the elastic deformation area is lower than the original surface.

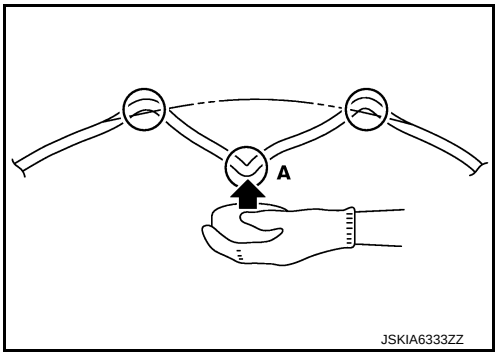


(b) Repair the plastic deformed portion using the hammer-off-dolly method. If a shrinking hammer is available, the stretched portion can be easily shrunk.

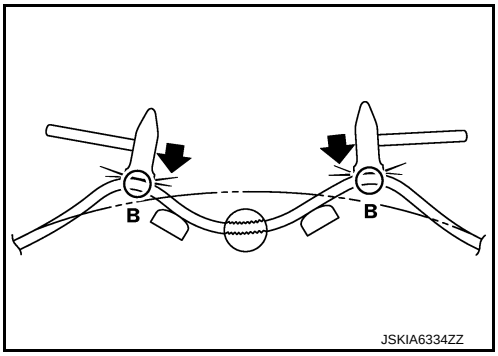


(3) WHEN PLASTIC DEFORMATION EXISTS AT THE CENTER AND AROUND THE DAMAGED PORTION

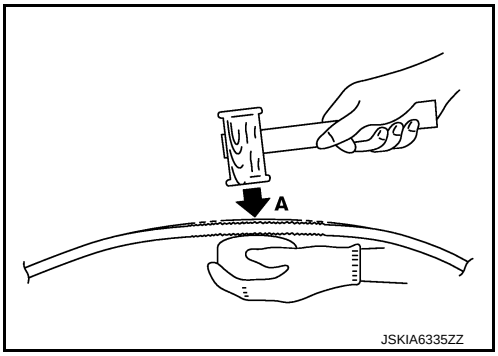
(a) Using a hammer and dolly, flatten the lowest portion (A) where the plastic deformation exists, so that the flattened surface is not higher than the original surface.



(b) Flatten the highest points (B) where plastic deformation exists.

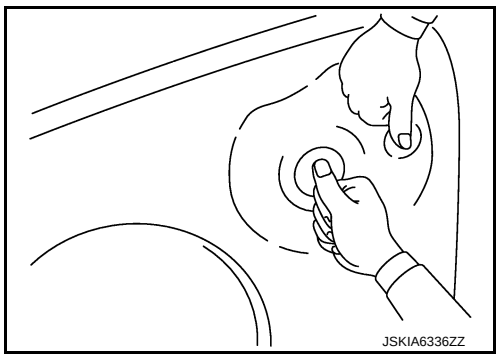


(c) Flatten portion (A) so that the panel surface is not higher than the original surface.
Correct irregularities using a wooden hammer and dolly. If the panel has been stretched, repair by shrinking.



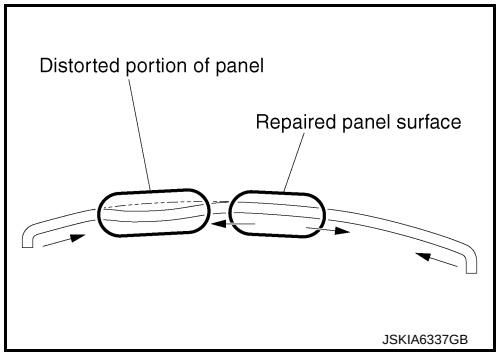
(4) CORRECTING PANEL DISTORTION

(a) Panel distortion occurs when panel damage is repaired. The panel is deformed within the range of elastic deformation. If pressed with a finger, the deformed area bends inward and outward. Panel irregularities occurring over a wide range other than the repaired portion may also indicate panel distortion.



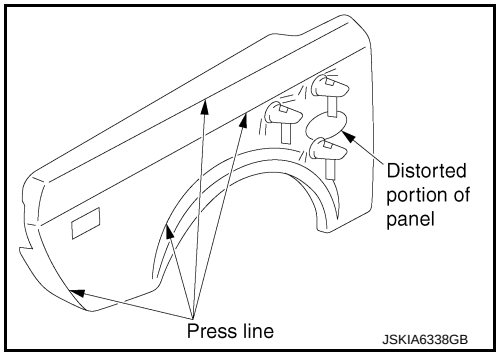
(b) Cause of panel distortion

Expansion stress due to damage repair is confined inside the panel because the outer area is bent and work hardened. Thus, it does not allow the panel to expand. The stress is released in the form of panel distortion.

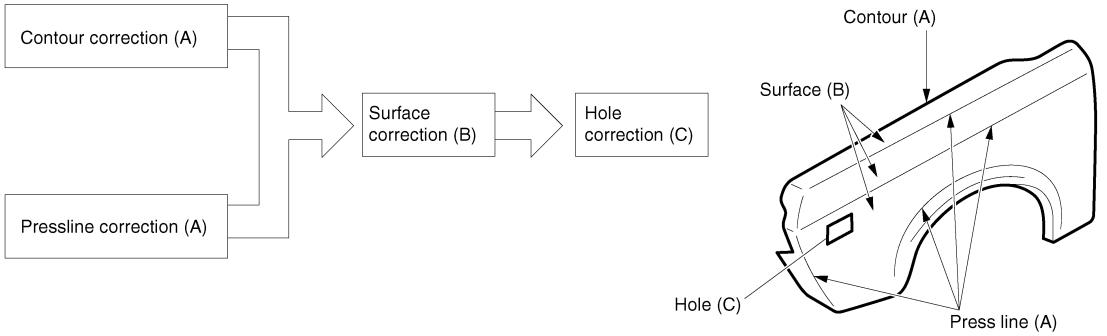


(c) How to correct panel distortion

Panel distortion can be removed by shrinking the stretched portion or by stretching the side of the press line using the hammer-on-dolly method.



The front fender repair procedure is explained below:



When repairing the body panel, paint and anti-corrosive wax must be thoroughly removed from the damaged area by sanding.

COLORED SHEET METAL WORK

COLORED SHEET METAL WORK : Colored Sheet Metal Work

INFOID:0000000012113016

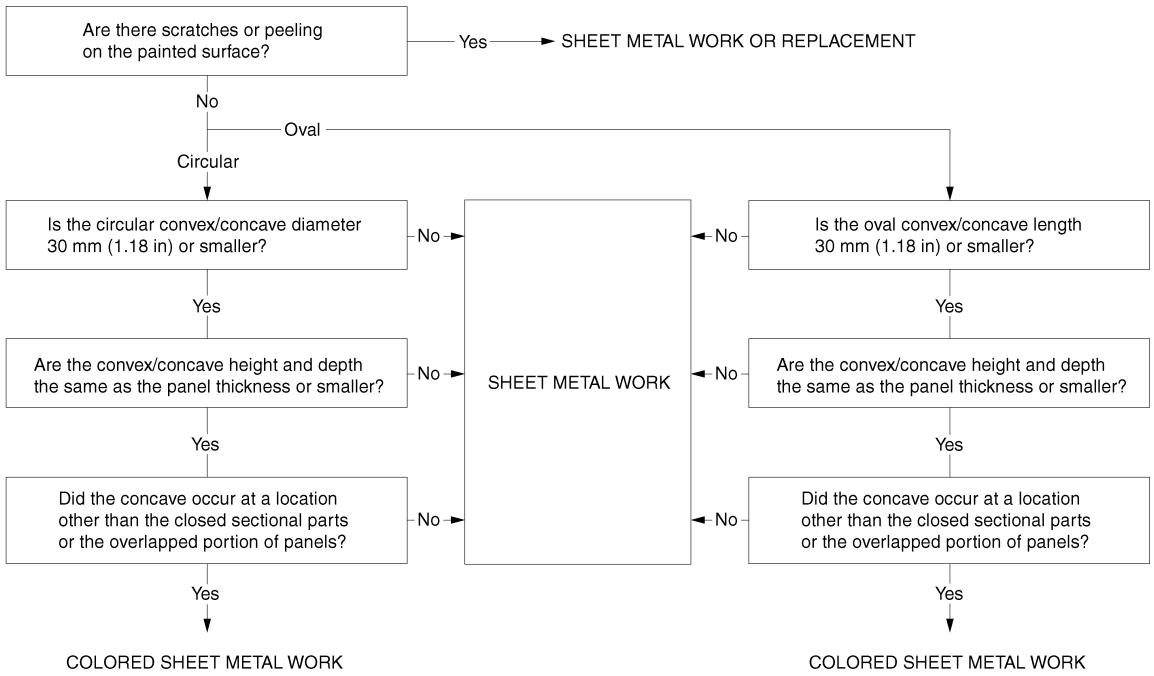
Colored sheet metal work is one type of panel repair technique. This technique is used to repair irregularities on painted outer panels without damaging the painted surface.

COLORED SHEET METAL WORK : Confirmation of The Panel

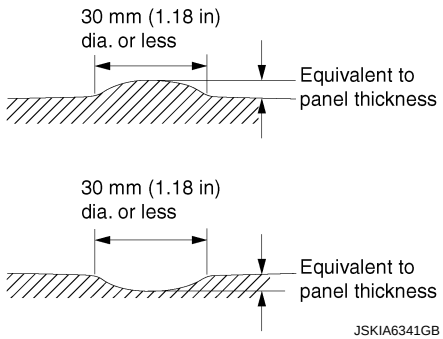
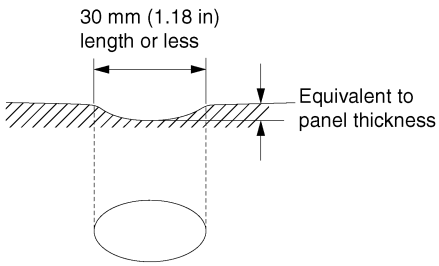
INFOID:0000000012107289

It is not possible to correct all convex/concave portions in colored sheet metal work.
Whether or not the parts need to be removed/installed, and tools that can be inserted must be checked for each repair location.
When checking the convex/concave location, determine whether or not the colored sheet metal work is possible. It is also important to determine the most suitable repair method.

COLORED SHEET METAL WORK FLOWCHART



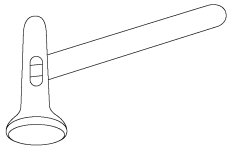
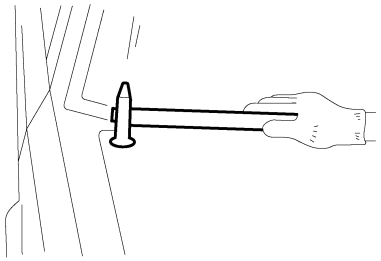
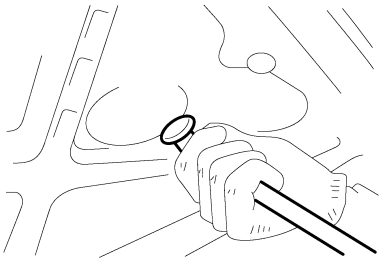
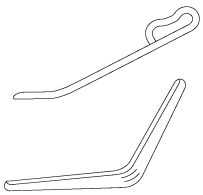
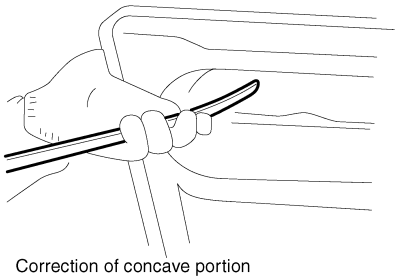
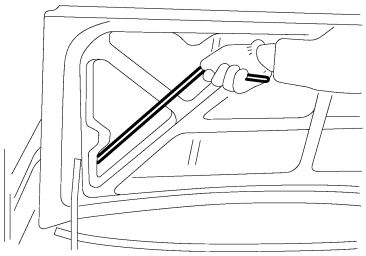
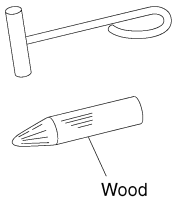
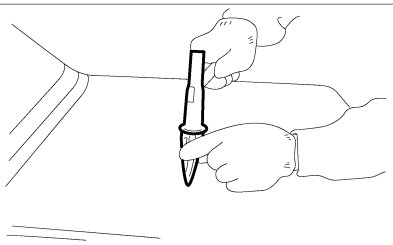
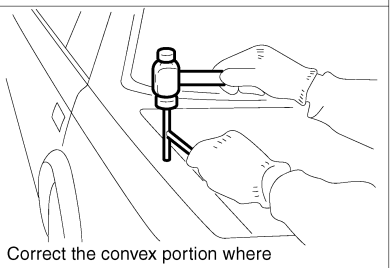
JSKIA6340GB

Example of circular convex/concave	Example of oval convex/concave
	
JSKIA6341GB	JSKIA6342GB

COLORED SHEET METAL WORK : Selection of Repair Tools

INFOID:0000000012107290

Tools for colored sheet metal work are hammers, spoons, dollies and punches. Some popular hand tools for colored sheet metal work and application examples are described below.

Hand tool	Usage example	
Hammer 	 Hammer the convex portion where elasticity of panel is not felt.	 Correct by directly pressing the concave portion.
Spoon 	 Correction of concave portion when no fulcrum point is available.	 Correct by inserting a spoon between inner panel and outer panel.
Punch Make by yourself.  Wood	 Correction of the center portion of trunk lid and other sections having elasticity.	 Correct the convex portion where no elasticity is felt, such as upper portion of rear fender.

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Choose suitable tools to repair the panel.

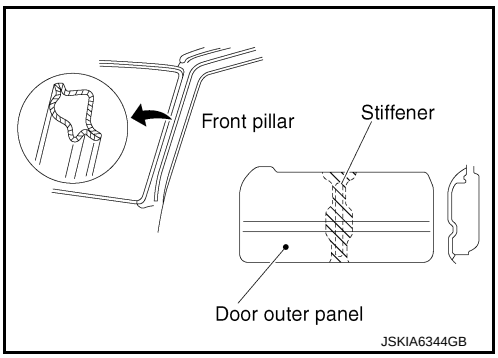
COLORED SHEET METAL WORK : Panel Repair Methods

INFOID:0000000012107291

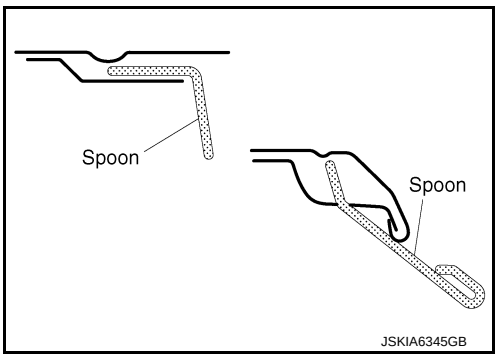
(1) CORRECTION OF CONCAVE PANEL WITH SPOONS

Convex panels can be repaired with a hammer and punch. Concave panels can be repaired with a spoon if the following conditions are satisfied:

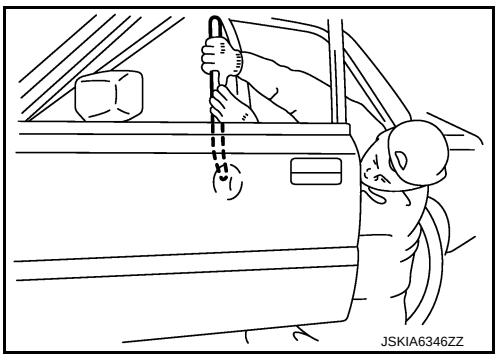
- The spoon must be able to be inserted behind the concave panel. A closed construction portion or mating panel cannot be repaired.



- Use of lever action should be allowed.
  If the surrounding portion of panel can be used to support a spoon as a lever, the concaved area can be repaired. Otherwise, corrective force cannot be transmitted to the desired portion.

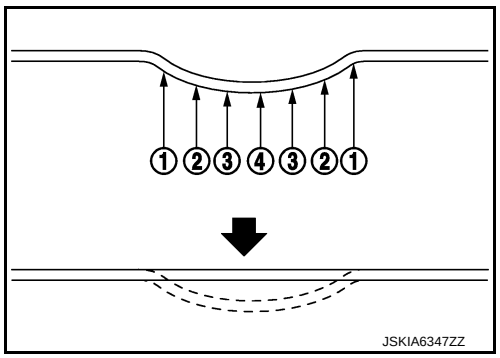


- The concave portion should be visible from outside.
  This work is performed visually, and dents in concealed areas cannot be repaired.

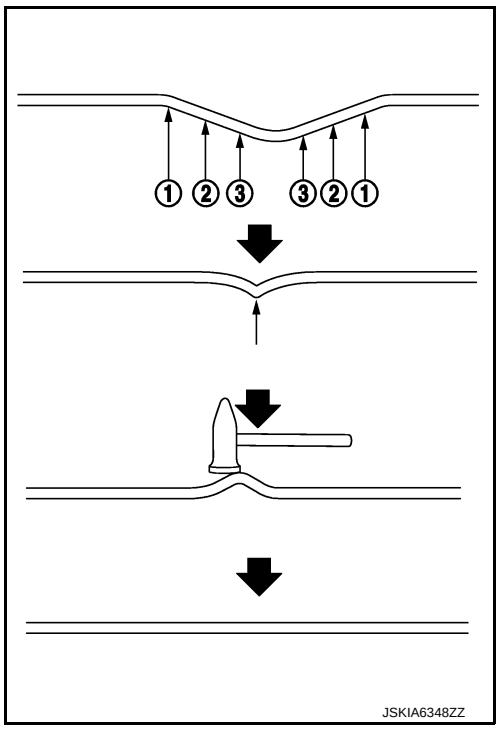


(2) KEY POINTS IN COLORED SHEET METAL REPAIR WORK

- Repairing a smoothly rounded concave section:
  Raise the concave portion little by little, beginning with the outside.



- Repairing a concave section bent sharply at the center:
  First, raise the concave portion 60% - 70%, beginning with the outside. Next, raise the sharply bent portion slightly higher than the surrounding panel surface.
  Then flatten the high point by tapping with a hammer.



- Do not attempt to correct panel deformation all at once.
  Use the step-by-step repair method, such as roughing → smoothing → finishing.
- After repairing, visually check the repaired portion from all directions.

COLORED SHEET METAL WORK : Polishing of Panel Surface and Anti-corrosive Treatment

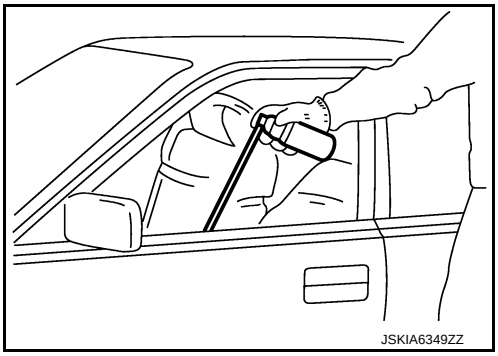
INFOID:0000000012107292

(1) POLISH-FINISHING OF CORRECTED SURFACE

If the painted surface is scratched during repair, polish with compound to remove scratches.

(2) ANTI-CORROSIVE TREATMENT OF BACK OF PANEL

The spoons may cause scratches. Apply anti-corrosive wax to the back of panel.



COLORED SHEET METAL WORK : Examination of Panel

INFOID:0000000012107293

Irregularities in the panel must be examined carefully to see whether or not they can be repaired, and also to determine the most suitable repair method.
Refer to BRM-83, "CORRECTING A DEFORMED PANEL : Examination of Panel Damage".

BODY WELDING AND PRECAUTIONS

OUTLINE OF WELDING

OUTLINE OF WELDING : Outline of Welding

INFOID:0000000012116172

Welding is a metalworking process in which metals are heated to their melting points and are joined by allowing the molten portions to fuse together.

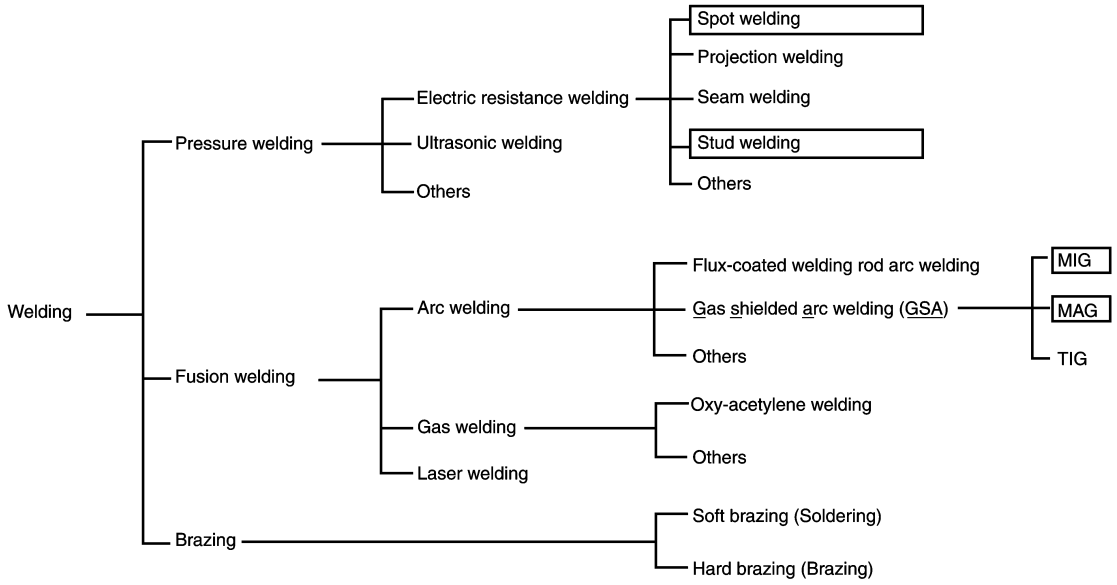
OUTLINE OF WELDING : Types of Welding

INFOID:0000000012111976

(1) PRESSUER WELDING
Metals are softened by heating and fused together by pressure.

(2) FUSION WELDING
Metals are melted by heating and are then fused without pressure.

(3) BRAZING
Metals are joined by another metal whose melting point is below that of the metals. The metals themselves are not melted. This method is divided into two types, soft brazing and hard brazing, according to the melting point of the material.



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NOTE:
Welding methods often used in repair work are enclosed in ☐ marks.

OUTLINE OF WELDING : Features of Welding

INFOID:0000000012111975

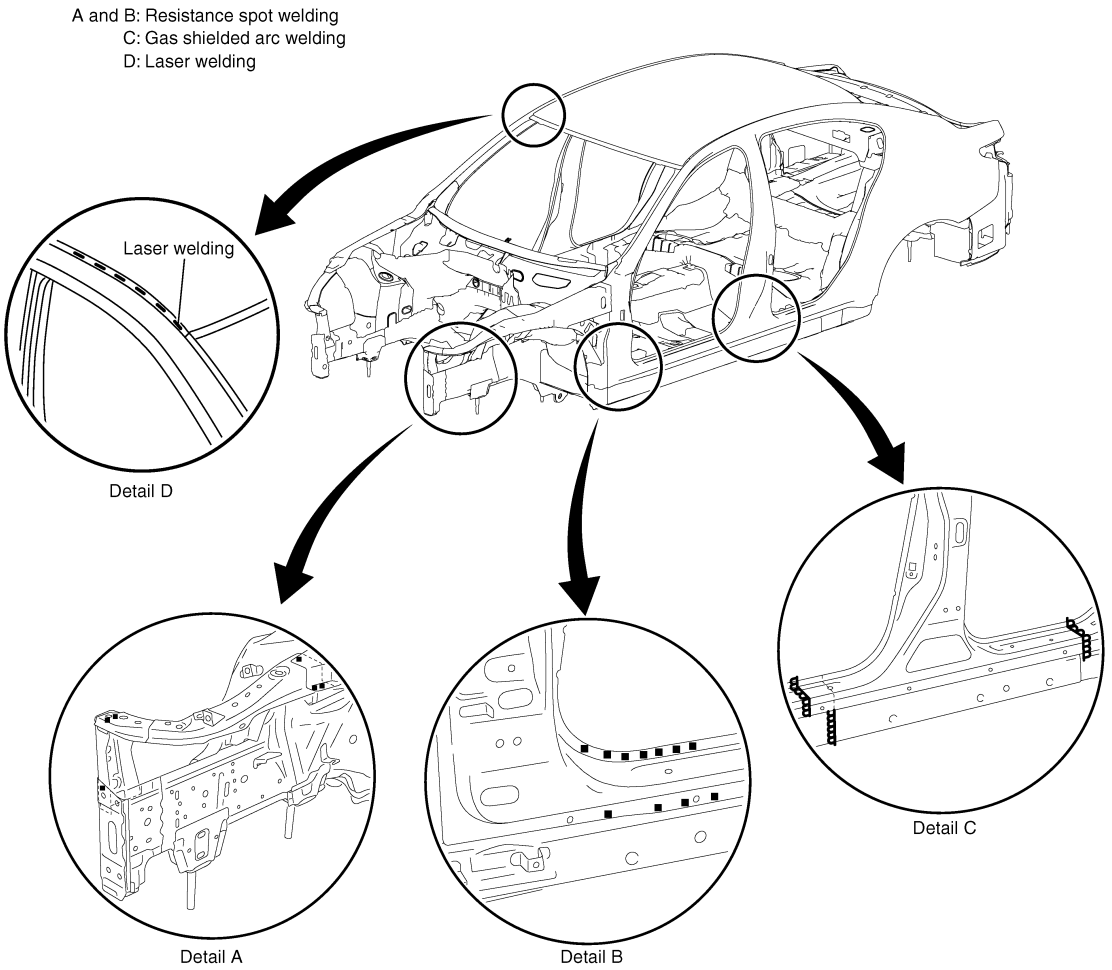
- No restrictions on the shape of joint
- Reduction in weight compared to using of bolts or rivets
- Great strength
- Airtight and watertight
- High working efficiency
- Some welding processes require higher welding skills.
- The welded parts can be separated only by breaking the weld. (Except when brazing)

OUTLINE OF WELDING : Welding of Automovile Body

INFOID:0000000012106667

The automobile body is fabricated by welding 0.6 mm - 1.4 mm (0.024 in - 0.055 in) thick sheet steel. Spot welding is most suitable in terms of cost, quality and working efficiency. On the automobile production line, spot welding is widely used, except for some special areas which cannot use this procedure. Today, spot welding is mostly performed by robots.
In addition to spot welding CO_2 arc welding and brazing are also used.
Soldering is not used in the automobile production line. Brazing is used on the roof joints, front pillar and rear pillar, and on the sealing surface of the center pillar.
Automobile assembly line welding processes are shown below.

Automobile assembly line welding processes are shown below.



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ELECTRIC RESISTANCE SPOT WELDING

ELECTRIC RESISTANCE SPOT WELDING : Principles of Spot Welding

INFOID:0000000012112001

Resistance spot welding is a kind of electric resistance welding. It is classified as pressure welding. Two or three sheets of metal are overlapped and pressed, and current is passed through the mating surfaces. As the current flows, the metals melt due to Joule heat at the mating surfaces and are joined by the pressure.

ELECTRIC RESISTANCE SPOT WELDING : Features of Spot Welding

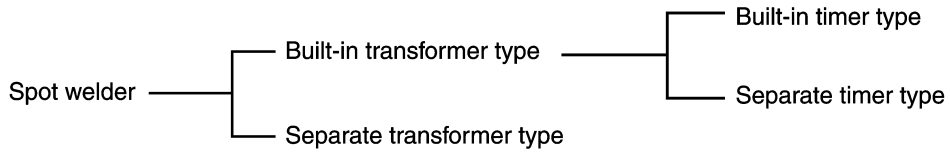
INFOID:0000000012111998

- Short welding time and high efficiency compared to other welding processes
- Minimum thermal strain due to partial heating
- No need to finish the welded surface
- Less rust formation compared to other welding processes due to application of conductive sealer
- Great welding skill is not needed. Uniform weld strength can be obtained regardless of worker's skill
- Heavy welding machine is required to produce high current
- Most suitable for welding thin sheet metals
- The condition of the weld is difficult to check from the outside
- Paint must be removed from the surfaces to be welded

ELECTRIC RESISTANCE SPOT WELDING : Construction of Spot Welder

INFOID:0000000012111997

The spot welding machine consists of a transformer unit which supplies the voltage and current required for welding, a timer unit which controls the current passing time, and a welding gun.



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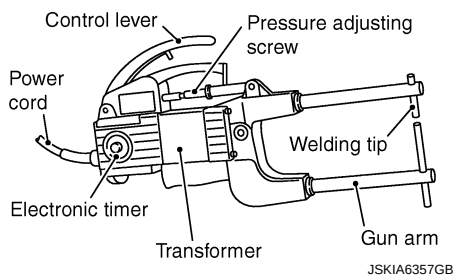
The separate transformer type includes a multi-functional type for welding of pins and washers.

BUILT-IN TRANSFORMER TYPE SPOT WELDER



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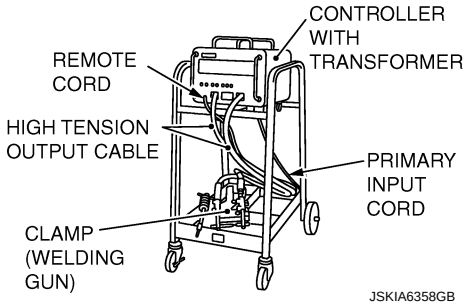
SEPARATE TRANSFORMER TYPE SPOT WELDER



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ELECTRIC RESISTANCE SPOT WELDING : Cooling Methods

INFOID:0000000012111996

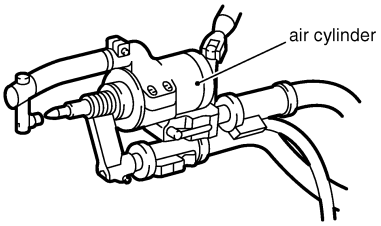
1. Air cooling: Forced air cooling with fan
2. Water cooling: Cooling by circulating the water

ELECTRIC RESISTANCE SPOT WELDING : Spot Welding Gun

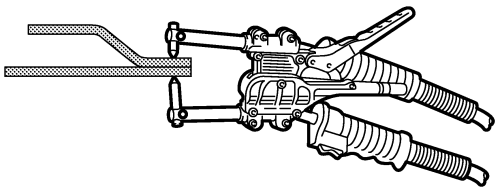
INFOID:0000000012111995

(1) TYPES OF CLAMP

Air clamp type
Panels are pressurized with compressed air pressure.
The welding pressure can be adjusted by adjusting air pressure.



Manual clamp type
Panels are pressurized manually.
This type of gun is lightweight.



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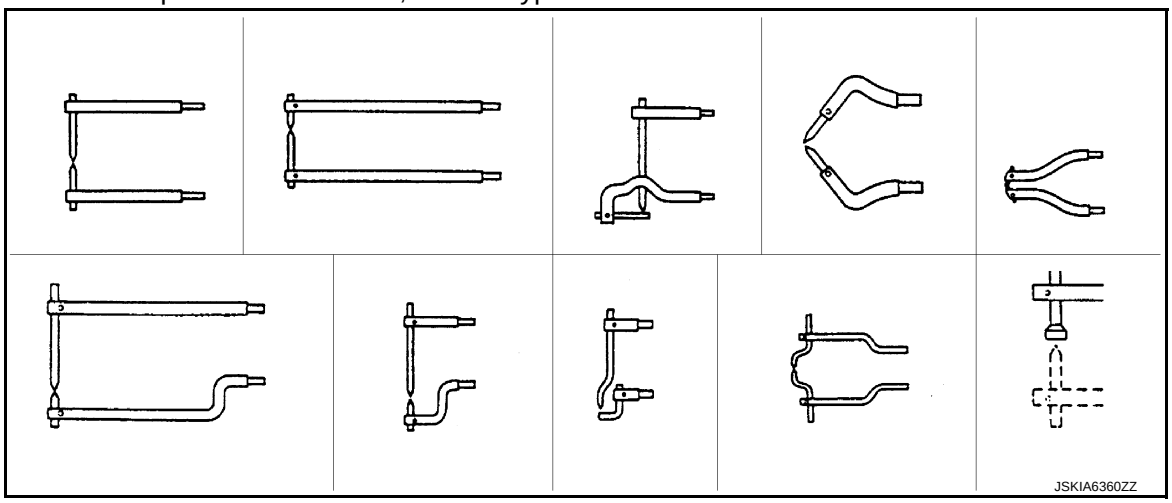
(2) ATTACHMENT ARM

- In spot welding, 2 or 3 panels to be welded must be clamped directly at electrodes. Therefore, the disadvantage of spot welding is that there are some points at which welding cannot be performed.
- In order to make up for this weakness, various types of attachment arms have been created.



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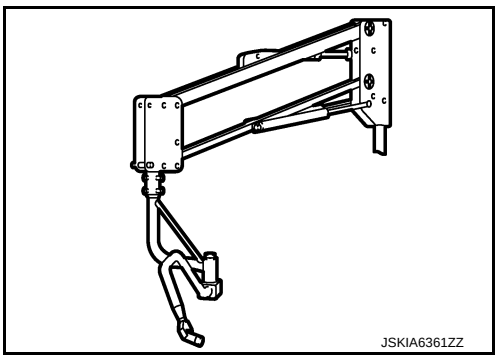
(3) HANGING UNIT

- The weight of guns, arms and cables has been reduced to minimize the burdens on workers.
- Depending on the unit type, the cable can simply be hung, or the gun can be hung with a cylinder.



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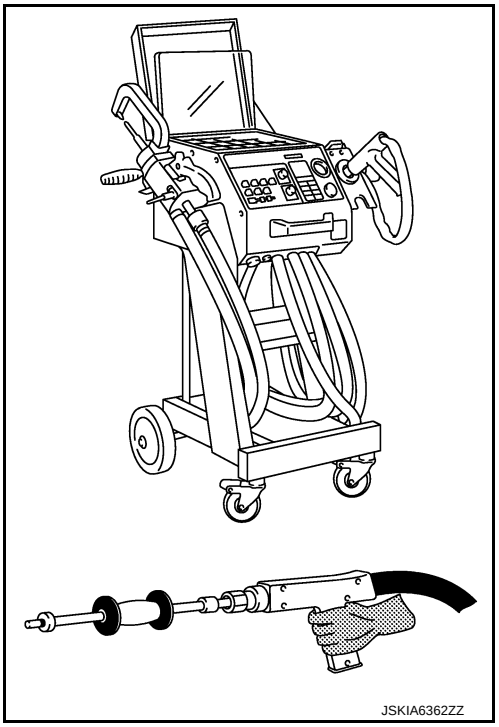
ELECTRIC RESISTANCE SPOT WELDING : Mult-functional Type Spot Welder

INFOID:0000000012111994

In addition to the ordinary spot welding function, sheet metal can be pulled with the sliding hammer.
Major functions:

- Both sided spot welding
- One sided spot welding (Pre tack welding)
- Spot hammer welding
- Nuts and bolts welding
- Carbon shrinking
- Contact shrinking
- Washer and pin or stud welding



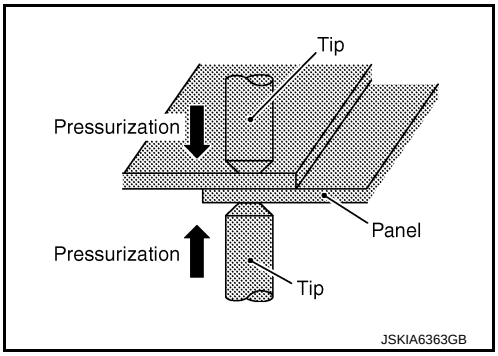
ELECTRIC RESISTANCE SPOT WELDING : Process of Spot Welding

INFOID:0000000012111993

It takes 3 processes, “pressurization”, “energization”, and “retention”, to complete the spot welding.

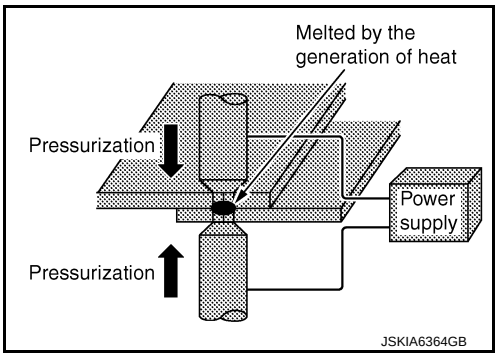
(1) PRESSURIZATION

- The welding points of overlapped panels are pressurized with the tip (electrode) for close contact.
- With the panels contacting closely, the current can run intensively.



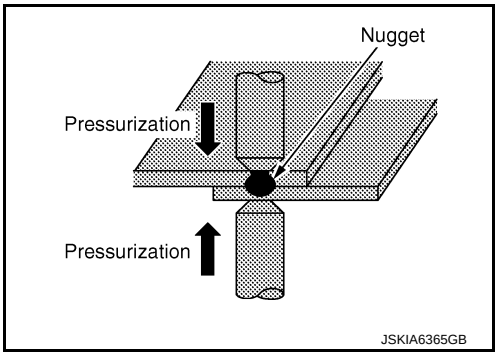
(2) ENERGIZATION

- With the panels being pressurized, heavy current is applied.
- Joule heat is generated at panel mating areas, and the temperature rises sharply.
- The panel mating areas are melted and fused together by welding pressure.



(3) RETENTION

- Even after the current is turned off, pressure is still applied until the welded point cools down.
- The nugget system becomes delicate by pressurization, resulting in better mechanical properties.
- Therefore, the retention process must not be omitted.



ELECTRIC RESISTANCE SPOT WELDING : Element of Spot Welding

INFOID:0000000012111992

(1) WELDING PRESSURE

If welding pressure only is changed at a constant current, the higher the welding pressure, the smaller the nugget becomes.
This is because, when the welding pressure becomes higher, the current carrying area becomes larger, which results in reduced current density.
In addition, when the welding pressure is low, excess spatter is produced, which causes welding strength to deteriorate.

(2) WELDING CURRENT

As the welding current increases, the nugget diameter also increases, and the strength is enhanced.
However, if the current is too large or too small for the welding pressure, a welding malfunction occurs.
Therefore, keeping the balance between the current and welding pressure is important.
Spot welding machine's current output performance is influenced by the electric power supply capacity of the workshop where the machine is utilized, so secure the sufficient electric power supply capacity of the workshop to cover the maximum current output of the welding machine.
Since an inverter-type welding machine has high output performance, use the machine which can output sufficient performance to the welding conditions described in each model's Service Manual.

(3) WELDING TIME

The amount of heat generated at welding points during the welding period increases as the welding time elapses. The nugget becomes larger at the same time.
However, even if the welding is continued beyond the saturation, the nugget size will not increase. Instead, impressions and thermal strain will be increased.

Nugget	Small	Large
Welding pressure Welding current Welding time	High Small Short	Low Large Long

(However, the nugget size does not become larger or smaller after it reaches a certain size limit.)

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(4) WELDING CONDITION

The appropriate value of each element for the welding condition varies depending on the panel's thickness and tensile strength.
Apply the specified values in each model’s Service Manual to get the proper spot welding.

Welding condition (Example)

Welder tip diameter	**6 mm**
Welding pressure (Gun force)	**3100 N**
Welding current	**8000 A**
Weld time	**• 0.20 sec. (10 cycle: 50 Hz)** **• 0.20 sec. (12 cycle: 60 Hz)**
Panel configuration	**Combination of a plate of tensile strength of 980 MPa and that of tensile strength less than 980 MPa. (Up to 3 plates)**

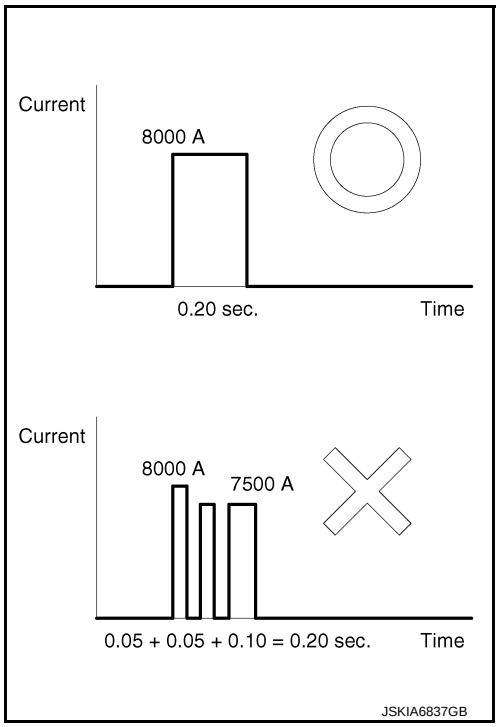
ELECTRIC RESISTANCE SPOT WELDING : Current Pulse Shape

INFOID:0000000012150290

To get the sufficient quality of spot welding, the specified current must be applied for the specified time continuously.
The current apply tire is divided, even if the total time is the same as the specified time, will lead to the insufficient quality of spot welding.

Welding condition (Example)

Welder tip diameter	**6 mm**
Welding pressure (Gun force)	**3100 N**
Welding current	**8000 A**
Weld time	**• 0.20 sec. (10 cycle: 50 Hz)** **• 0.20 sec. (12 cycle: 60 Hz)**
Panel configuration	**Combination of a plate of tensile strength of 980 MPa and that of tensile strength less than 980 MPa. (Up to 3 plates)**



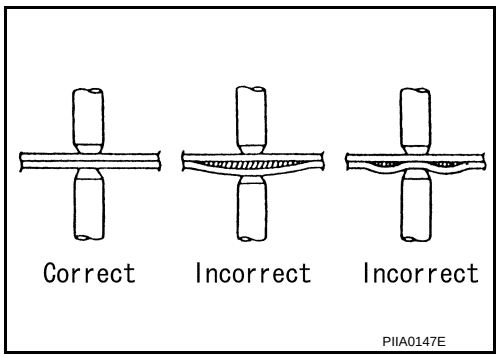
ELECTRIC RESISTANCE SPOT WELDING : Condition of the Panel

INFOID:0000000012111991

Before beginning, thoroughly check the panel and make any necessary corrections.

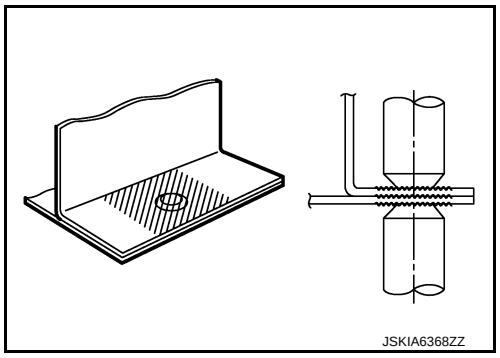
(1) CLEARANCE BETWEEN WELDING SURFACES

Gaps between the surfaces to be welded cause poor current flow. Even if welding could be done without removing such gaps, the welded area would be smaller, resulting in poor strength.
Flatten the two surfaces to remove the gaps, and clamp them tightly before welding.



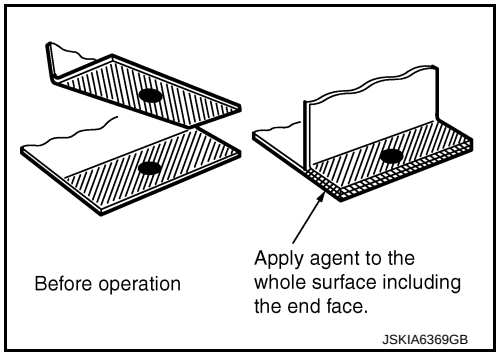
(2) PANEL SURFACES TO BE WELDED

Paint, rust, dust, or any other contamination on the panel surfaces to be welded cause insufficient current flow and poor results.
Remove such foreign matter from the surfaces to be welded by sanding or wiping clean.
Do not remove electrodeposited coatings.



(3) CORROSION PREVENTS PROPER WELDING OF PANEL SURFACES.

Coat the surfaces to be welded with an anticorrosion agent that has high conductivity.
It is important to evenly apply the agent to the panel including the end face.
Perform the spot welding before the anticorrosion agent gets dry, as the agent has generally low conductivity.
Because the wet agent can move from the welding portion due to the welding pressure, that leads to the good quality of spot welding by high conductivity.

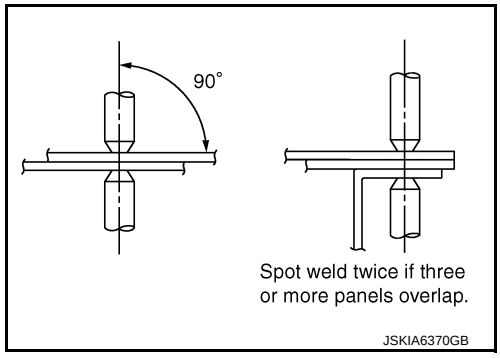


ELECTRIC RESISTANCE SPOT WELDING : Precautions when Performing Spot Welding

INFOID:0000000012111990

(1) SELECTION OF SPOT WELDING MACHINE

Use the direct welding method whenever possible.
(When direct welding cannot be applied, use MIG/MAG plug welding.)



(2) APPLICATION OF ELECTRODE TIPS

Apply electrodes at right angles to the panel. If they are not applied properly, the current density will be low, resulting in poor welding strength.

(3) LAP WELDING OF MORE THAN TWO PANELS

Where three or more panels overlap, spot welding should be done twice.

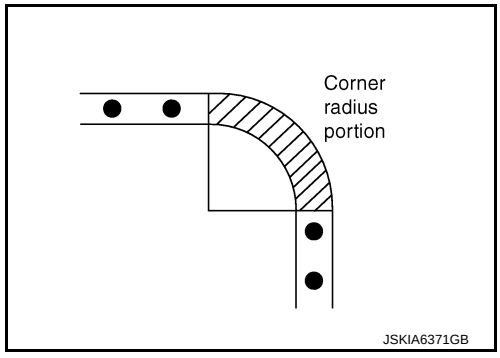
(4) NUMBER OF SPOT WELDING POINTS

Generally, the capacity of repair shop spot welding machines is smaller than that of factory welding machines. Accordingly, the number of points of spot welding should be increased by 20% - 30%.

(5) WELDING CORNERS

Do not weld the curved corner. Welding this portion results in stress concentration, which leads to cracks.
Examples:

- Upper corner of front and center pillars
- Front upper portion of rear fender
- Corner portion of front and rear windows

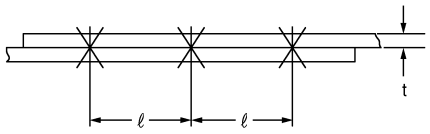


(6) MINIMUM WELDING PITCH

The minimum welding pitch varies with the thickness of panels to be welded. In general, observe the values in the following table.

Unit: mm (in)

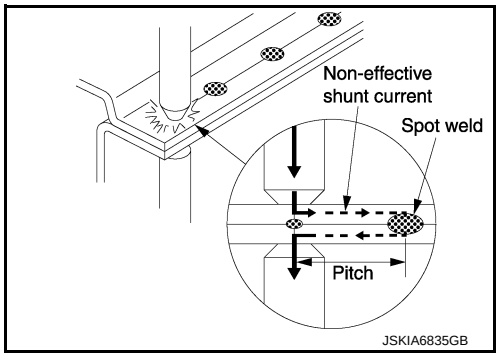
Thickness (t)	Minimum pitch (ℓ)
0.6 (0.024)	10 (0.39)
0.8 (0.031)	12 (0.47)
1.0 (0.039)	18 (0.71)
1.2 (0.047)	20 (0.79)
1.6 (0.063)	27 (1.06)
1.8 (0.071)	31 (1.22)



JSKIA6372GB

NOTE:

The excessively small pitch allows the current to flow through surrounding portions, resulting in poor welding strength.



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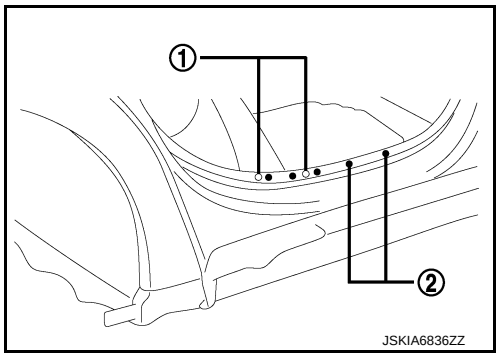
Avoid welding over previously welded areas.

① **Old Spot Locations**
② **New Spot Locations**



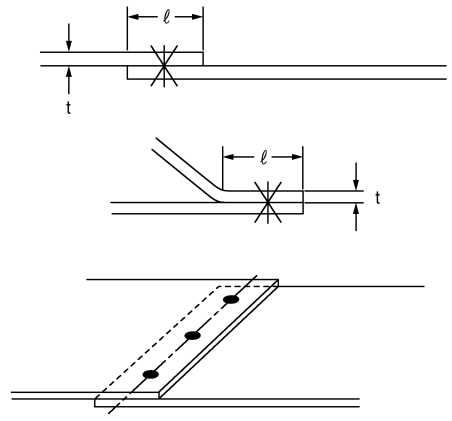
JSKIA6836ZZ

(7) MINIMUM LAP OF PANELS

Observe the following values for the lap distance of panels. Too short of a lap distance results in reduced strength and also in a strained panel.

Unit: mm (in)

Thickness (t)	Minimum pitch (ℓ)
0.6 (0.024)	11 (0.43)
0.8 (0.031)	11 (0.43)
1.0 (0.039)	12 (0.47)
1.2 (0.047)	14 (0.55)
1.6 (0.063)	16 (0.63)
1.8 (0.071)	17 (0.67)



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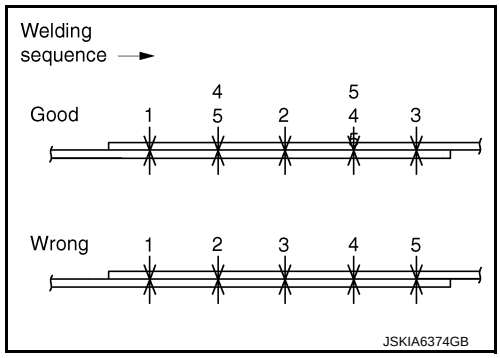
NOTE:

Be sure to spot weld at the center of the overlapped portion.

(8) SPOTTING SEQUENCE

Do not spot weld continuously in one direction only. This causes weak welding due to the shunt effect of the current. If the welding tips become red-hot, stop welding and cool the tips.



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ELECTRIC RESISTANCE SPOT WELDING : Inspection of Welded Portion

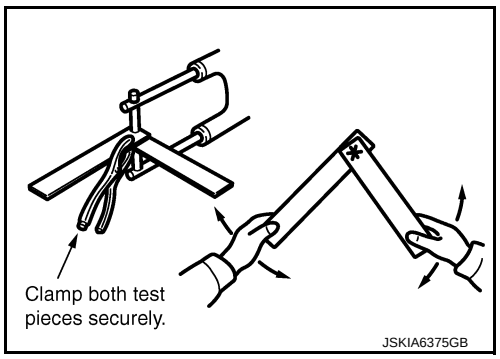
INFOID:0000000012106666

Spot welded portions can be checked by the destructive inspections explained below. They can be easily adopted when welding. Before and after welding, you should perform these destructive inspections to check the strength of the welded portions.
The welding spots should be equally spaced and arranged at the center of the flange to be welded.

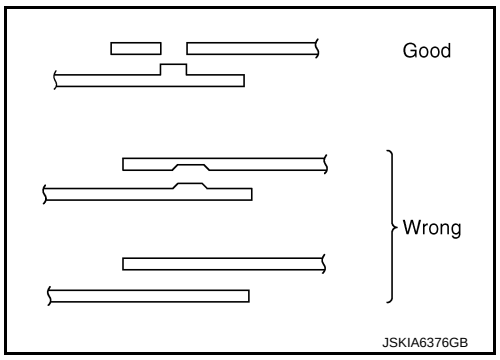
(1) CHECK BY USING TEST PIECE (Confirmation before operation)

NOTE:
Clamp both test pieces together so that they will not slip or move during welding.

(a) Weld together test pieces with the same thickness as the panel to be welded.
Break the weld by twisting, and examine the break.

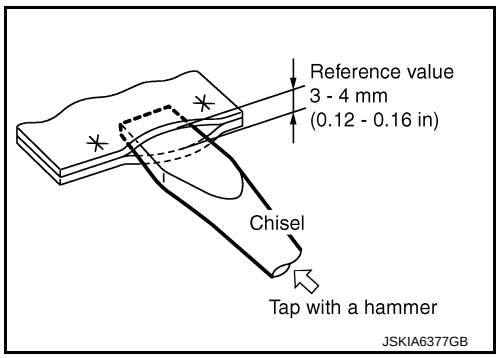


(b) With this test, a hole should be made on one test piece by tearing at the welded portion. If no hole is formed, it indicates that the welding conditions are incorrect. Adjust the pressure, welding current, current passing time and other conditions, and repeat test until the best result is obtained.

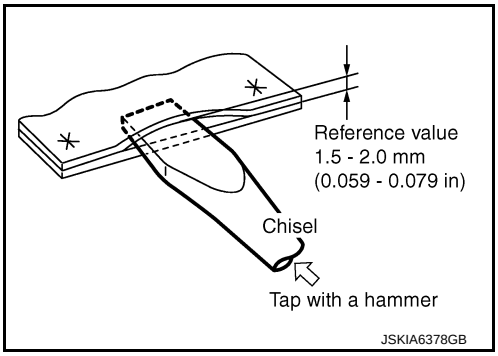


(2) CHECK BY USING CHISEL AND HAMMER (Confirmation after welding)

(a) Insert a chisel tip between the welded panels, and tap the end until a clearance 3 mm - 4 mm (0.12 in - 0.16 in) [when the panel thickness is 0.8 mm - 1.0 mm (0.031 in - 0.039 in)] is formed between the panels. If the welded portions do not separate, it indicates that the welding has been done properly.



This clearance varies with the location of the welded spots, length of the flange, panel thickness, welding pitch, and other factors. Note that the value shown above is only for reference.
(b) If the thickness of the panels is different, the clearance must be limited to 1.5 mm - 2.0 mm (0.059 in - 0.079 in). Further opening of the panels can become a destructive test.
(c) Be sure to repair the deformed portion of the panel after inspection.



ARC WELDING

ARC WELDING : Arc Welding

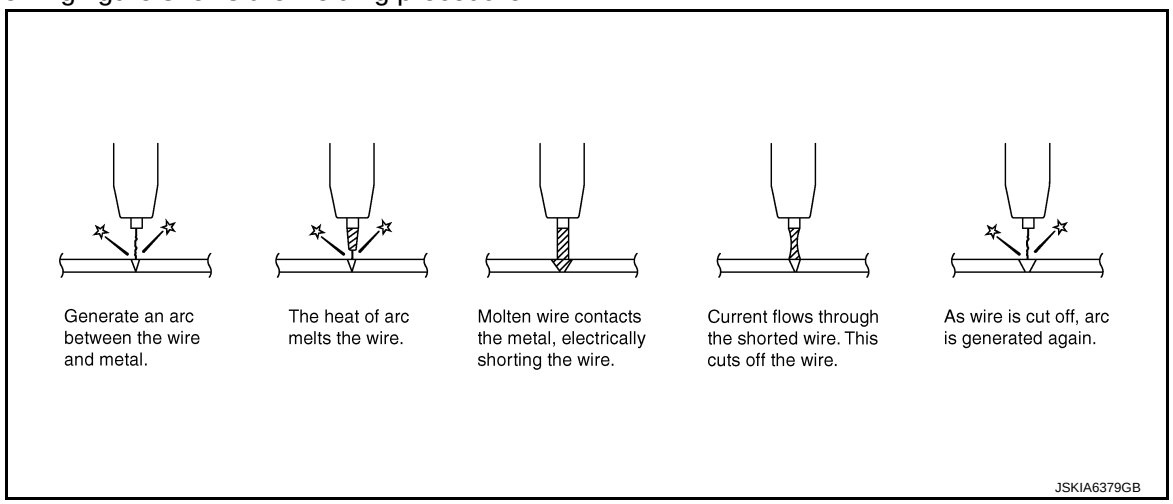
INFOID:0000000012116173

Arc welding uses the heat of an electric arc to join two pieces of metal by fusing both the metal and the electrode. For auto repair, MIG (Metal Inert Gas) and MAG (Metal Active Gas) are the types of arc welding most often used.

ARC WELDING : Principles of MIG and MAG Arc Welding

INFOID:0000000012112006

The welding electrode consists of a wire wound on a reel. This welding wire is fed by an electronically controlled motor.
The welding zone is shielded from the atmosphere by injecting a shielding gas. This prevents oxidation and nitriding so that greater weld strength and a good weld bead can be obtained. The shielding gas is argon, CO_2, or a mixture of both.
MIG arc welding uses argon gas as a shield. If CO_2 is used, the method is called MAG arc welding. Use of argon gas permits most metals, including aluminum, copper, stainless steel, titanium, to be welded.
The following figure shows the welding procedure.



ARC WELDING : Features of MIG and MAG Welding

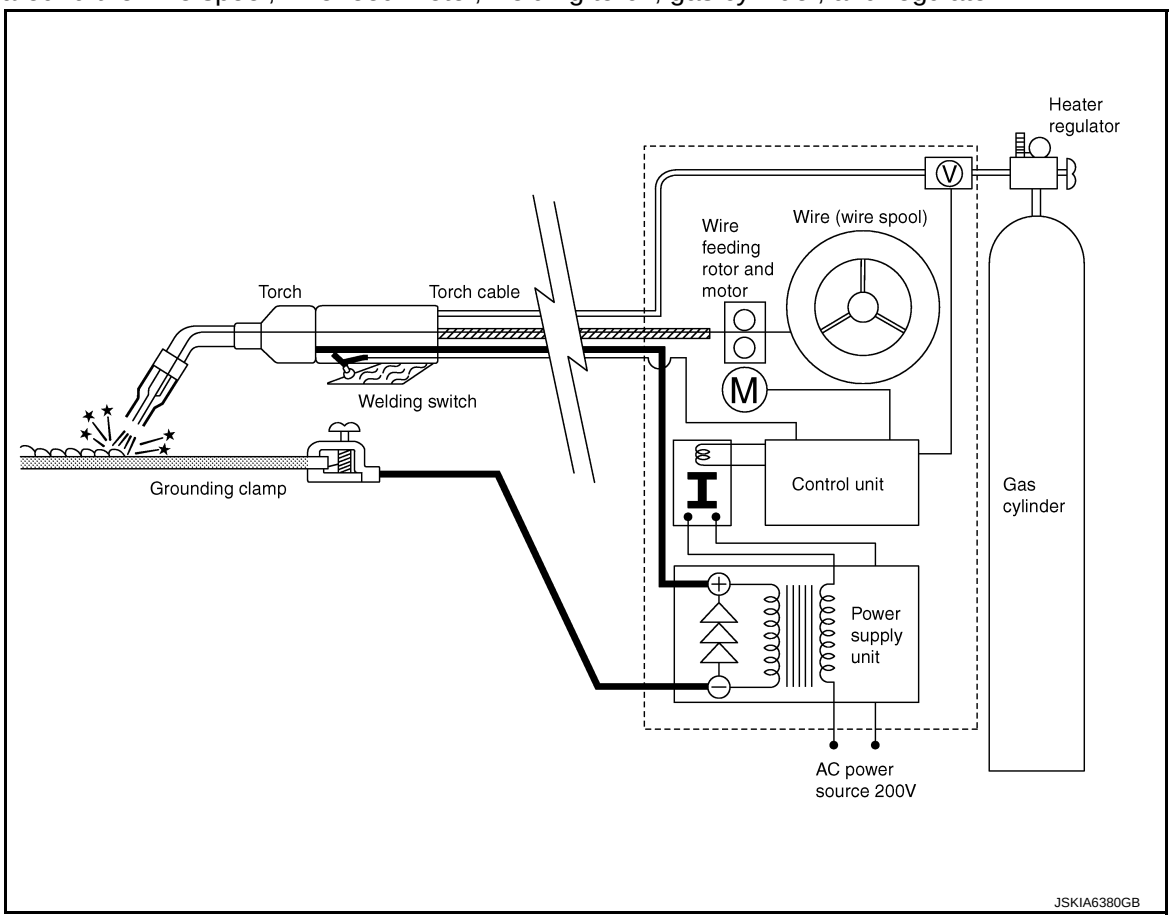
INFOID:0000000012112005

- Less slag
- Less thermal strain
- Comparatively easy to master
- Greater weld strength than gas or spot welding
- Suitable for thin sheet metal
- Less influence of welding position to the strength of weld
- Not suitable for windy locations

ARC WELDING : Structure of MIG and MAG Welding Machine

INFOID:0000000012112004

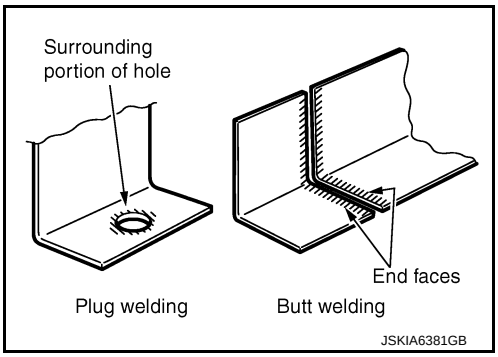
The welding machine consists of a power supply unit composed of a transformer and rectifier which converts the source voltage to welding voltage and rectifies the current. A controller which controls the voltage, current and welding wire feed speed corresponding to the thickness of the welding panel. Welding wire which is wound around the wire spool, wire feed motor, welding torch, gas cylinder, and regulator.



ARC WELDING : Condition of Panel to be Welded

INFOID:0000000012112003

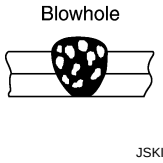
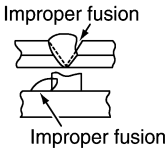
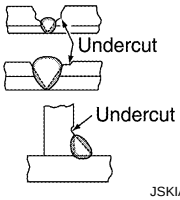
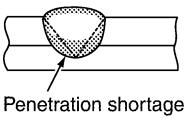
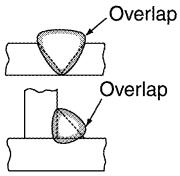
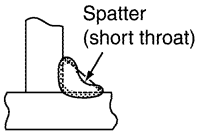
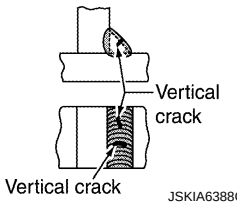
Paint, rust, or oils on the surface of the panel cause blowholes and spatter when the panel is welded. Thoroughly remove any foreign matter with a belt sander or wire brush.
Do not remove electrodeposited coatings.



ARC WELDING : Inspection of Welded Portions

INFOID:0000000012112002

Refer to the inspection method for spot welding. Refer to BRM-107, "ELECTRIC RESISTANCE SPOT WELDING : Inspection of Welded Portion".
Sample defects and welding conditions of MIG, MAG welding.

Defect	Check points	Remarks
 JSKIA6382GB	• Is correct wire selected? • Is gas sealed properly? • Is weld joint surface clean? • Is weld zone quickly cooled?	A hole is made when gas is trapped in the weld metal.
 JSKIA6383GB	• Is torch feed operated properly? • Is voltage low? • Is the area to be welded clean?	This is an unfused condition between weld metals or between deposited metals.
 JSKIA6384GB	• Is current too great? • Is torch feed too fast? • Is torch angle correct?	• Undercut is a condition where the overmelted metal has made grooves or an indentation. • Metal's section is made thinner, and therefore the weld zone's strength is severely lowered.
 JSKIA6385GB	• Is current too little? • Is wire feed out of order? • Is extrude extension too long? • Is groove face too small?	This is a condition where there is poor deposition made under the panel.
 JSKIA6386GB	• Is torch feed too slow? • Is current too little?	• Overlap is apt to occur in fillet weld rather than in butt weld. • Overlap causes stress concentration and results in premature corrosion.
 JSKIA6387GB	• Is current too great? • Is correct wire selected?	Spatter is prone to occur in fillet weld.
 JSKIA6388GB	Are there any stains on welded surface (paint, oil, rust)?	Cracks usually occur on top surface only.

ARC WELDING : Types of MIG and MAG Welding

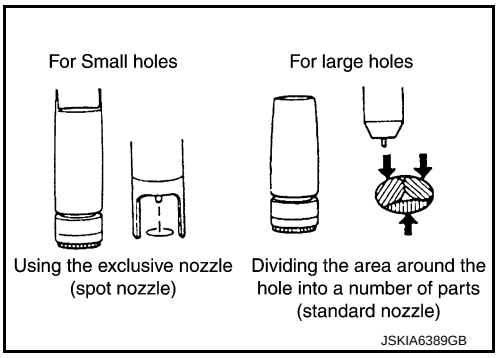
INFOID:0000000012106665

(1) CONTINUOUS WELDING

This welding process is suitable for sheet steel 2 mm (0.08 in) thick or over. If applied to thinner panels, it will cause melt-through.

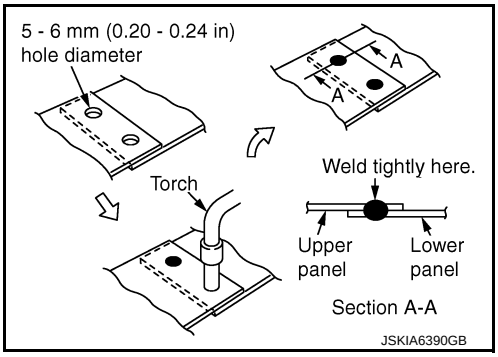
(2) SPOT WELDING

Replace the torch nozzle with a spot welding nozzle.
Grind the surfaces to be welded and press tightly together.



(3) PLUG WELDING

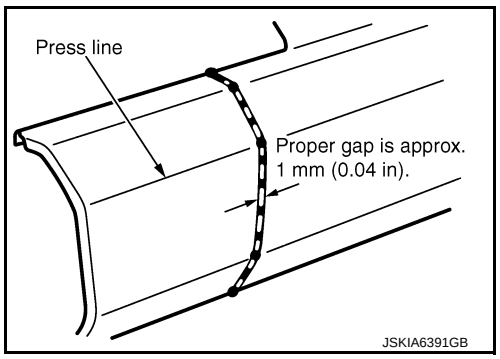
(a) Make a hole 5 mm - 6 mm (0.20 in - 0.24 in) in diameter in the upper of the two panels to be welded. Keep the upper panel and lower panel tightly together.
(b) Apply the torch at a right angle to the panel and quickly fill the hole with the molten metal. Intermittent welding generates oxide film, causing blowholes. If this occurs, remove the oxide film with a wire brush or belt sander.
(c) Weld the upper and lower panels together tightly.



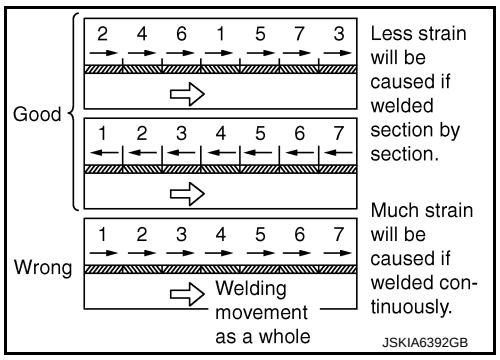
(4) INTERMITTENT (STEP) WELDING

This method is suitable for thin or rusted panels to prevent thermal deformation and melt-through. In body repair, it is used as butt welding on partial panel replacements.

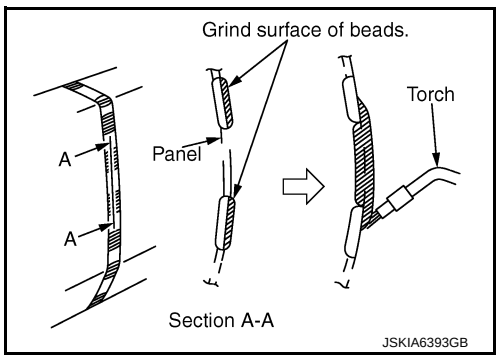
- Before step welding, tack weld the panels to be welded to prevent strain and to align panel surfaces.
  To do this, point weld and then fill in the spaces with short welding beads.



- Long weld line will cause strain. Use the method as shown in the figure to reduce strain.



- To fill the spaces between intermittently placed beads, grind the beads using a sander, then fill with molten metal. If this is done without grinding the surface of the beads, blowholes may result.



GAS WELDING

GAS WELDING : Gas Welding

INFOID:0000000012116174

This method uses oxygen and acetylene gas. However, it is not used on the automobile production line. It is used for cutting panels or heating damaged panels in repair work.
When oxygen and acetylene gas are mixed and burned, they produce a very high temperature [approximately 3,000°C (5,432°F)] for melting and fusing metals.
When used for cutting sheet metal, it is also called the oxygen cutting method. One end of the sheet metal is preheated to the fitting temperature [800°C - 900°C (1,472°F - 1,652°F)]. High pressure oxygen is then injected from the nozzle to burn off the sheet metal.

GAS WELDING : Features of Gas Welding Method

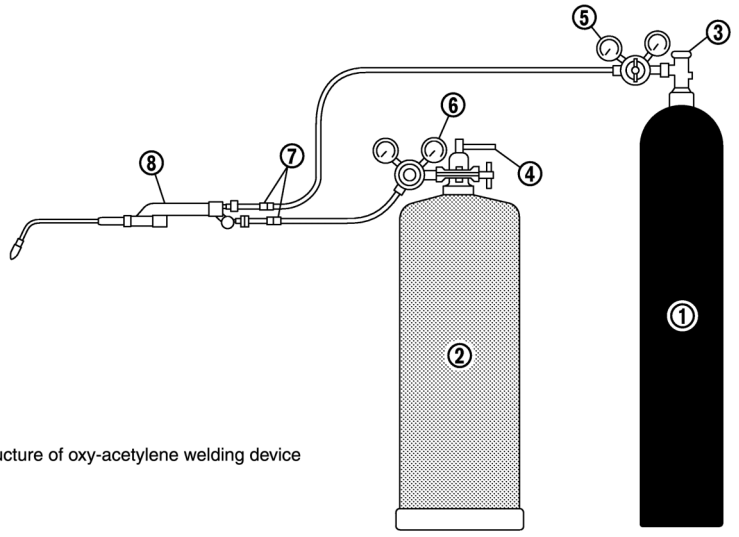
INFOID:0000000012112010

- No electricity needed
- Easy control of flame
- Thermal strain is generated around the weld zone as the heat cannot be concentrated in a short time at one point when welding
- Reduction in strength of sheet steel
- There is danger of explosion if gas leaks

GAS WELDING : Configuration of Gas Welding Equipment

INFOID:0000000012112009

1 Oxygen cylinder
2 Acetylene cylinder
3 Oxygen cock
4 Acetylene cock
5 Oxygen regulator
6 Acetylene regulator
7 One-touch joint
8 Torch



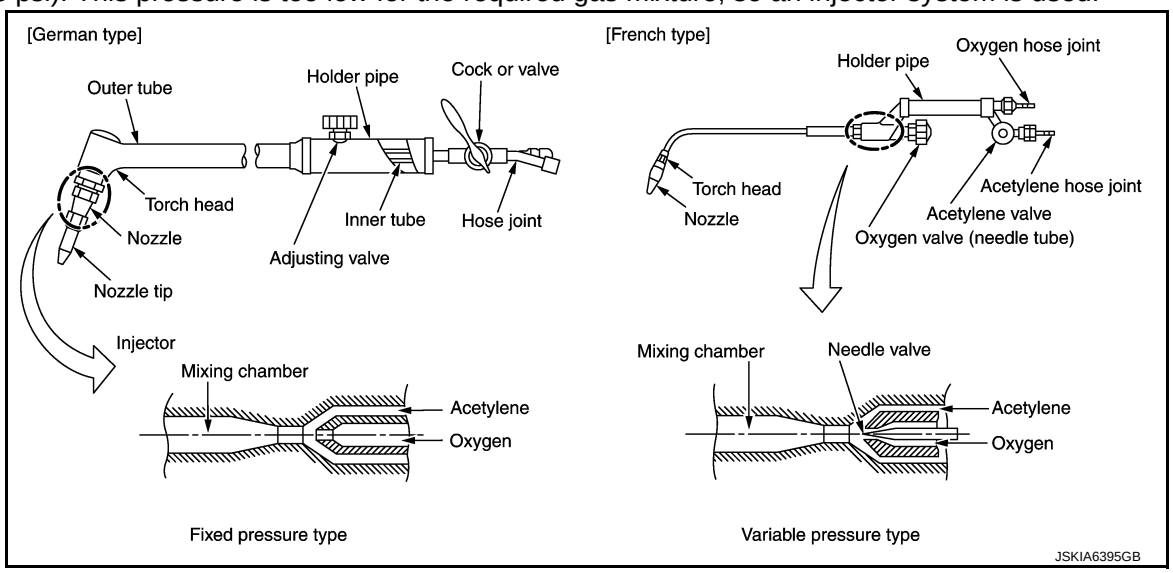
Structure of oxy-acetylene welding device

JSKIA6394GB

GAS WELDING : Welding Torch

INFOID:0000000012112008

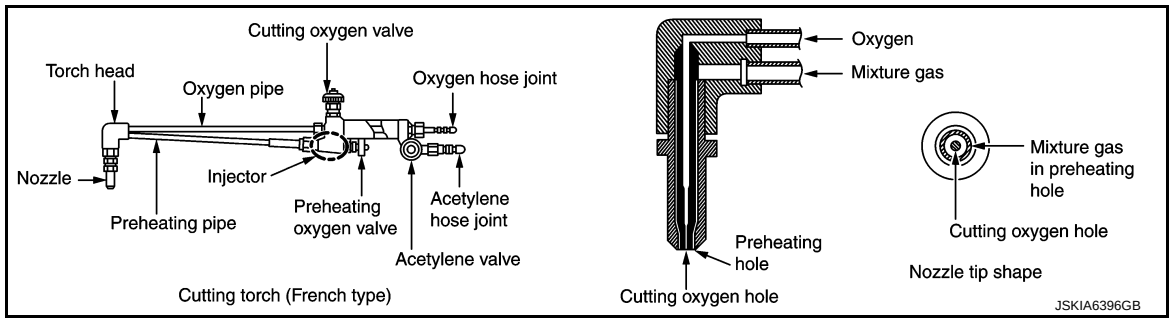
When using the welding torch, the acetylene supply pressure must be kept below 127 kPa (1.27 bar, 1.3 kg/cm^2, 18 psi). This pressure is too low for the required gas mixture, so an injector system is used.



GAS WELDING : Cutting Torch

INFOID:0000000012112007

The portion for generating the preheating flame is the same as that of the welding torch. Cutting oxygen is injected from the center of nozzle.

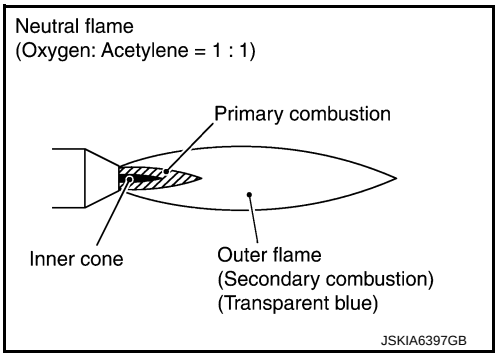


GAS WELDING : Flame Types

INFOID:0000000012106664

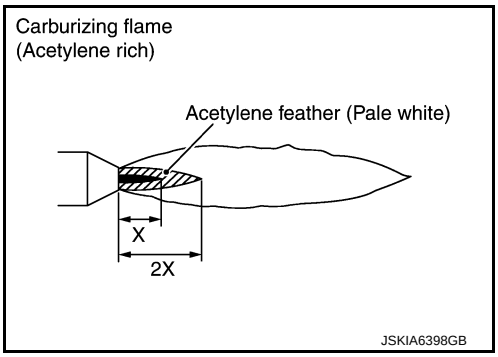
(1) NEUTRAL FLAME

This flame uses an acetylene to oxygen volume ratio of 1:1. Most gas welding operations use this flame.



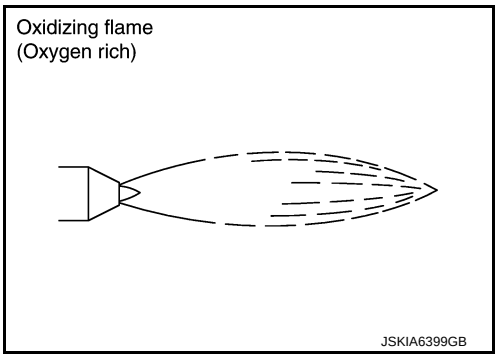
(2) CARBURIZING FLAME

This flame uses a percentage of acetylene gas slightly greater than oxygen. It is suitable for welding aluminum, nickel, and nickel alloy.If the length of the acetylene feather is twice that of the inner cone, the flame is called a ″2X″ excess acetylene flame. In this case, the mixture ratio is 1:1.4 (volume ratio).



(3) OXIDIZING FLAME

This flame has an oxygen content greater than that of acetylene. With it, the molten metal oxidizes quickly.
Hence, this flame is not used for welding soft steel. It is used for welding brass and bronze.

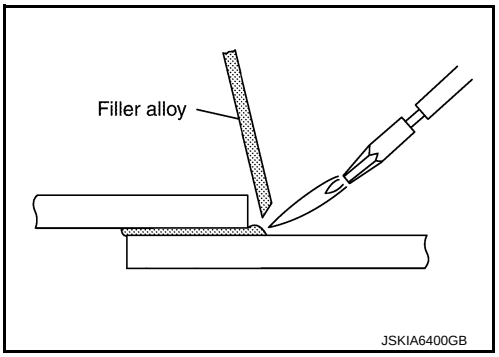


BRAZING

BRAZING : Principle

INFOID:0000000012112012

Brazing is a metal joining method in which a filler alloy, having a lower melting point than the metal to be joined, is used as a filler. This filler material penetrates into thin gaps in the sheet metal by capillary action.
Brazing with alloys having melting points below 450°C (842°F) is called soldering. Brazing with alloys having melting points above 450°C (842°F) is called brazing.



BRAZING : Features of Brazing

INFOID:0000000012112011

- The melting point of the filler metals is lower than that of the metal to be joined, resulting in less thermal strain.
- The filler metal penetrates into thin gaps, which provides a good seal.
- Different types of metal can be joined.
- The strength of the brazed portion is low, particularly against impact and repeated stress.

BRAZING : Types of Brazing Filler

INFOID:0000000012106663

Brazing fillers are classified according to melting point, affinity to metal, fluidity, and strength.
Brass brazing, composed primarily of copper and zinc, is widely used for automobile body production and repair.

Type	Principal composition
Brass	Copper, zinc
Silver	Silver, copper
Phosphor bronze	Copper, phosphorus
Aluminum	Aluminum, silicon
Nickel	Nickel, chromium
Solder	Lead, tin

COMPARISON BETWEEN WELDING METHODS FOR REPLACED PANEL

COMPARISON BETWEEN WELDING METHODS FOR REPLACED PANEL : Comparison between Welding Methods for Replaced Panel

INFOID:0000000012106662

	GSA PLUG WELDING	SPOT WELDING	GAS WELDING
Advantage	As far as the torch nozzle can reach, welding points are not restricted. Less thermal strain.	Great welding skill is not needed. Little thermal strain. Post-welding process is not necessary.	Paint can be removed easily. Side members can be cut quickly.
Disadvantage	During panel replacement, a new panel needs to be drilled.	Panels must be clamped from both sides to perform welding.	Thermal strain is generated around the weld zone. Not used for panel replacement.

SAFETY AND HEALTH
PRECAUTIONS FOR OPERATION

PRECAUTIONS FOR OPERATION : Precautions for Operation

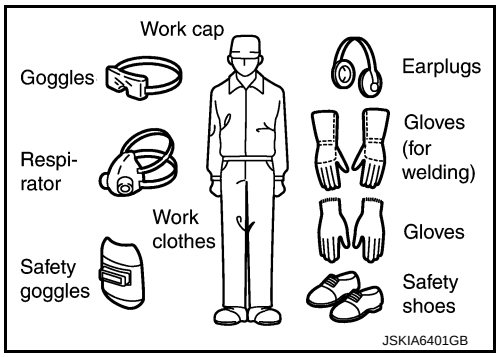
INFOID:0000000012118076

In body repair, great importance is attached to quality, efficiency and cost. Consideration for workers' safety and health should, however, be deemed as the most important item. In reality, it is essential that measures be established to prevent accidents and to make the work environment safer and healthier.

PRECAUTIONS FOR OPERATION : Protectors

INFOID:0000000012112320

- While working, suitable work clothes, a work cap and safety shoes must be worn. To prevent burns, a long sleeve shirt and trousers must also be worn and must not be taken off under any circumstances.
- Keep work clothes clean. Do not keep a lighter or other flammable materials in pockets.
- During oxygen and acetylene gas welding, to protect eyes wear goggles according to the quantity of infrared rays.
- During arc welding, to protect eyes wear a safety goggles with a shading plate according to the quantity of ultraviolet rays.
- Gloves, apron, foot covers, earplugs and arm covers should be used to prevent burns.



PRECAUTIONS FOR OPERATION : Safety Stand

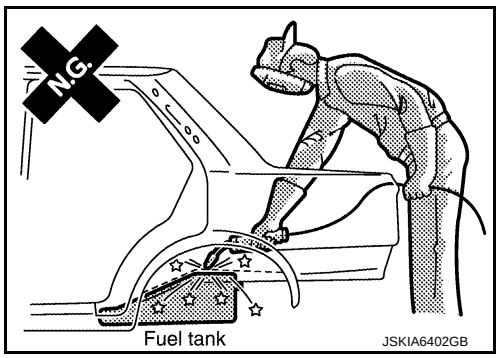
INFOID:0000000012112319

After jacking up a vehicle body, be sure to support it with the safety stand. For the supporting positions, refer to “Lifting Points” in the Service Manual for each model.

PRECAUTIONS FOR OPERATION : Inflammables

INFOID:0000000012112318

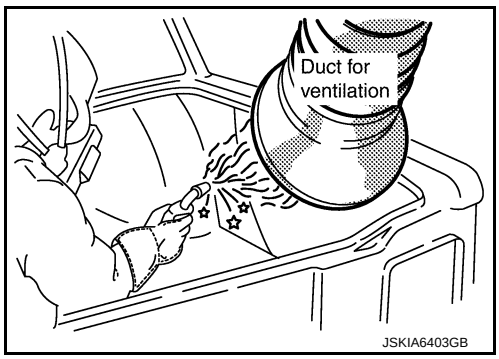
- Before starting repair work, be sure to disconnect the negative terminal of the battery.
- When welding parts near the fuel tank fuel filler, be sure to remove the fuel tank. Plug the filler port of the tank.
- Plug the fuel pipe and brake pipes to avoid leakage when removing connectors from the pipes.



PRECAUTIONS FOR OPERATION : Working Environment

INFOID:0000000012112317

- Pay attention to ventilation and the health of workers.
- Paint and sealant may generate poisonous gases when heated by fire. To prevent this, do not use a gas welder for cutting off damaged portions.
- Use an air saw or an air chisel.
- Use a belt sander or rotary wire brush for removing paint from the panel.

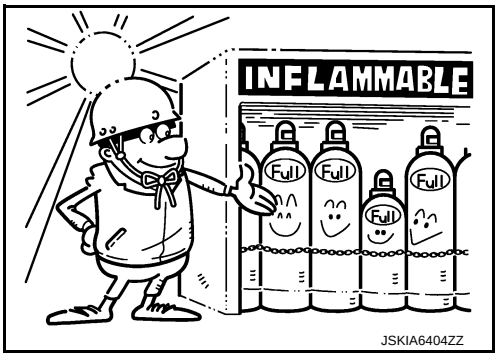


PRECAUTIONS FOR OPERATION : Handling of Welding Equipment

INFOID:0000000012106670

(1) STORAGE OF GAS CYLINDERS

- In a well ventilated area, post a “No Fire” sign.
- Avoid the direct rays of the sun. Maintain temperature below 40°C (104°F).
- Inflammable gas cylinders and oxygen cylinders must not be stored in the same place.
- Acetylene cylinders must be stored upright. Check that they cannot fall down.



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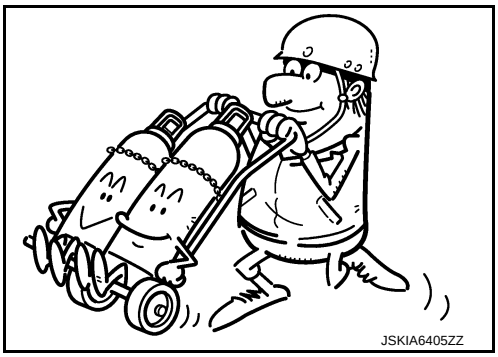
(2) MOVEMENT AND TRANSPORTATION OF CYLINDERS

- Be sure to properly close the valve and securely install the cap.
- Do not drag or roll the cylinder.
- Use a cylinder transportation cart.
- When moving, tilt the cylinder slightly and roll it carefully on the bottom edge with one hand while supporting its cap with the other hand.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(3) USE OF CYLINDERS

- The cylinder valve must be kept clean and free from oil.
- After opening the cylinder, leave the open-end wrench attached to the valve so it can be turned off quickly in an emergency.
- When the cylinder is replaced, open the valve of the new cylinder slightly and remove dust from around the valve seat.
- To check the cylinder for leakage, apply soapy water.
- The valve should be fully open for oxygen and open 1.5 turns or so for acetylene.
- To prevent the cylinder from falling down, ensure that it is properly secured.
- And never give a shock to the cylinder.


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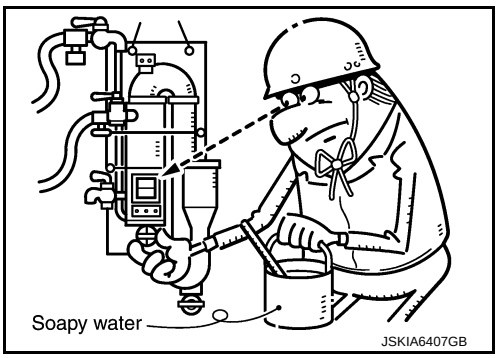
(4) HANDLING OF THE PRESSURE REGULATOR

- Always handle the pressure regulator with care and avoid impact.
- Inspect the regulator periodically (at least once a year).
- After use, purge the gas, and set the gauge to “0” (except the indoor type pressure regulator).

(5) HANDLING OF WATER-SEALED SAFETY DEVICES

- This device must be installed vertically. Check the water level every morning.
- In case of freezing, antifreeze solution can be added.

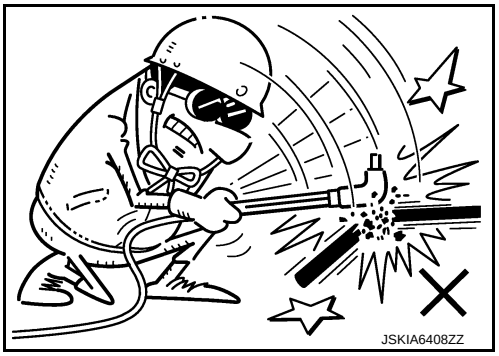


(6) HANDLING OF HOSES

- All hoses must be checked before use for flaws or leaks.
- Never use the pipe coupling made of copper or 70% copper alloy for the acetylene hose.
- Do not use compressed oxygen to clean the gas hose.
- Do not use any hose that has experienced backfire.

(7) HANDLING OF THE TORCH

- Keep the torch clean and free from oil.
- To replace the nozzle, use a special tool.
- Do not use the torch as a hammer, etc..
- Do not place it directly on the ground or on the floor.
- Check suction of the torch at the end of the inflammable gas pipe coupling.



(8) DANGER OF ARC WELDING ELECTRICAL SHOCK

- Keep cables and connections in good shape.
- Do not place machine in a wet place. Do not stand in a wet place when welding.
- Electrically ground welder. The vise clamp is not an electrical ground connection.

WORKING WITH BODY STRAIGHTENING EQUIPMENT

WORKING WITH BODY STRAIGHTENING EQUIPMENT : Use of Protectors

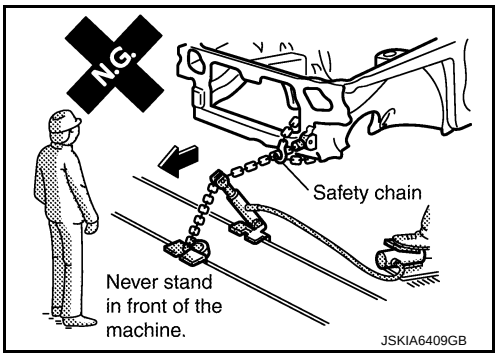
INFOID:0000000012112322

- Use of work clothes should be the same as for “PROTECTORS”. Refer to BRM-119, "PRECAUTIONS FOR OPERATION : Protectors".
- Wear a safety helmet and safety shoes.
- When working under a vehicle or when using a grinder, wear goggles.

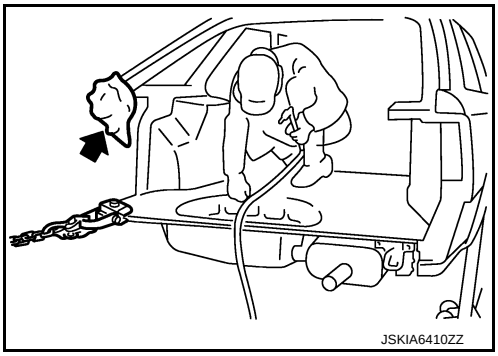
WORKING WITH BODY STRAIGHTENING EQUIPMENT : Precautions while Working

INFOID:0000000012112321

- To prevent danger in case the clamp slips or the panel breaks, be sure to apply a safety chain. Be careful not to stand near the area where the chain is stretched.



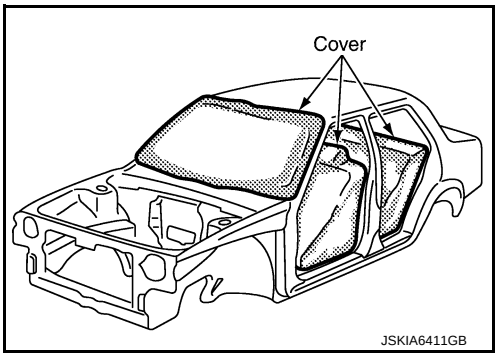
- To prevent danger, any excessive slack in the safety chain must be taken up and properly wound.
- Do not wear a working glove on the hand that is hammering.
- Cracked glass must be removed or taped to prevent separation.
- Any cut panels must be protected with cloth or tape.



WORKING WITH BODY STRAIGHTENING EQUIPMENT : Protection of Vehicle

INFOID:0000000012106669

- The seats and glass must be removed or covered with incombustible material, according to the type of work to be done, to prevent contamination and welding spatter.
- When removing parts, utilize padding (cloth) or protective tape.



WORKING WITH GRINDING THE BODY FILLER (PUTTY)

WORKING WITH GRINDING THE BODY FILLER (PUTTY) : Danger from Dust

INFOID:0000000012112325

If workers continue to inhale dust generated during paint film removal or body filler grinding work for long periods, they may suffer from respiratory insufficiency, which results in pneumoconiosis or asthma.

WORKING WITH GRINDING THE BODY FILLER (PUTTY) : Precautions during Dust Generating Work

INFOID:0000000012112324

- Workers must use a sander equipped with a dust collecting function.
- Workers must work in the facilities where a dust collector is installed on the floor or the wall.

WORKING WITH GRINDING THE BODY FILLER (PUTTY) : Protector and Equipment

INFOID:0000000012112323

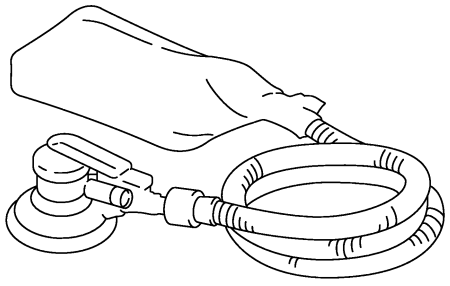
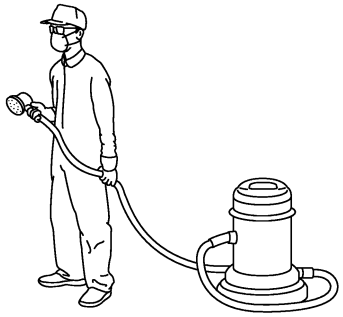
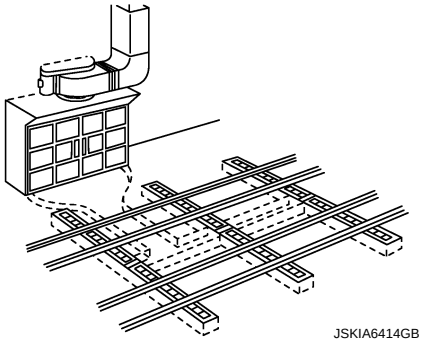
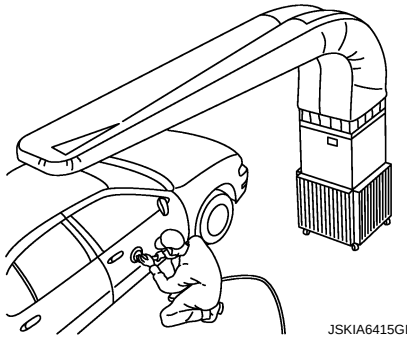
(1) DUSTPROOF RESPIRATOR

- This is an important protector to prevent workers from inhaling dust.
- The cup type, gauze type, and other types of respirators are available.
- The respirators with the deodorizing function which utilizes activated carbons, or with the exhaust valve to release air can be selected.
- In order to maximize the respirator performance, be sure to cover your nose and mouth.
- Do not use the respirator whose useful life has expired. This is because the function of the respirator has been deteriorated.

(2) DUSTPROOF GOGGLES

- Dustproof goggles prevent dust from entering workers' eyes.
- Goggles which can be worn on top of ordinary eyeglasses are also available.

(3) DUST COLLECTOR

Dustproof sander equipped with dust collecting bag	Dustproof sander hose connected to the industrial cleaner
 JSKIA6412GB	 JSKIA6413GB
Dust collector installed on the floor or the wall	•Dust collected through the filter •Ambient air forcibly circulated
 JSKIA6414GB	 JSKIA6415GB

WORKING WITH GRINDING THE BODY FILLER (PUTTY) : Precautions during Air Blow

INFOID:0000000012106668

- Workers must wear dustproof goggles and dustproof respirators, even during cleaning work after grinding.
- Adjust the pressure for air blow duster gun to prevent dust from being scattered all over the place.
- Be sure not to disturb other workers.

PAINT SAFETY PRECAUTIONS

PAINT SAFETY PRECAUTIONS : Paint Safety Precautions

INFOID:0000000012149137

Observe the following precautions to maintain a safe painting work area.

- Wear an approved respirator and eye protection when painting.
- Wear approved gloves and appropriate clothing when painting. Avoid contact with skin.
- Spray paint only in a well-ventilated area.
- Cover spilled paint with sand or another absorbent material, or wipe it up at once.
- If paint gets in your mouth or on your skin, rinse and wash thoroughly with water. If paint gets in your eyes, flush with water and get prompt medical attention.
- After the painting work is finished, wash your face and gargle with water.
- Paint is flammable. Store it in a safe place, and keep it away from sparks, flames, or cigarettes.

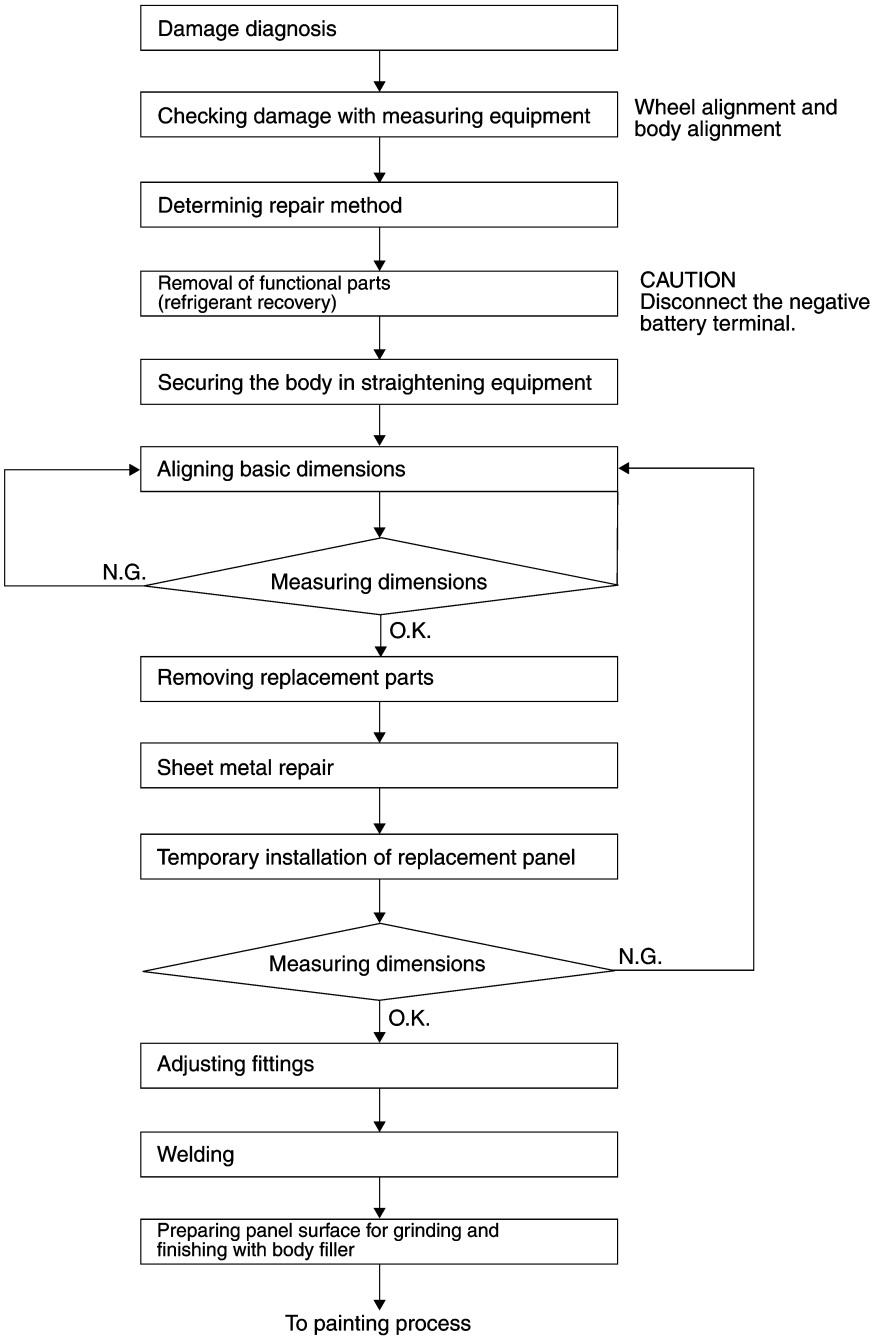
REPAIRING PROCEDURES AND PRECAUTIONS
FUNDAMENTALS OF BODY REPAIR

FUNDAMENTALS OF BODY REPAIR : Fundamentals of Body Repair

INFOID:0000000012106677

There are many kinds of damage caused by collisions.Therefore, the appropriate repair method for the damage should be selected. This section outlines repair methods of major damage and how to use the main tools.

BODY REPAIR FLOWCHART



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DAMAGE DIAGNOSIS

DAMAGE DIAGNOSIS : Damage Diagnosis

INFOID:0000000012119624

The damage must be diagnosed using the following criteria.
- Location of damage
- Range of affected area
- Degree of damage

These three points relate directly to the quality, efficiency and cost of damage repair, and they must be determined correctly.

DAMAGE DIAGNOSIS : Determining Various Conditions of the Collision

INFOID:0000000012112328

- Size, shape, position, rigidity, etc. of the other vehicle involved in the collision
- Speed of both vehicles at the time of collision
- Collision angle and direction
- Number of occupants and their positions at the time of collision
- Size, shape, hardness, etc. of load in the vehicle
- History of damaged portion, date of occurrence, and range of affected area

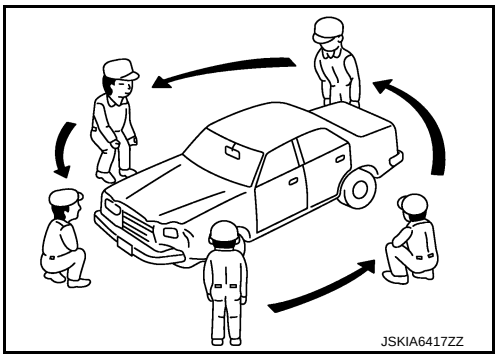
DAMAGE DIAGNOSIS : External Appearance

INFOID:0000000012112327

In body repair work, be careful not to overlook indirect damage. To avoid this, mechanical and structural analysis of the vehicle body is essential.

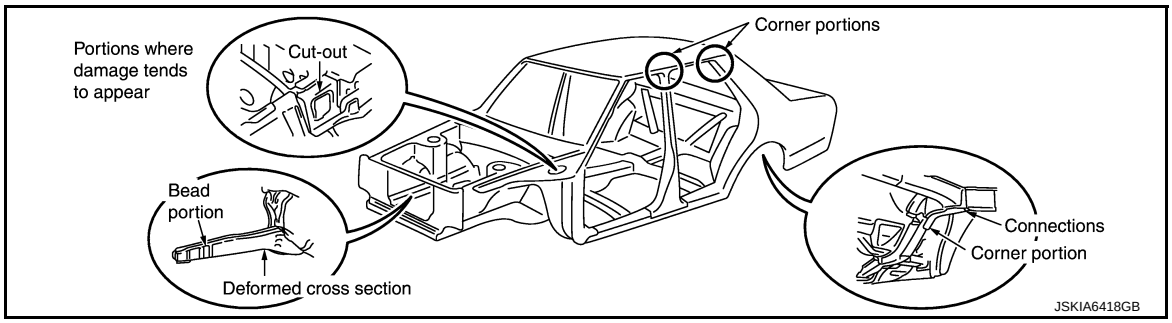
(1) OBSERVATION OF OVERALL VEHICLE
- The extent of the impact damage
- Twisting, bending, and inclination of the whole vehicle
- Amount and location of damage: Check by examining the whole vehicle

Examples
- Cracked or stressed paint
- Cracked or broken glass



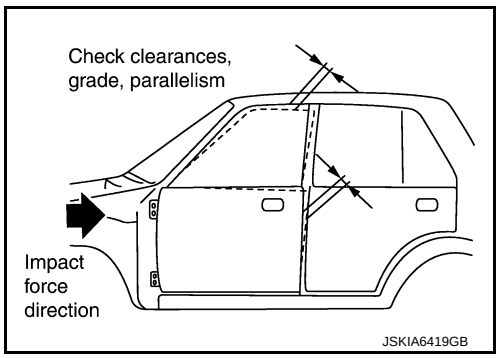
(2) DETAILED OBSERVATION OF VEHICLE

Check for any gaps or dislocation at the welded seams of panels, or cracks in paint film, undercoating or sealing material.



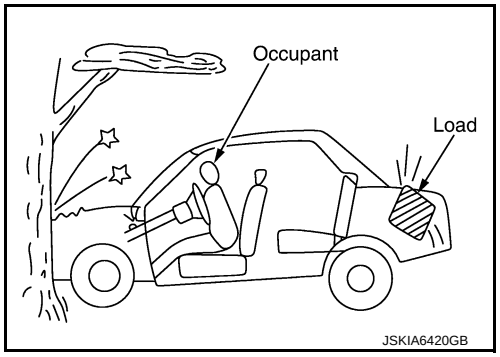
(3) OBSERVATION OF FITTING

Examine the fit of various portions without lifting them.
Estimate the damage in the pillar and hinge portions.
- Door alignment
- Alignment of hood and trunk lid
- How doors, hood, and trunk lid open and close
- Smooth operation of windows



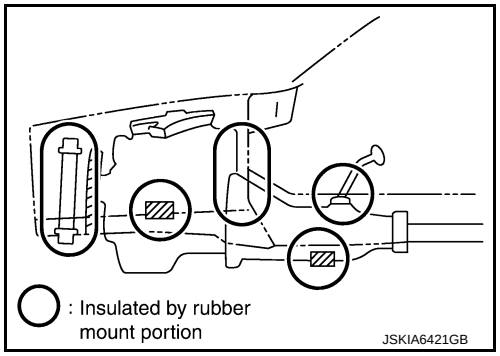
(4) CHECKING FOR MECHANICAL DAMAGE

Damage analysis also involves inspecting mechanical, steering and suspension parts for damage. When inspecting mechanical parts, look for signs of damage such as
- Bent or damaged parts
- Fluid leaks
- Binding or noise when turning the steering wheel



(5) DAMAGE BY INERTIA

Check indirect damage such as a concave roof in frontend collisions, load damage and damage to the engine, which is insulated by rubber mounts.
- Damaged or misaligned mounting points.



DAMAGE DIAGNOSIS : Key Points in Choosing Repair Methods

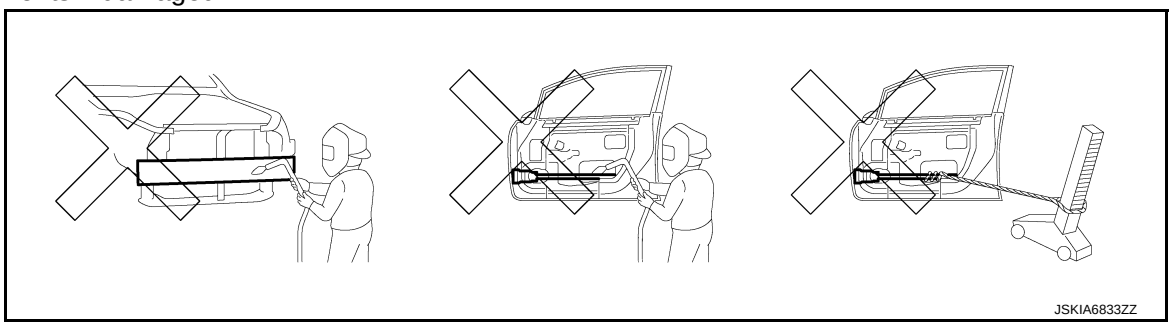
INFOID:0000000012112326

- Do not reduce strength when repairing panels. Avoid excessive hammering which may lead to extending the panel.
  Also avoid prolonged heating.
- Do not increase the strength of impact absorbing portions unnecessarily. Do not patch these parts.
- Choose a method for properly aligning the body.
  For example, if changing the front side member of an FF car, it is recommended that the front suspension mounting member be left alone.
- Examine carefully how past collision damage was repaired. This is necessary to properly decide the range to be repaired.

DAMAGE DIAGNOSIS : Parts to be Replaced

INFOID:0000000012150623

- High-strength steel parts: The strength of these parts will be reduced if repaired by heating.
- Parts relating to body alignment and wheel alignment: Replacement of such parts would not provide proper alignment.
- When repair costs exceed replacement cost.
- Availability of service parts.
- When asked by customer.
- Repair of door side impact beam and bumper reinforcement is prohibited: Beams and reinforcements must be their original shape to perform as designed. Always replace door side impact beams and bumper reinforcements if damaged.



When performing repair work, it is necessary to consider quality, efficiency and cost, as well as safety and health. It is also important to gain the customer's confidence.

CHECKING DAMAGE

CHECKING DAMAGE : Checking Damage

INFOID:0000000012119625

When completing body and frame repairs, the front body and underbody dimensions must be correct, because these dimensions directly affect wheel alignment and steering angles.
The degree of damage should be determined by using a steel tape, tram tracking gauge and centering gauge or other measuring device. The measuring points are shown in the Body Repair Manual for each model. Wheel alignments are shown in the Service Manual for each model.

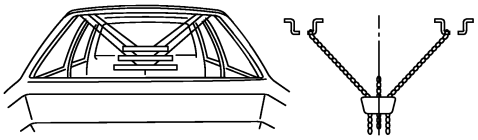
CHECKING DAMAGE : Centering Gauge

INFOID:0000000012112330

Suspend the body so that it is symmetrical to the frame member. Check for bending or twisting in the body.

(1) TYPES

Chain type



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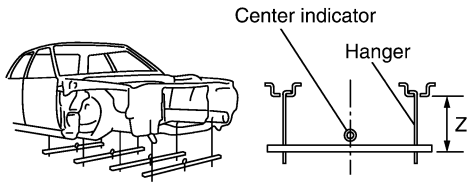
Bar type



Z: Distance shown is the underbody point in the BRM for each model.

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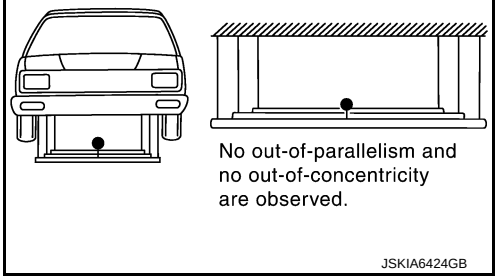
(2) DETERMINING STATE OF DEFORMATION

- Normal state
  The horizontal bar and center target are in their correct positions.



No out-of-parallelism and no out-of-concentricity are observed.

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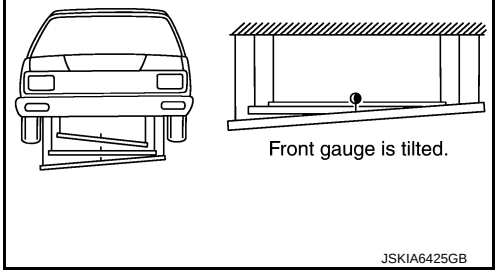
- Twist
  The horizontal bar is tilted on both ends.



Front gauge is tilted.

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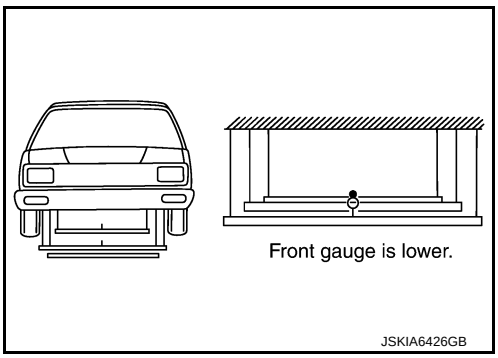
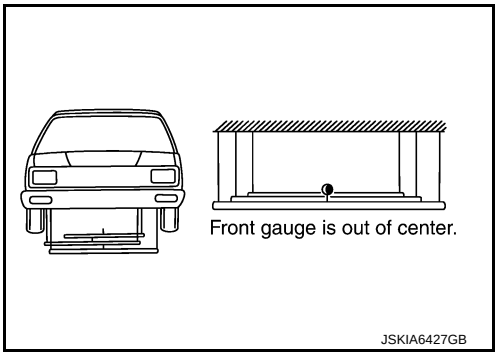
- Sag
  One of the horizontal bars is lower in the vertical direction than the others.



- Side-sway
  The horizontal bars are correctly aligned, but the center target is displaced.



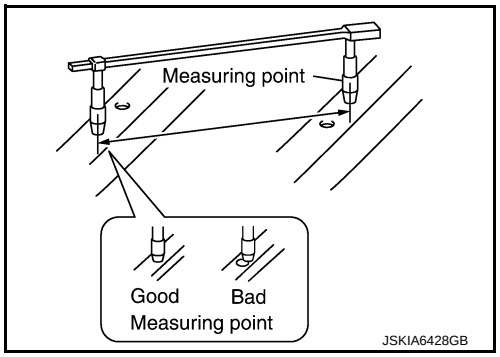
CHECKING DAMAGE : Tracking Gauge and Steel Tape

INFOID:0000000012112329

Measure the distance between two points. Before using the tracking gauge, check the measuring points with the steel tape.

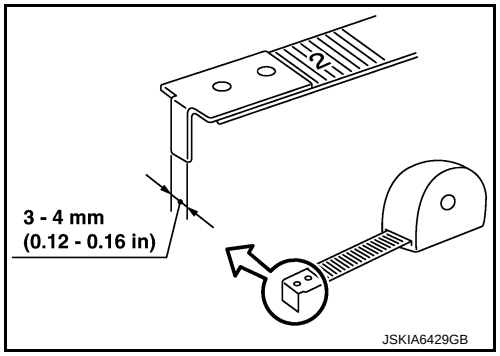
(1) TRACKING GAUGE

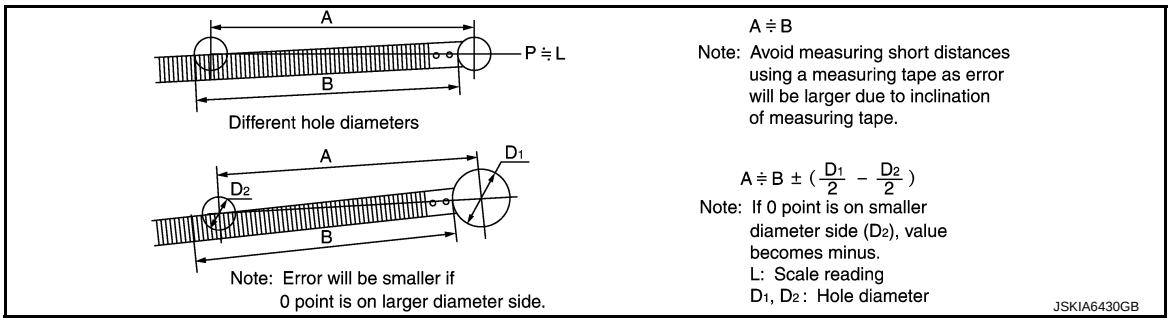
- Fit the tracking gauge correctly to the measuring point.
- The dimension is indicated between the hole center.
  If measurement is unavailable, use the method shown below.



(2) STEEL TAPE

- Shape the end of the rule for ease of measurement.
- If the measuring point hole diameter is different, use the following measuring method.





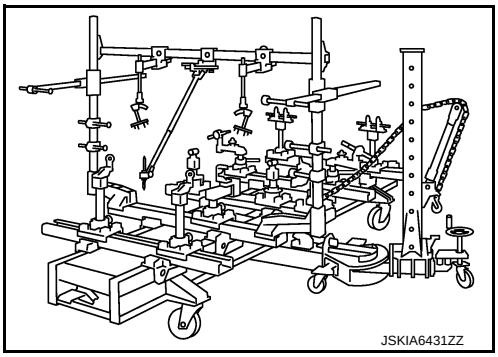
CHECKING DAMAGE : Three-dimensional Measuring Equipment

INFOID:0000000012106679

The equipment has function of the measurement to display the vehicle measuring points in three dimensions: height, width and length.

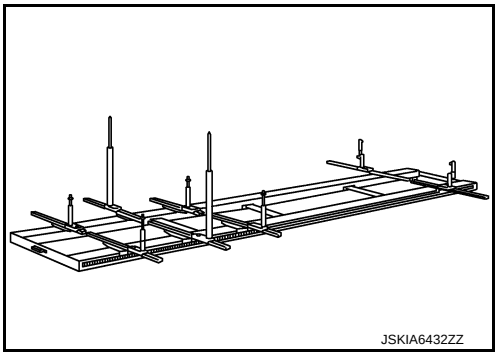
(1) UNIVERSAL JIG TYPE

This is one of the universal jig type body straightening equipment functions. The jig is assembled according to the instruction card specific to each vehicle model. The jig, which can move forward/backward, left/right, and up/down, is anchored to each location on the underbody. The three-dimensional coordinates for the anchored point are read from the scale at the sliding base and jig head positions.


JSKIA6431ZZ

(2) UNIVERSAL MEASURING TYPE

The probe, which can move forward/backward, left/right, and up/down, is positioned on the frame. The three-dimensional coordinates at the measurement point and the distance between measurement holes can be measured by bringing the probe into contact with a locating hole on the body.
It is set on the straightening equipment for use.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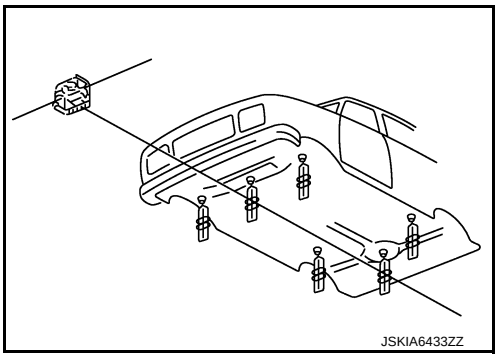
(3) LASER TYPE

The three-dimensional coordinates are read using convergence and straight-line stability of a laser beam.
A laser beam is used for measurement. Once set, repair work can be performed during measurement.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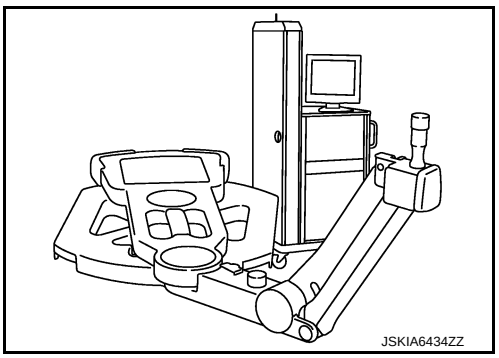
(4) COMPUTER MEASURING TYPE

This is set on the straightening equipment. The probe which is mounted on flexible arm is positioned at each point of the vehicle body for measurement.
The computer compares the vehicle model data and the actual measurement data to identify the damage range and determine acceptability.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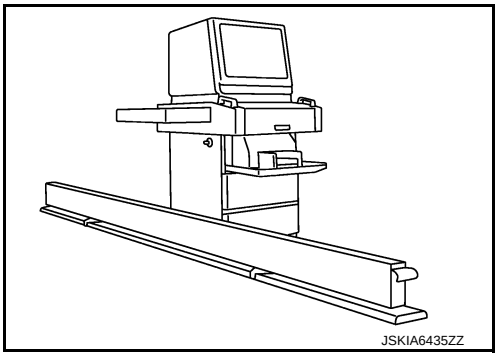
(5) ULTRASOUND TYPE

Ultrasound is transmitted from the probe, installed at the measurement point on the vehicle body, to the beam placed under the body in order to measure the three-dimensional coordinates at each measurement point.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REFRIGERANT HANDLING PRECAUTIONS

REFRIGERANT HANDLING PRECAUTIONS : General Refrigerant Precautions

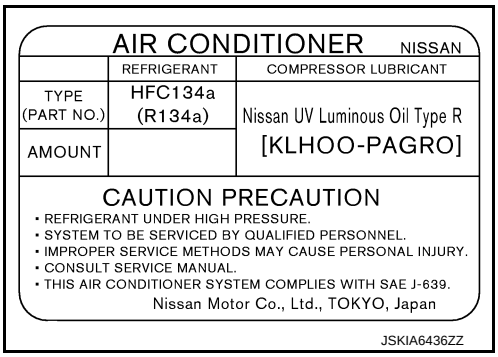
INFOID:0000000012112332

WARNING:

- **Do not release refrigerant into the air. Use approved recovery/recycling equipment to capture the refrigerant every time an air conditioning system is discharged.**
- **Always wear eye and hand protection (goggles and gloves) when working with any refrigerant or air conditioning system.**
- **Do not store or hear refrigerant containers above 52°C (125°F).**
- **Do not heat a refrigerant container with an open flame. If container warming is required, place the bottom of the container in a warm pail of water.**
- **Do not intentionally drop, puncture, or incinerate refrigerant containers.**
- **Keep refrigerant away from open flames. Poisonous gas will be produced if refrigerant burns.**
- **Refrigerant will displace oxygen, therefore be certain to work in well ventilated areas to prevent suffocation.**
- **Do not pressure test or leak test HFC-134a (R-134a) service equipped and/or vehicle air conditioning systems with compressed air during repair. Some mixtures of air and HFC-134a (R-134a) have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage. Additional health and safety information may be obtained from refrigerant manufacturers.**

Precaution for Identification Label on Vehicle

- Vehicles with factory installed fluorescent dye have this identification label on the under side of hood.
- Vehicles with factory installed fluorescent dye have a green label.
- Vehicles without factory installed fluorescent dye have a blue label.



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REFRIGERANT HANDLING PRECAUTIONS : Precautions for Working with HFC-134a (R-134a)

INFOID:0000000012112331

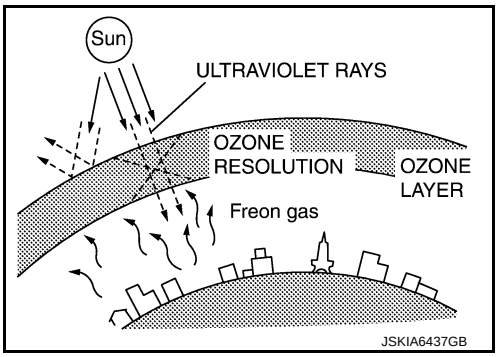
WARNING:

- **CFC-12 (R-12) refrigerant and HFC-134a (R-134a) refrigerant are not compatible. These refrigerants must never be mixed, even in the smallest amounts. If the refrigerants are mixed, compressor malfunction is likely to occur.**
- **Use only specified lubricant for the HFC-134a (R-134a) A/C system and HFC-134a (R-134a) components. If lubricant other than that specified is used, compressor malfunction is likely to occur.**
- **The specified HFC-134a (R-134a) lubricant rapidly absorbs moisture from the atmosphere. The following handling precautions must be observed:**
- **When removing refrigerant components from a vehicle, immediately cap (seal) the component to minimize the entry of moisture from the atmosphere.**
- **When installing refrigerant components to a vehicle, do not remove the caps (unseal) until just before connecting the components. Connect all refrigerant loop components as quickly as possible to minimize the entry of moisture into system.**
- **Only use the specified lubricant from a sealed container. Immediately reseal containers of lubricant. Without proper sealing, lubricant will become moisture saturated and should not be used.**
- **Avoid breathing A/C refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose and throat. Remote HFC-134a (R-134a) from the A/C system, using certified service equipped meeting requirements of HFC-134a (R-134a) recycling equipment, or HFC-134a (R-134a) recovery equipment. If accidental system discharge occurs, ventilate work area before resuming service. Additional health and safety information may be obtained from refrigerant and lubricant manufacturers.**
- **Do no allow lubricant (NISSAN A/C System Oil Type S and Type R) to come in contact with styrofoam parts. Damage may result.**

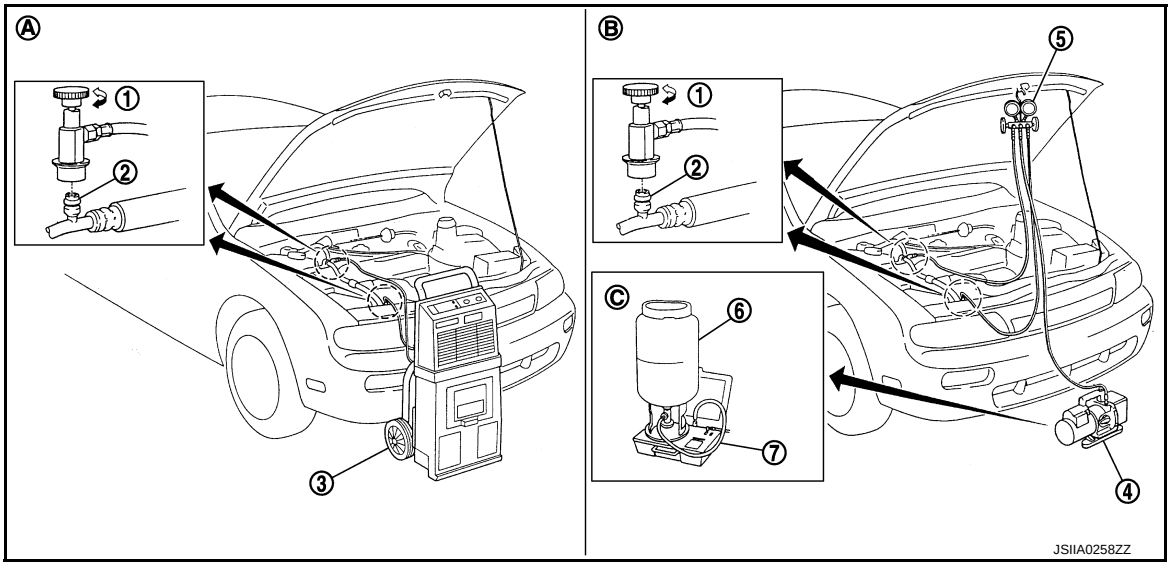
REFRIGERANT HANDLING PRECAUTIONS : Recovery of Refrigerant

INFOID:0000000012106680

Freon gas R12 used in air conditioners is harmful to the ozone layer of the atmosphere. We must take utmost caution to prevent this freon gas from entering the atmosphere. When performing automobile repair or when disassembling the air conditioner, the R12 freon should be controlled by the device shown below and reused when the repair is completed.



Example



① Shut-off valve	② A/C service valve	③ Recovery/recycling/recharging equipment
④ Vacuum pump	⑤ Manifold gauge set	⑥ Refrigerant container (HFC-134a)
⑦ Weight scale		
Ⓐ Preferred (best) method	Ⓑ Alternative method	Ⓒ For charging

REFRIGERANT HANDLING PRECAUTIONS : Precautions for HFO-1234yf

INFOID:0000000012148969

WARNING:

- **Always use HFO-1234yf for A/C refrigerant. If CFC-12 or HFC-134a is accidentally charged, compressor is damaged due to insufficient lubrication.**
- **Always observe and follow precautions described on refrigerant container. Incorrect handling may result in an explosion of refrigerant container, frostbite, or the loss of eyesight.**
- **Never breathe A/C refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose, or throat.**
- **Never allow HFO-1234yf to be exposed to an open flame or others because it generates poisonous gas when in contact with high temperature objects. Keep workshop well ventilated.**

BODY STRAIGHTENING EQUIPMENT

BODY STRAIGHTENING EQUIPMENT : Equipment Standards

INFOID:0000000012112337

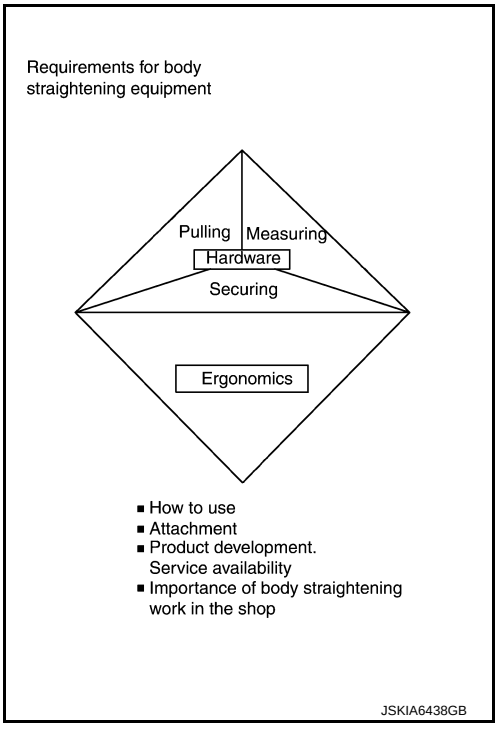
- Capable of securing the vehicle without removing the axle, suspension or other functional components.
- To prevent unnecessary replacement, choose equipment having high capacity and accuracy.
- Capable of holding parts securely during welding.
- Permits use of puller equipment on each side of vehicle.
- Capable of being operated easily by a single worker.
- Capable of being operated by an ordinary floor jack instead of a power lift.
- Designed for convenience of movement in the repair shop.
- Permits measurements to be made before, during and after operation, without interrupting or delaying repair work.
- Permits reduction of repair cost.
- Permits height to be adjusted according to the worker's position.

BODY STRAIGHTENING EQUIPMENT : How to Select Body Straightening Equipment

INFOID:0000000012112336

Numerous types of body straightening equipment with different features are currently available.
General considerations for selecting straightening equipment are explained below.
Requirements for body straightening equipment.
Body straightening equipment has three equally important functions: pulling, securing and measuring.
As well as the hardware, ergonomic factors such as ease of handling must also be considered.

Other important factors to consider are:
- Availability of shop space
- Number of vehicles to be repaired
- Proportion of heavy, medium and light repair work
- Proportion of body panel replacement to repairing
- Skill level of repair technician
- Budget



When purchasing repair equipment, take the following points into consideration.
- When a large number of similar types of vehicles with major damage is anticipated, the bench type straightening equipment is recommended. Panel exchange work can easily be done on this equipment.
- When minor damage on many different types of vehicles is expected, the base frame type is recommended.
- When selecting the bench type, consideration should be given to acquisition of special tools, easy operation, quick gathering of information, and reliability.
- Please select the most suitable type of equipment that will meet your needs. When making the selection, consider the ease of setting up the vehicle, the pull equipment, measuring, and the reliability of the repair.
- Principal body straightening equipment is shown in the tools and equipment section.

BODY STRAIGHTENING EQUIPMENT : Body Straightening Equipment and Specifications

INFOID:0000000012112335

Body straightening equipment is classified according to structure and configuration in the following types:

(1) BENCH TYPE

The vehicle is tied down to a movable bench with wheels. The straightening equipment is directly attached to this bench and the repair work is performed. With this type, the bench is attached to a lift and the vehicle is elevated up and down to increase work efficiency.

Type: CAROLINER, CELETE, DATALINER, GLOBAL JIG, CAR-BENCH, etc.

The bench type straightening equipment can be classified into three types based on the differences in anchoring and measuring methods.

(a) UNIVERSAL JIG BENCH TYPE

DETERMINING STATE OF UNDERBODY DEFORMATION	
The jig is assembled according to the data issued for each vehicle model. The jig head is secured at the underbody anchoring point. Then, the coordinates are read from the scale at the jig installation point to check deformation of the damaged area. The number of anchoring jigs can be decided according to the degree of damage.	
Merit	Demerit
• A single set of attachments can accommodate almost all vehicle models. • Pulling work can be performed without concerns approximately secondary damage because measurement and anchoring are performed simultaneously with the jig. • New parts can be positioned correctly. • The degree of damage can be checked in numerical values. • The jig itself can be used as a straightening device by combining with the port power. (Only high strength jigs can be allowed for this use.)	• Setup time is long because the universal jig must be assembled for each vehicle model. • When a jig is set, mechanical components and suspension system need to be removed and reinstalled to avoid interference with the jig. For this reason, it may be necessary to remove and reinstall components that are not damaged. (There are such anchoring locations and methods that do not require removal of mechanical components and suspension system.) • Assembling accuracy of the jig affects correction accuracy.

(b) DEDICATED JIG BENCH TYPE

DETERMINING STATE OF UNDERBODY DEFORMATION	
The dedicated jig is installed onto the bench according to the data issued for each vehicle model. Deformation is identified by the relative position between the jig head and the locating points of underbody. The number of anchoring jigs can be decided according to the degree of the damage.	
Merit	Demerit
• The setup time is shorter than the universal jig. • Pulling work can be performed without concerns approximately secondary damage because measurement and anchoring are performed simultaneously with the jig. • New parts can be positioned and anchored correctly. • Even workers with less experience can perform accurate straightening work without measuring.	• The dedicated jig must be purchased or rented. • When a jig is set, mechanical components and suspension system need to be removed and reinstalled to avoid interference with the jig. For this reason, it may be necessary to remove and reinstall components that are not damaged. (There are such anchoring locations and methods that do not require removal of mechanical components and suspension system.) • Anchoring is not possible until damage is corrected. • Amount of deformation in the damaged area cannot be read in numerical values.

(c) UNIVERSAL MEASURING BENCH TYPE

DETERMINING STATE OF UNDERBODY DEFORMATION	
The dedicated measuring system is installed on the bench (horizontal reference plane). The underbody is measured three-dimensionally, and the measurement data for each model and the actual measurement value are compared for confirmation.	
Merit	Demerit
• Anchoring time of the vehicle is short compared to the jig type. • Alignment for each location of the underbody can be measured correctly because there are multiple measurement points. • This is suitable for cost estimation work. Damage range can be identified quickly.	• Measurement and anchoring cannot be performed simultaneously. • When basic four-point anchoring is used and strong pulling work is necessary, additional anchoring or dedicated anchoring jig needs to be installed to avoid secondary damage.

(2) BASE FRAME TYPE

Repair work is performed by firmly securing the vehicle and the straightening equipment on anchor hooks or on rails which are imbedded in the floor. The entire floor functions as part of the repair equipment. A post or hydraulic jack assembly is used to straighten the body.
Type: KOREK, PULLDOK, AUTO-POLE

DETERMINING STATE OF UNDERBODY DEFORMATION	
The dedicated or common used measuring system is installed on the floor (horizontal reference plane). The underbody is measured three-dimensionally, and the measurement data for each model and the actual measurement value are compared for confirmation.	
Merit	Demerit
• The setup time is short. (Anchoring requires a floor jack only.) • Urgent vehicle change can be accommodated. • Space can be utilized for other work when not in use. • Simultaneous pulling in multiple directions is easy. (There are fewer restrictions on installation of the pulling unit.) • Additional anchoring is easy. (There are fewer restrictions on installation of additional anchoring.)	• A low working posture can easily cause fatigue. • Installation work is necessary. • When basic four-point anchoring is used and strong pulling work, additional anchoring is necessary. • A dedicated anchoring jig is necessary for the vehicle body that cannot be anchored at the sill lower flange.

(3) STATIONARY RACK

This is one of the oldest types of repair equipment. The vehicle is positioned on the rack where it is repaired. The rack is firmly stationed on the ground or over a pit. Recently, this rack has been redesigned so that after the vehicle is tied down, it can be elevated or tilted. A swing or sliding type pulling tower is usually mounted on the rack.
Type: FLEX-O-LINER, KOREK 2000, CHIEF EZ LINER

DETERMINING STATE OF UNDERBODY DEFORMATION	
The dedicated or common used measuring system is installed on the stand (horizontal reference plane). The underbody is measured three-dimensionally, and the measurement data for each model and the actual measurement value are compared for confirmation.	
Merit	Demerit
• The setup time is short. (The vehicle to be repaired can be drived on the rack attaching the pulling unit.) • Repair can be performed according to the damage level.	• A large space is required for installation. • The space cannot be used for other work even when the system is not in use. • The height of the stand cannot be changed with a certain type. Workers must climb up and down the rack.

(4) PORTABLE TYPE

A simple frame is used to connect the vehicle and the pull equipment. The vertical mast of the L-shaped structure counterbalances the pulling force. Wheels may be attached to the frame to make it movable.
Type: DOZER, PORTO-POWER

DETERMINING STATE OF UNDERBODY DEFORMATION	
Refer to the vehicle dimension drawing, and check using a tracking gauge.	
Merit	Demerit
• Most suitable for relatively minor damage. • Easy to set up. • Can be used anywhere.	• Pulling direction is limited. • Repair is only possible for minor damage. • Care must be exercised to avoid secondary damage during work.

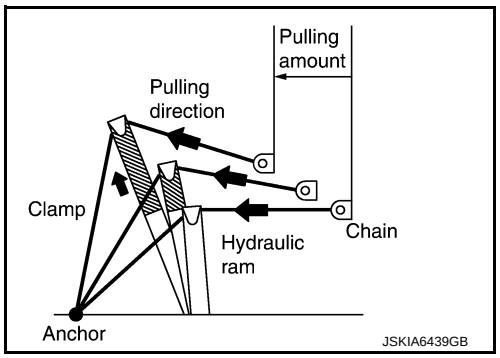
BODY STRAIGHTENING EQUIPMENT : Comparison of Pulling Methods

INFOID:0000000012112334

(1) HYDRAULIC RAM TYPE

In this method, the pressing force of a hydraulic ram is converted to a pulling force by a chain.

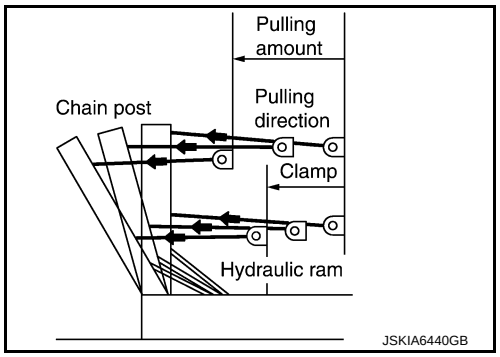
- Pulling points on the body may be added easily, and there is more freedom to select the pulling direction.
- The pulling direction changes during pulling.
- Difficult to simultaneously pull several points on a vertical line.



(2) TOWER TYPE I

In this type, force is applied by the hydraulic ram pushing the post.

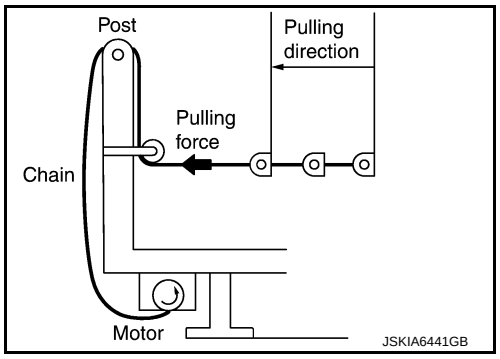
- A strong force is obtained because a large ram is used, creating much leverage.
- The chain can be hooked to the post in many ways.
- Leverage can be increased or decreased by changing the position of the hook.
- The pulling direction is not restricted by the shape of the bench or a floor anchor.
- The pulling direction changes during pulling.
- Difficult to increase the number of pulling points on the body because the pulling tool itself is large.



(3) TOWER TYPE II

The chain is wound up through the tower by an electric or hydraulic motor.

- The direction of force does not change during pulling.
- The chain is easily set on the post because the pulling direction is constant.
- Provides great flexibility in pulling direction.
- Pulling points on the body are restricted by the number of posts.
- Pulling force is relatively strong.

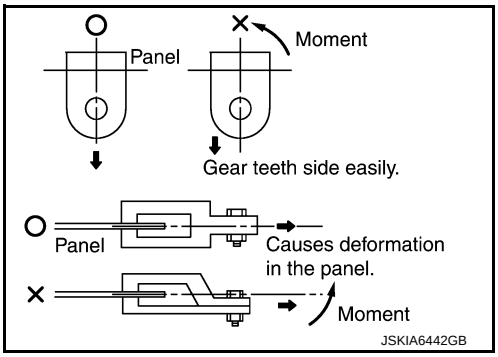


BODY STRAIGHTENING EQUIPMENT : Clamps

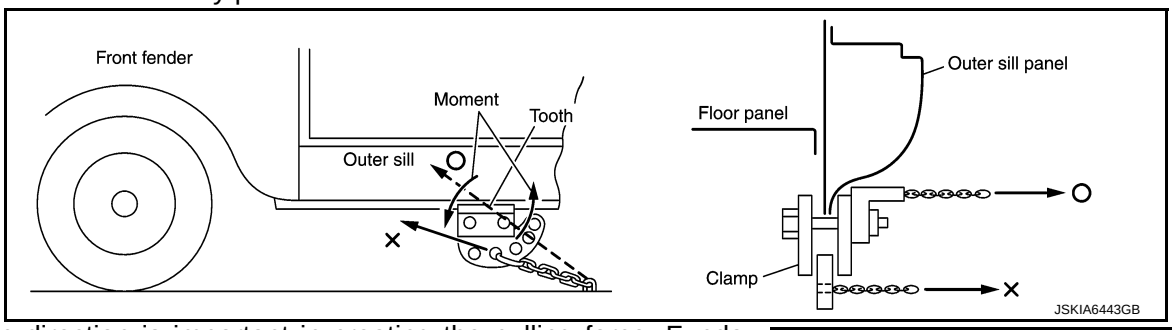
INFOID:0000000012112333

Generally speaking, when a body has to be straightened, the pulling device and the body must be attached to each other and the body itself must remain stationary. For this purpose, various clamps are used.
Common types of clamps and their characteristics are listed below:

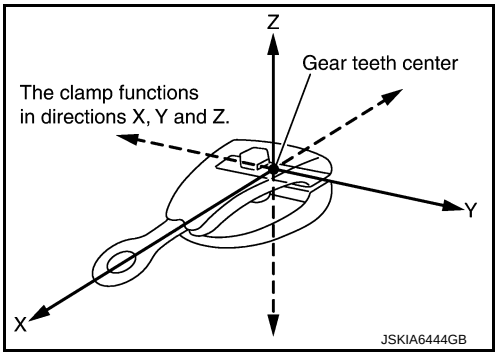
DIRECTIONAL CHARACTERISTICS
When pulling the clamp, the line of pulling force must extend through the center of the clamp teeth. Otherwise, the clamp may come off or damage the body panel as the clamp rotates.



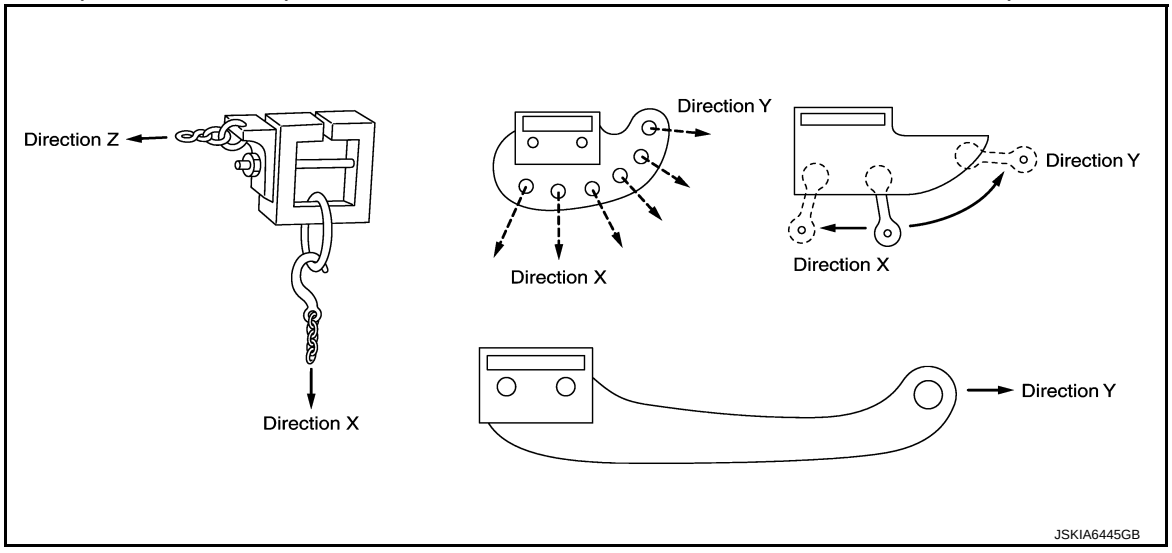
- The figure shows how the direction of the chain's pulling force is at a downward angle from the center of the teeth. This generates a turning force on the entire clamp in the direction of the arrow. This force is amplified because of leverage, but only some of its teeth are engaged. Thus, the clamp tends to slip, which results in deformation of the body panel.



- Clamp direction is important in creating the pulling force. Fundamentally, three directions are considered, "X", "Y" and "Z".



- DIrectional ("X", "Y" and "Z") characteristics are shown below for several kinds of clamps.

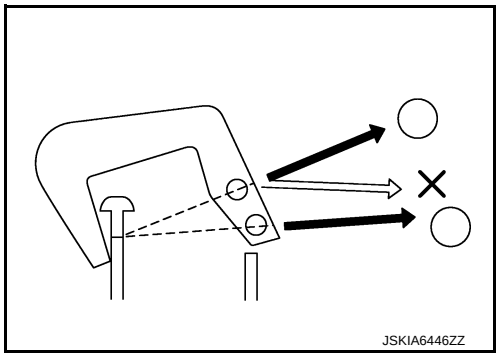


BODY STRAIGHTENING EQUIPMENT : Hooks and Other Tools

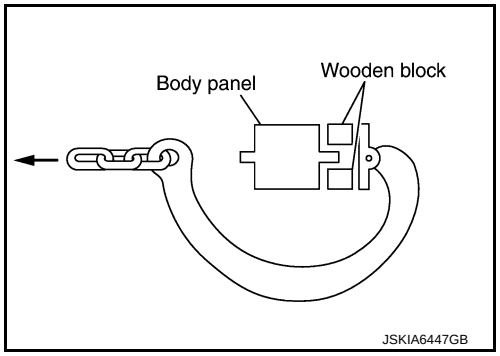
INFOID:0000000012106681

(1) HOOKS

- Unlike clamps which grab an object, hooks are curved tools that pull on the body. When a hook is used, it must be set so that the point where the body is pulled and the position of the hook's chain are lined up straight.

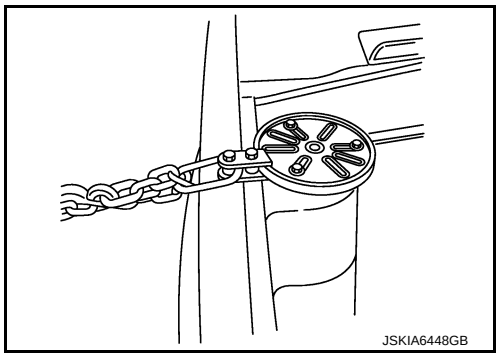


- When a hook is used, a piece of wood, etc. should be inserted between the hook and body in order to prevent damage to the body.



(2) SPECIFIC-USE PULLING TOOL

Specific-use pulling tools are special jigs which are used to repair a specific part of the vehicle.
An example of a specific-use pulling tools, a strut puller, is shown in the figure.



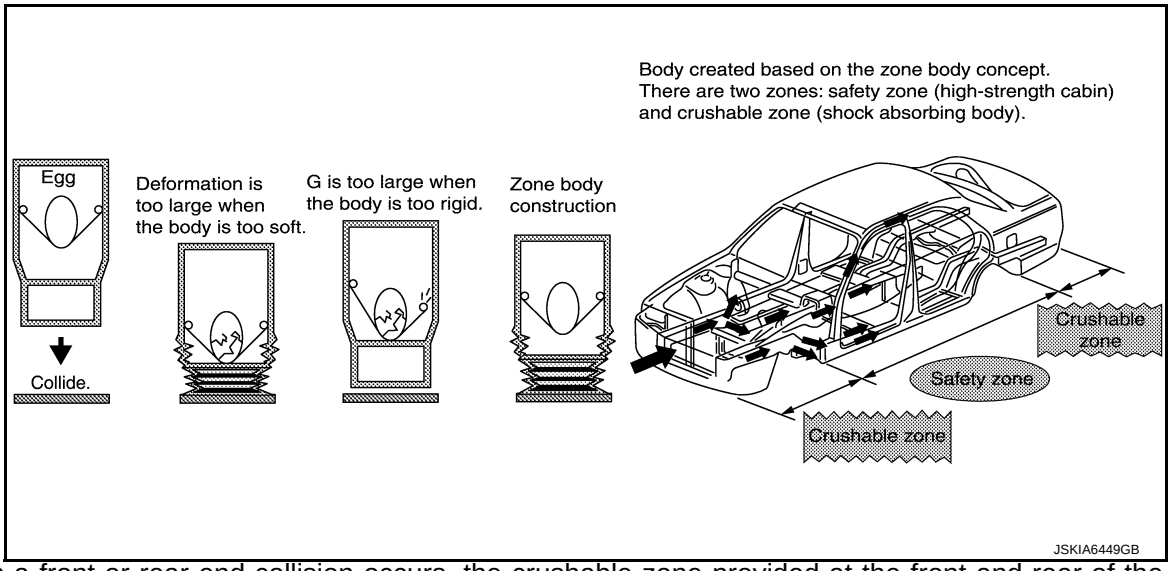
BODY STRAIGHTENING EQUIPMENT : High Intensity Cabin Structure

INFOID:0000000012119073

In recent years, the body construction of vehicles is changing for the purpose of protecting passengers at the time of the collision.
A greater use of high strength sheet steel reinforcements and the adoption of sheet steels of different thicknesses are good examples of securing survival space for passengers. Deformation caused when the vehicle body is damaged is controlled through modification of the body construction.

The following points must be kept in mind when high intensity cabin structure bodies need to be repaired.
- No special skills are necessary in body straightening work.
- Body technicians must have a good understanding of the construction of the vehicle body to be repaired.
- Understanding the accurate damage range (performing accurate measuring work) is necessary.
- A greater force is required for straightening because of an increased use of high strength steel plate reinforcements.
  It is necessary to perform additional anchoring for the frame straightening equipment with which multiple jig anchoring is not possible in order to prevent secondary damage.
- Pulling force must be applied evenly to prevent welded points from breaking. (Simultaneous pulling in multiple directions, etc..)
- The anchoring jig specific to each vehicle model is used for vehicles which cannot be anchored at the sill lower flange.

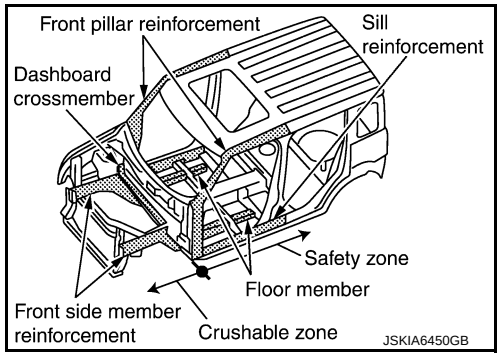
(1) HIGH INTENSITY CABIN STRUCTURE



- When a front or rear end collision occurs, the crushable zone provided at the front and rear of the vehicle effectively absorbs impact energy and cushions the shock to the passengers. In addition, the safety zone securely maintains a survival space.
- Energy absorbing beads and high strength sheet steel reinforcements are used as front side members.
- Outrigger construction. (Distributes impact energy from front side members.)

(2) HIGH INTENSITY CABIN STRUCTURE (SIDE IMPACT)

- To improve the lateral strength of the occupant compartment, lateral strength such as crossmembers, steering member and reinforcements for roof side, center pillars and body sills are redesigned.
- When a side collision occurs, the side door beams and doors minimize deformation of the body by absorbing impact energy subjected from the lateral direction, and by distributing energy over the reinforced body side.



REPAIR TECHNIQUES USING BODY STRAIGHTENING EQUIPEMENT

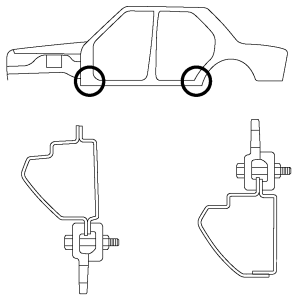
REPAIR TECHNIQUES USING BODY STRAIGHTENING EQUIPEMENT : Securing the Vehicle

INFOID:0000000012112338

To prevent the movement of vehicle, use a suitable method that can resist the pulling force required for repair.

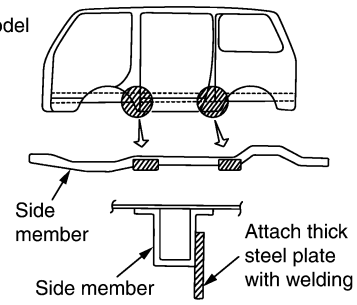
(1) ANCHORING POINT

For passenger vehicle



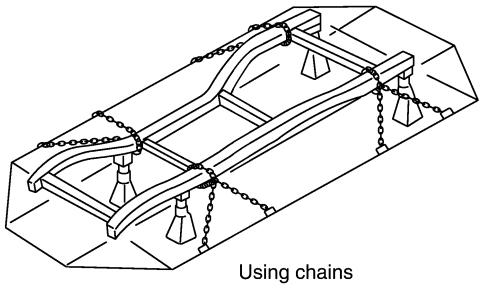
JSKIA6451ZZ

For van model



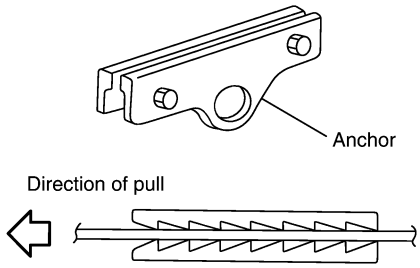
JSKIA6452GB

For frame model



Using chains

JSKIA6453GB



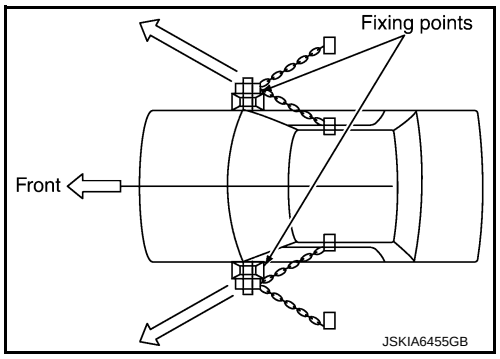
JSKIA6454GB

CAUTION:

- **Choose the foundation of a rigid pillar or a member for anchoring point.**
- **Set the equipment so that the direction of claw clamp is opposite to the direction of pull.**

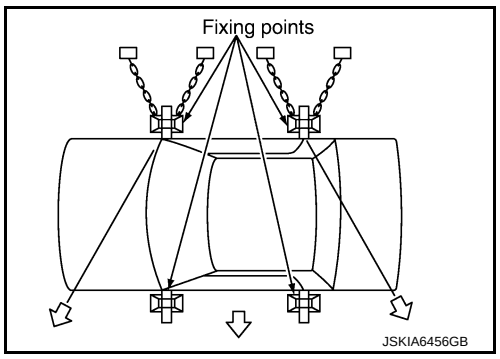
(2) ATTACHMENT OF CHAINS

- Pulling to the front of vehicle
  The vehicle will be secure if it is pulled in the range indicated by the arrows in the figure. The rear side is the opposite of this.



JSKIA6455GB

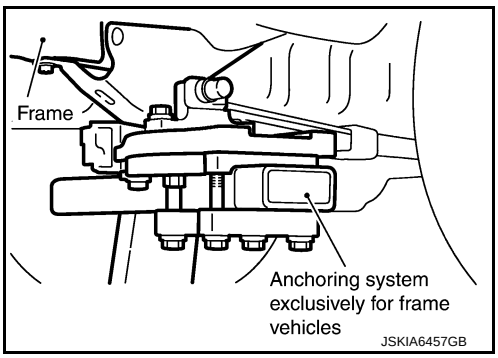
- Pulling to the left or right side
  Pull the vehicle within the range indicated by arrows.



JSKIA6456GB

(3) ANCHORING POINT FOR FRAME MODEL USING FRAME CLAMPING

If the frame cannot be anchored to the straightening equipment with the basic anchoring method the frame can be directly anchored by using frame clamping system. The figure shows an example in which the spring shackle is anchored without the spring being removed.



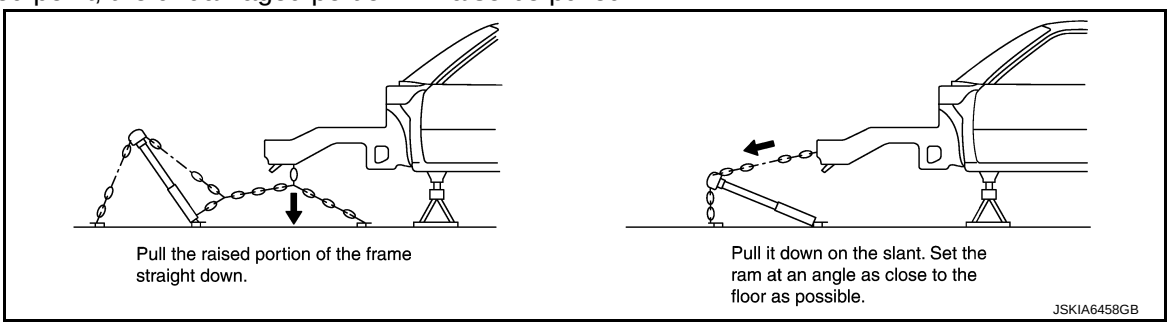
REPAIR TECHNIQUES USING BODY STRAIGHTENING EQUIPEMENT : Securing and Pulling

INFOID:0000000012106682

In principle, the pulling force must be applied in the exact opposite direction of the impact force (input). The securing method must match this pulling direction.

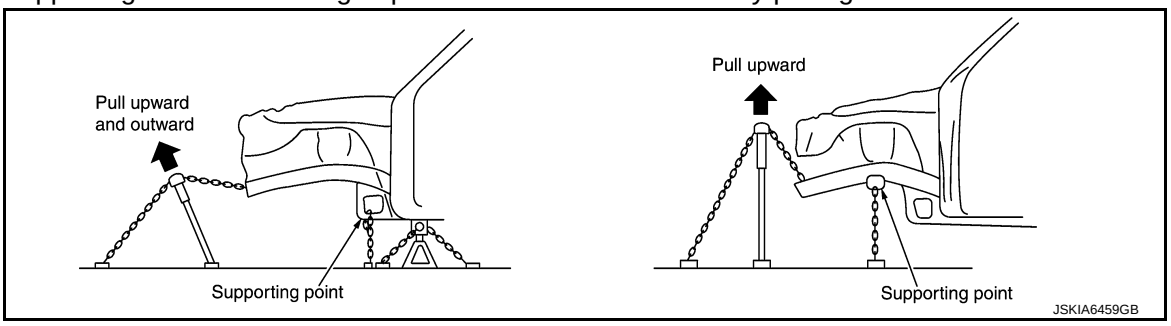
(1) DOWNWARD PULL

Secure as close to the damaged portion as possible. If there is a separation between the pulling point and damaged point, the undamaged portion will also be pulled.



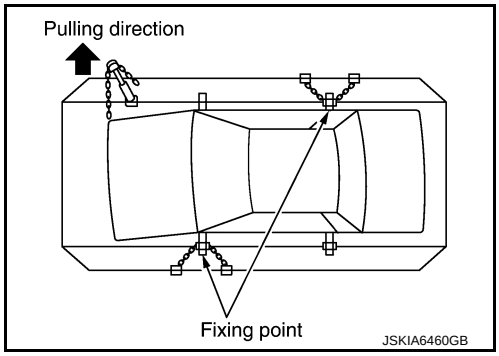
(2) UPWARD PULL

Set the supporting so that undamaged portions will not be affected by pulling.



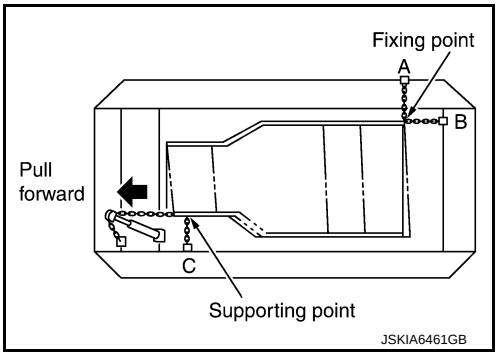
(3) FIXING AND PULLING METHOD FOR SIDE BEND

To pull the front part of vehicle, secure the vehicle body to avoid movement by the moment of rotation caused by pulling.



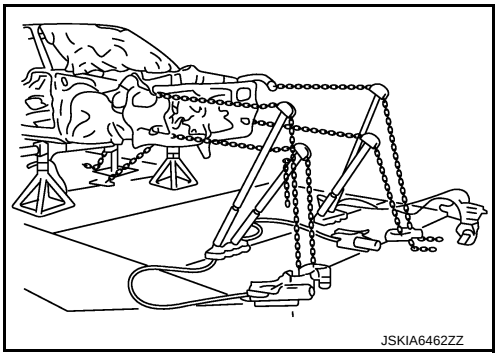
(4) FIXING AND PULLING METHOD FOR DIAMOND

If only points (A) and (B) are secured, a moment of rotation may result. Establish another supporting point at portion (C).



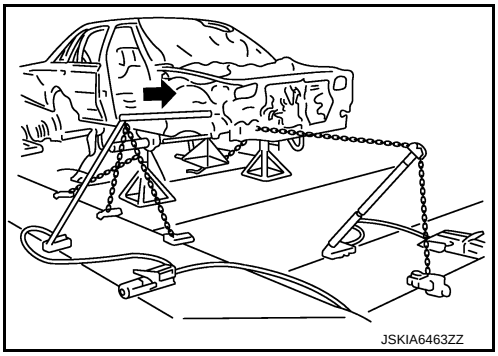
(5) SIMULTANEOUS PULLING IN MULTIPLE DIRECTIONS

This method can shorten repair time, and also prevent secondary damage.



(6) SIMULTANEOUS PUSH-PULL METHOD

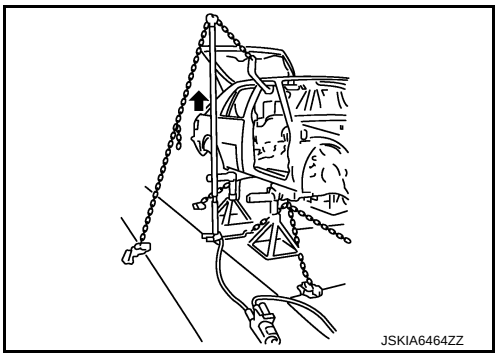
This method may be used when stress is concentrated at the front side member. The front of the front side member is bent inward while the rear is bent outward.



(7) ROOF DAMAGE

Connect an extension tube to the ram.

Positioning it near the vehicle body will result in increased pulling length.

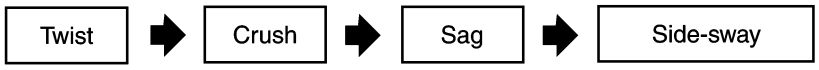


REPAIR PROCEDURE FOR PULLING

REPAIR PROCEDURE FOR PULLING : Repair Sequence

INFOID:0000000012112339

In general, no single bend or twist is produced in a collision. Body deformation results from a combination of bending and twisting and other types of damage.
Repair should start where the damage is most deeply propagated.
If concentrating only on apparent damage while overlooking the propagation of impact to the whole body, it is impossible to obtain correct body alignment.



JSKIA6465GB

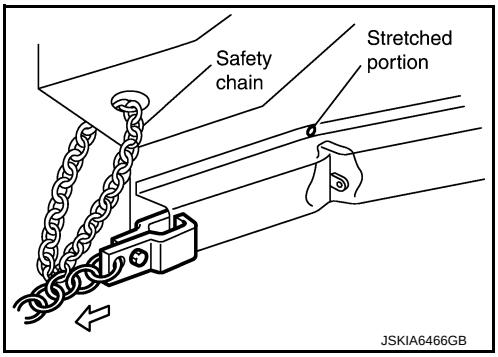
Repair work should basically be performed in this order of damage.

REPAIR PROCEDURE FOR PULLING : Key Points in Actual Repair Work

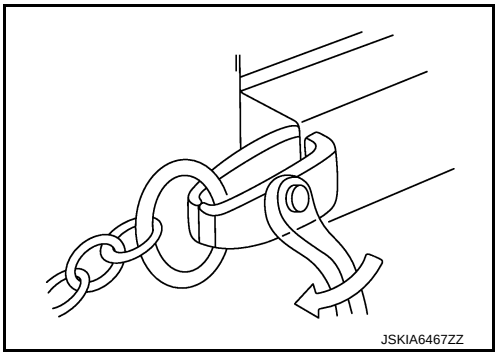
INFOID:0000000012106671

(1) STRETCHING SHRUNK PORTIONS

- The repair of a bent closed cross-sectional structure, such as a side member, is done by clamping the surface of the bent-in side and pulling. The pulling direction should be such that force is applied in the direction of an imaginary straight line extending through the original position of the part.

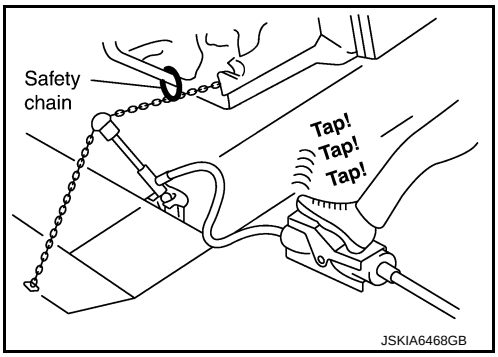


- Sometimes a load of approximately 5,000 kg (11,025 lb) is applied during repair work. Accordingly, the clamp must be tightened securely. Be sure to use safety chain.

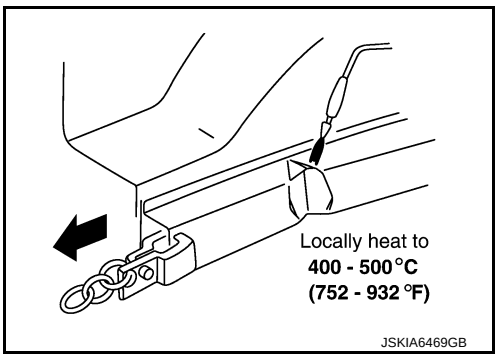


(2) GRADUAL PULL

- Pull step by step.
  The damaged portion may be work hardened.
  Pulling all at once may cause cracking.



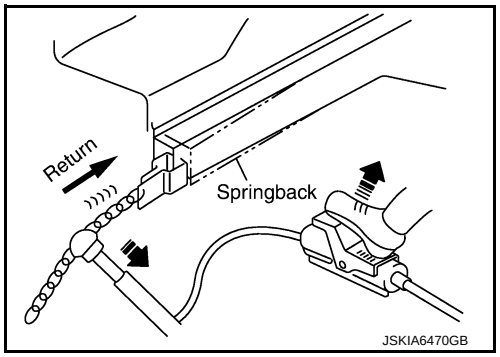
- Reduce the hardness of the work-hardened portion.
  Locally heat the panel to 400°C - 500°C (752°C - 932°F) to the extent that the panel is not colored. Do not heat above 700°C (1,292°F), or strength will be reduced. Do not raise to a temperature of more than 550°C (1,020°F) for HSS parts.



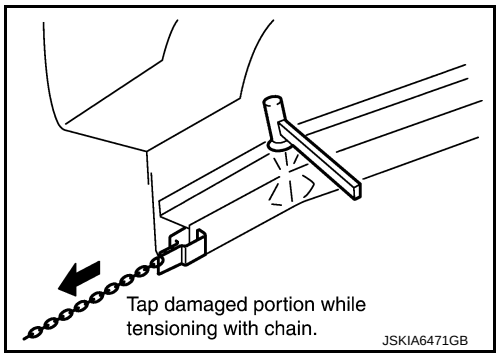
(3) CONSIDER SPRING-BACK

When pulling force is applied to a panel, spring-back is generated by the residual stress.

- Proper amount of pull
  Pull 2 mm - 3 mm (0.08 in - 0.12 in) more than the required dimension. Adjust the amount of pull corresponding to the spring-back.

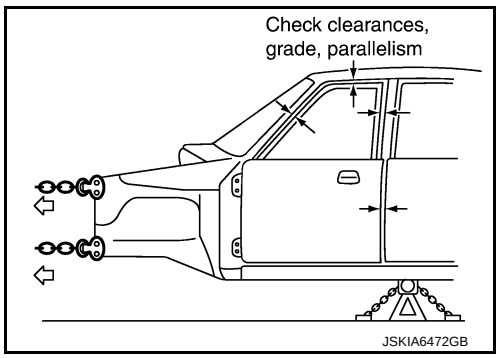


- Use of hammer
  Residual stress caused by kinetic energy of the collision can be removed by hammering.



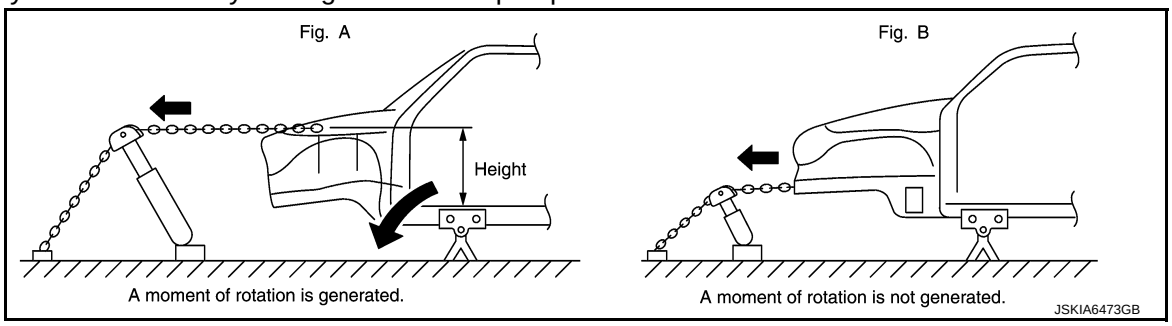
(4) DETERMINING PROPER AMOUNT OF PULL BY OBSERVING DOOR FIT

The proper amount of pull can be determined by observing the clearance at the door or trunk lid.

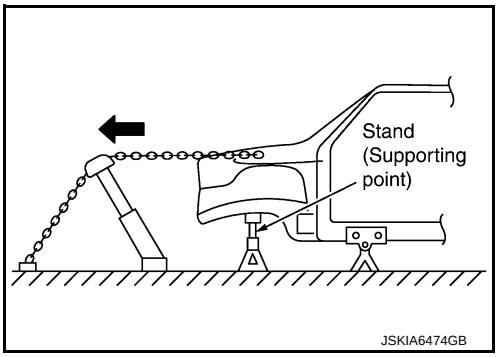


(5) PULLING UPPER PORTIONS FROM UNDERBODY CLAMP

Note that if there is distance between the pulling point and the underbody clamp, as indicated by (A) in the figure, a moment of rotation is produced.
This may cause secondary damage to the clamped portion.

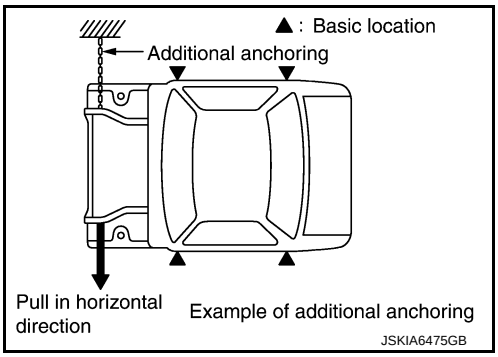


Provide a supporting point under the side member to prevent generation of this moment of rotation.



(6) ADDITIONAL ANCHORING

Pulling work must be performed with care taken not to damage the anchoring points or undamaged area of the body. If area not targeted for repair is affected by the excessive pulling force or the direction of pulling, additional anchoring points need to be provided to protect undamaged areas. Side sills are strong enough against longitudinal force, however, they are easily damaged by downward or lateral force. For this reason, additional anchoring should be provided by supporting side members with the port power, or attaching a clamp and chain.



(7) PURPOSE OF BODY ALIGNMENT

This operation is necessary to obtain correct alignment of parts to be used again. Therefore, the damage caused by propagated impact is recovered by pulling out the first input point.

REPLACEMENT OF PANEL

REPLACEMENT OF PANEL : Replacement of Panel

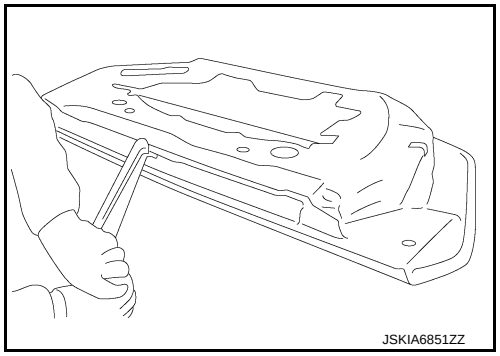
INFOID:0000000012119626

Panel replacement work includes replacement of the front fenders and hood which are installed by bolts, and replacement of rear fenders and the roof which are welded. This section explains panel replacement procedures after adjusting body alignment.

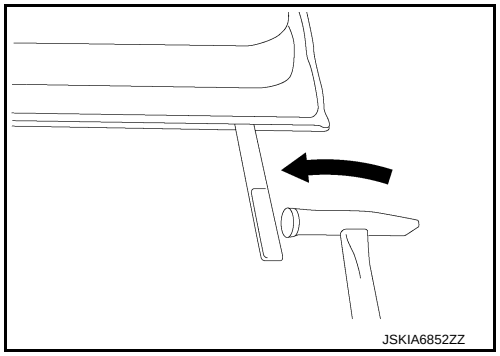
REPLACEMENT OF PANEL : Door Hemming

INFOID:0000000012157584

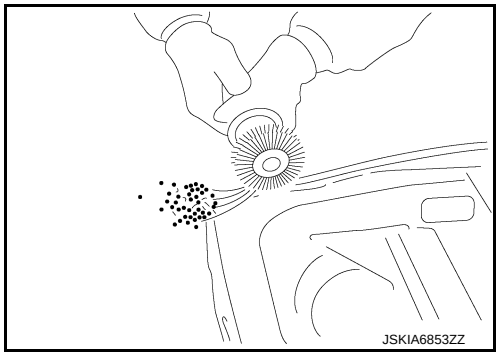
(a) Sand the edge part of door outer panel using belt sander.



(b) Insert the tip of a sharp-edged tool, such as a chisel, into the clearance at door outer panel. Use a hammer to tap the tool inserted into the clearance from the side to separate the door inner panel and door outer panel.

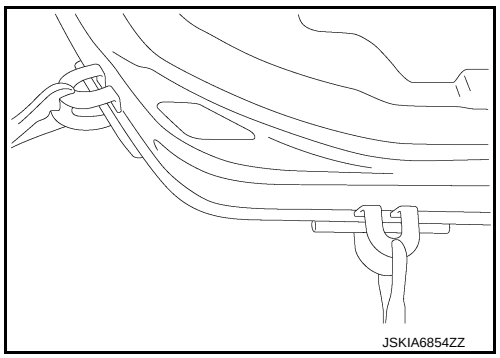


(c) Remove the adhesive adhering to the door inner panel flange area surface.

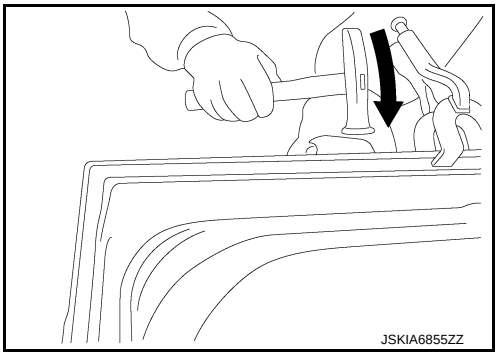


(d) Adjust the position where the new door outer panel and door inner panel overlap. Once these are positioned correctly, fix them with clamps to prevent them from being displaced.
Apply new adhesive to both door outer panel and door inner panel.

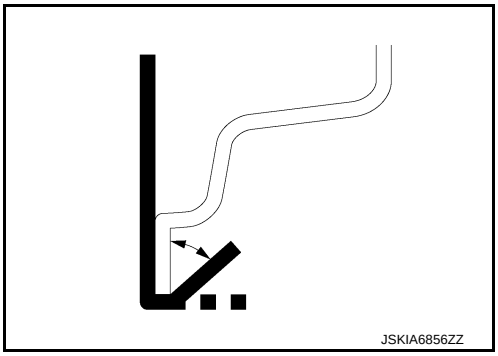
<Adhesive> 3M™ Automix™ Panel Bond 8115 or equivalent



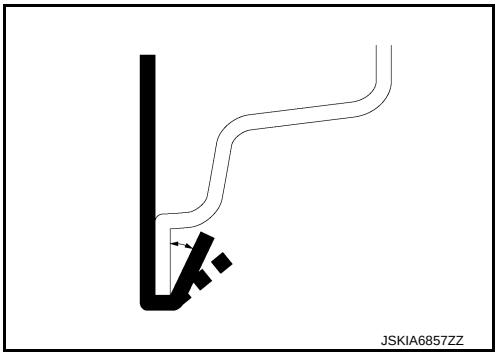
(e) Hold the dolly on the corners of the flange at door outer panel. Tap the dolly with a hammer to bend the door outer panel flange area gradually.



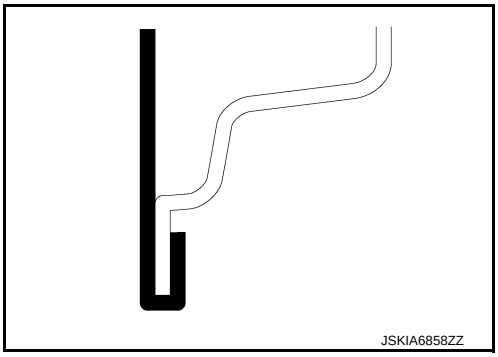
(f) Bend with hammer until the angle of the whole circumference of the door outer panel flange area becomes approximately 45°.



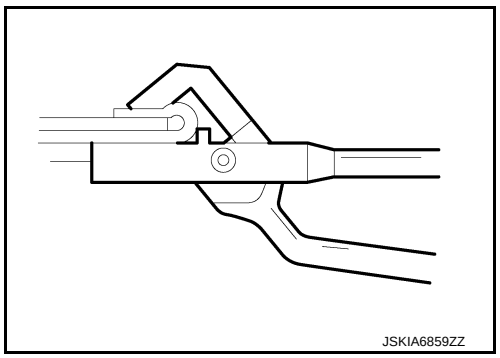
(g) Check that the position of the door outer panel and door inner panel is not displaced while tapping it with a hammer to bend it until the angle of whole circumference of the door outer panel flange area becomes approximately 15°.



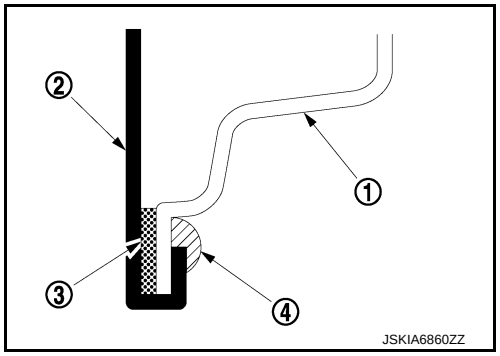
(h) Check that the position of the door outer panel and door inner panel is not displaced while taping it with a hammer to bend it until the angle of the whole circumference of the door outer panel flange area becomes approximately 0°.



(i) Use the hemming tool [SST: KV991-10000] to adjust the shape of the whole circumference of the door outer panel flange area.



(j) Seal up the area around the hemmed end of the flange.



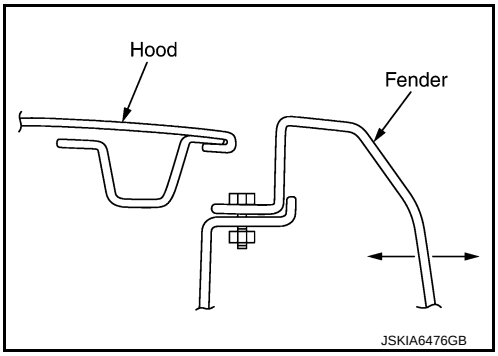
① **Door inner panel**
② **Door outer panel**
③ **Adhesive**
④ **Sealant**

REPLACEMENT OF PANEL : Adjustment Fitting of Front Fender

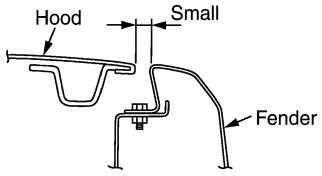
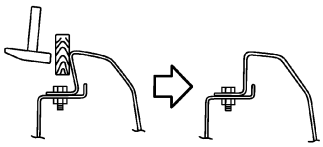
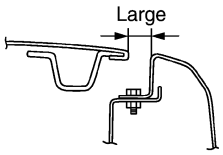
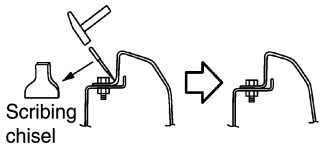
INFOID:0000000012112340

Fitting adjustment means adjustment of clearance or gradient of the hood, door, front fender, etc. with respect to its adjacent part, and adjustment of gradient at the press line.
Adjustment of front fender is described as an example.

- Adjust the fitting at the front fender mounting position. Tighten the front fender mounting bolts loosely, and adjust the fit by moving the front fender sideways or in the up-down direction while observing the clearance with the hood and door.



- Adjust the front fender bend angle.
  If a proper fit cannot be obtained by step (1) above, change the bending angle of the front fender.

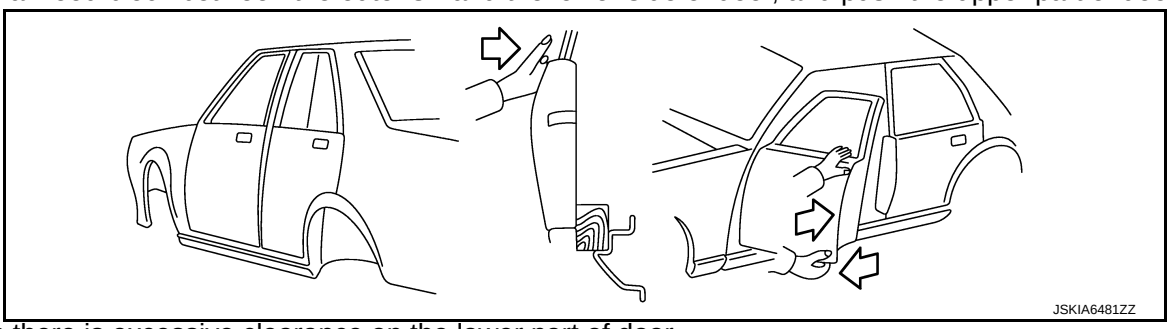
Explanation	Condition	Correction method
When the clearance between the front fender and hood is too small: Apply a flat wood plate to the upper corner of front fender, and correct by hammering. Before hammering, securely tighten the front fender mounting bolts.		
When the clearance between the front fender and hood is too large: Apply a scribing chisel to the bend at the base of the front fender. Tap with a hammer to adjust the clearance. Securely tighten the front fender mounting bolts before tapping. Apply the scribing chisel along the press line.		

REPLACEMENT OF PANEL : Adjustment Fitting of Door Assembly

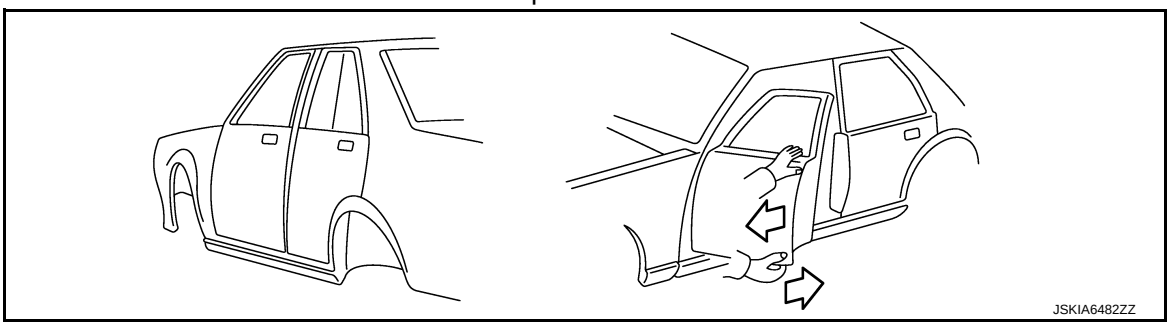
INFOID:0000000012106672

When there is excessive clearance on the upper part of door:

- Apply a wood block between the outer sill and the lower side of door, and push the upper part of door.



- When there is excessive clearance on the lower part of door.



PARTIAL REPLACEMENT OF PANEL (WELDED PANEL)

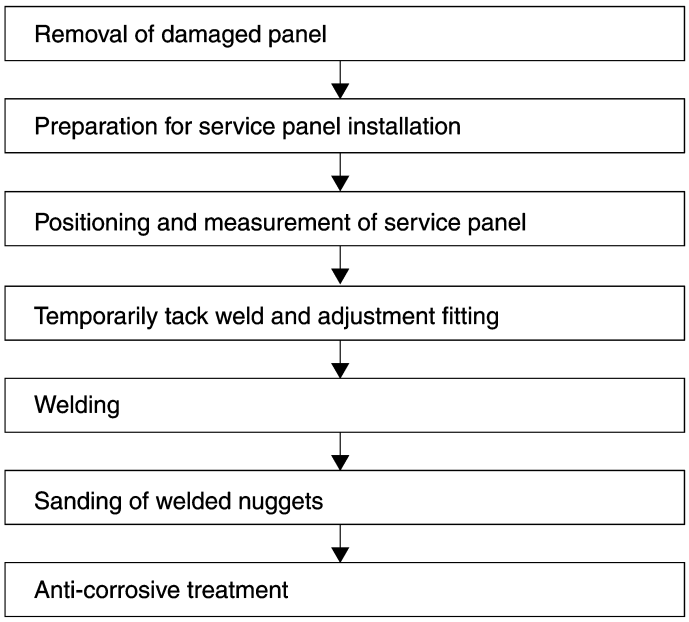
PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Partial Replacement of Panel (Welded Panel)

INFOID:0000000012119628

If damage occurs in a welded panel, it can be entirely replaced by a service panel or partial replacement can be done by cutting and replacing damaged portion with a service panel.

PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Welded Panel Replacement Procedure

INFOID:0000000012112348



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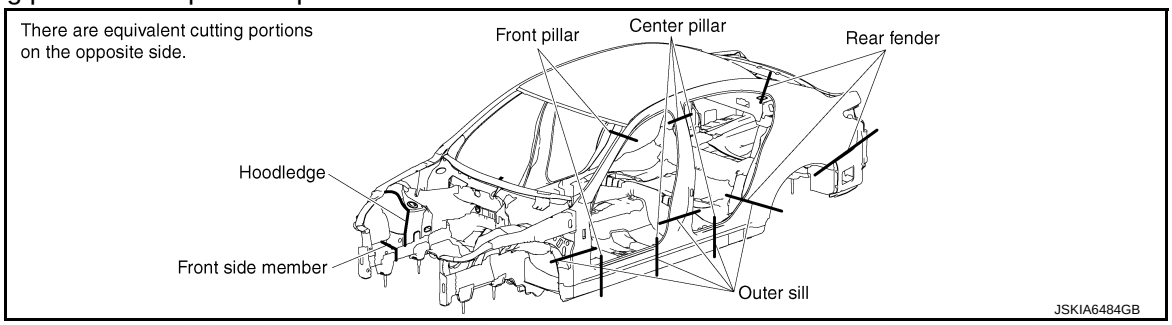
NOTE:

When welding and dressing the parts, cover up holes of these parts with tape to prevent debris from entering.

- Assembly panel replacement or partial panel replacement
  Assembly panel replacement means replacement of a complete panel by cutting all the welded portions.
  Partial panel replacement is a method by which only the damaged portion of a panel is replaced. Partial panel replacement can be used when assembly panel replacement is too costly and time consuming, and when the damage is localized.
- Cutting positions for partial replacement



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Cutting panels for partial replacement is not allowed on some portions. If panels are cut in improper portions, body strength cannot be maintained. The allowable positions vary with body structure, panel strength or shape and differ from model to model. They are indicated in the Body Repair Manual of each model. In principle, the following portions may be cut:

- Portions without reinforcement or ducting
- Portions where no stress concentration occurs
- Portions with small finish area where finishing can be easily accomplished (where the connected portions can be covered by garnish or moulding)
- Portions where work area or disassembling of parts is minimized

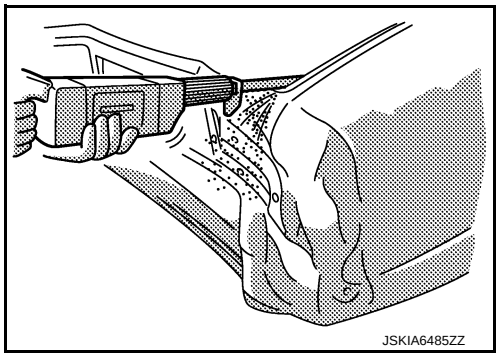
PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Rough Cutting of Panel

INFOID:0000000012112347

Most body panels are joined by spot welding. It is difficult to cut them at the welded portion.
To shorten work time, pull the damaged portion roughly, them cut near the panel joint in advance so that tools can be used properly to cut the spot welded portion. It is commonly used on panels having complicated structures.
Cutting body panel and service panels by leaving an overlap tolerance is also called rough cutting.
Use the cutting tools properly according to the portion to be cut, panel thickness, and panel structure.
Tools commonly used for this purpose and their features are described below:

(1) ROUGH CUTTING USING AN AIR SAW

(a) Major application
Members and pillars including side member, cross member, rear pillar, etc..
(b) Features
Clear cut line. Suitable for cutting both thin and comparatively thick sheet metal.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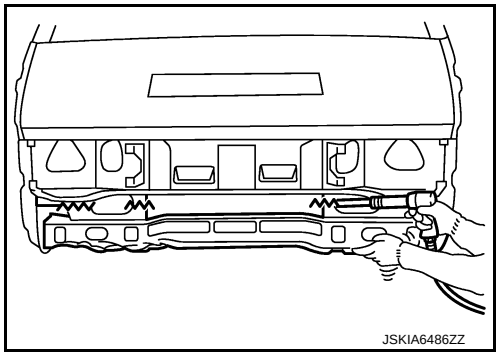
(2) ROUGH CUTTING USING AN AIR CHISEL

(a) Major application
Thin sheet metal including the rear fender and rear floor
(b) Features
Faster cutting speed
High noise level
Not applicable to thick sheet metal
Irregular cut line
Excessive sparking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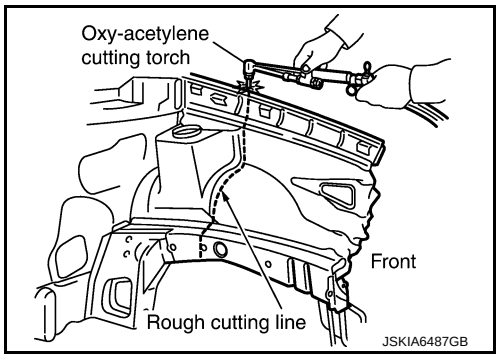
(3) ROUGH CUTTING WITH AN OXY-ACETYLENE CUTTING TORCH

(a) Major application
Thick sheet metal including side member, cross member, hoodledge, etc..
(b) Features
Faster cutting speed



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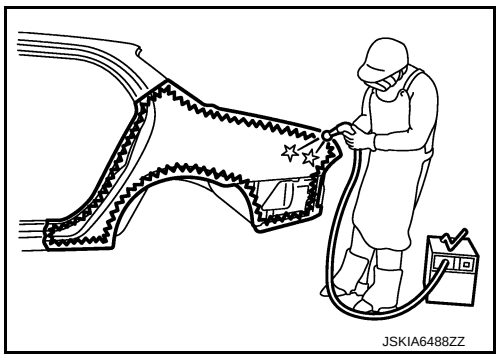
(4) ROUGH CUTTING WITH A PLASMA CUTTER

(a) Major application
Floor, door, rear fender, roof, flat panels.
(b) Features
Faster cutting speed
Only small will be affected by heat.
This is suitable for cutting conductive materials.
Aluminum, stainless, and carbon steel can be cut.
Cut off damaged portion as shown in the figure.
Be careful not to cut inner rear pillar reinforcement.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PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Cutting Off Welded Portions

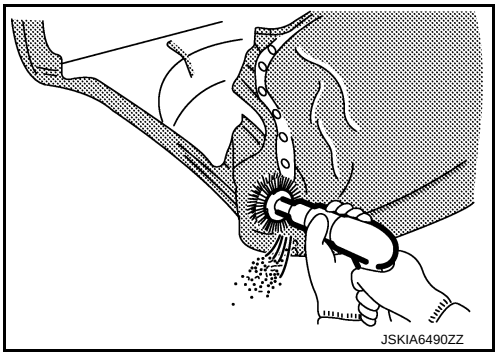
INFOID:0000000012112346

A vehicle body is constructed by using three different welding methods [spot welding, gas shielded arc (GSA) welding and brazing]. Cutting welded portion by these methods is described below.
Spot welding is generally used on two or more overlapped panels. The tool or cut off method must be changed according to whether the panel to be removed is on the top, in the middle or on the bottom.

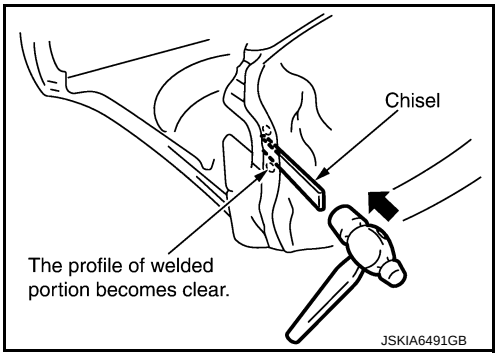
(1) CONFIRMING THE SPOT WELDED POSITION

Remove paint, undercoat, and sealer from the panel to confirm the spot welded positions.

(a) Using air sander or rotary wire brush:
When using this method, do not grind too much of the panel. Sand or brush the panel while confirming the spot welded portion.



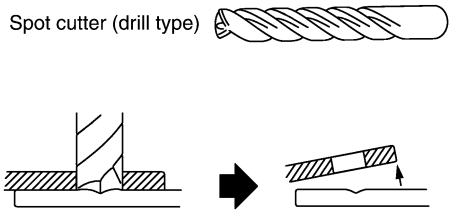
(b) Using a chisel:
If the spot welded portion is indiscernible even after removing paint, insert the chisel blade between the panels and tap lightly with a hammer for confirmation.



(2) CUTTING OFF SPOT WELDED PORTION

(a) Using a spot cutter:

There are two types of spot cutters (a drill type and a hole saw type). When using the spot cutter, be careful not to cut the lower panel.



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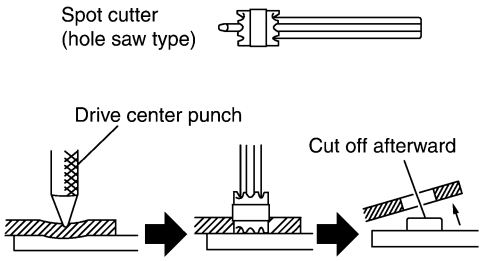

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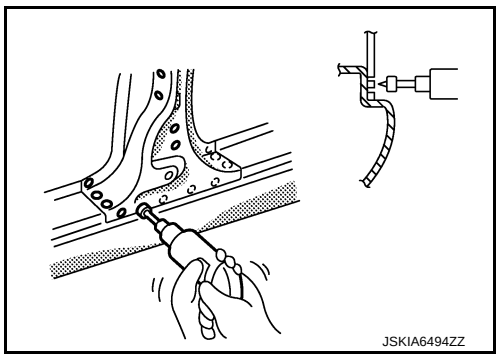
If it is difficult to weld from behind the lower panel, the spot cutter may be used to cut the spot welded portions without drilling the bottom panel.

The hole saw type spot cutter requires grinding of the spot weld after cutting. This requires additional work time.



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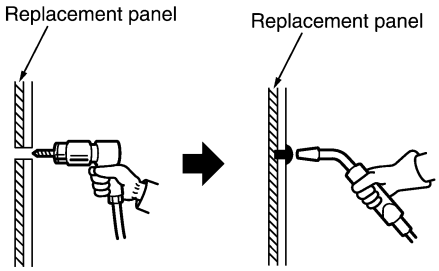
(b) Using drill:

The drill may be used to cut welds from any portion welded by plug welding, by drilling out the plug welded portion.



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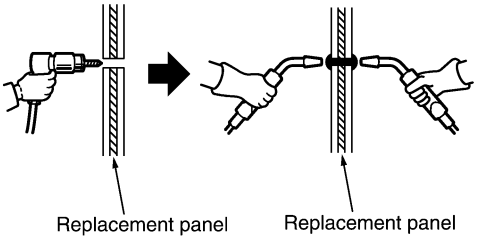

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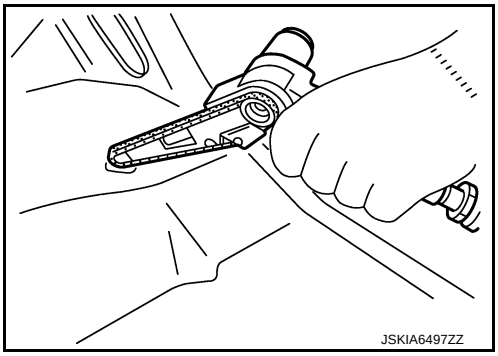
(3) CUTTING SPOT WELDED PORTIONS WITH AN AIR SANDER

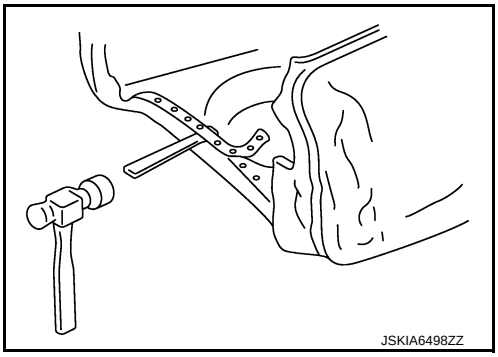
If the spot cutter cannot be used, use the air sander (or belt sander) to cut off the spot welded portion.



(4) REMOVING PANEL WITH A CHISEL

After cutting the spot welded portions, separate the panel using the chisel.

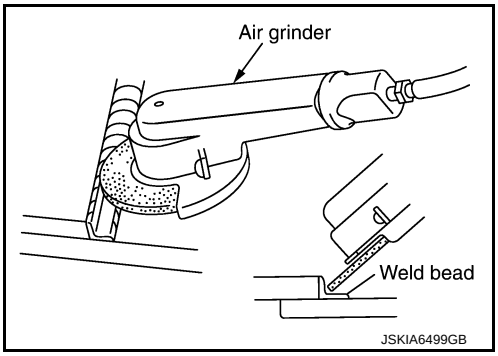
By doing this, spot welded portions will separate from their mating surfaces. Thus, work can proceed while confirming the separation of spot-welded portions.



(5) CUTTING GSA WELDED PORTIONS

The GSA welding method is divided into two types (plug welding and seam welding). The plug weld portion can be cut off with a spot cutter or the like. To cut off the seam welded portion, grind the seam-weld bead with an air grinder to cut the welded portion. Be careful to grind from the replacement panel. Do not grind the reused panel excessively.

GSA = Gas Shielded Arc welding



(6) CUTTING OFF BRAZED PORTION OF PANEL

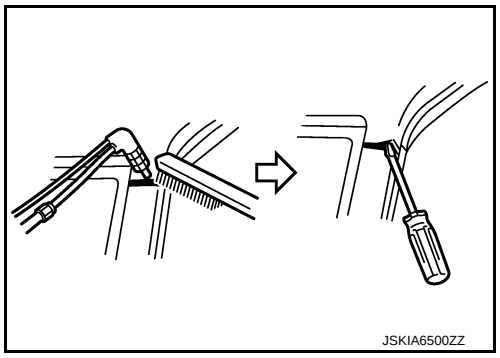
Brazing is used to improve the external appearance of the joined portion (roof and fender) of the body outer panel as well as to improve sealing. Brazed portions can be generally disconnected by dissolving the braze with an oxy-acetylene torch.

If arc brazing was used, cut off the welded portion with an air sander or the like. The melting temperature of arc brazed metal is higher than that of ordinary brazing, and the panel may be damaged by this high temperature. Ordinary brazing and arc brazing may be discriminated by observing the color of the brazed metal. Ordinary brazing looks like a brass, while arc brazing has a copper color.

(a) Cutting with an oxy-acetylene torch

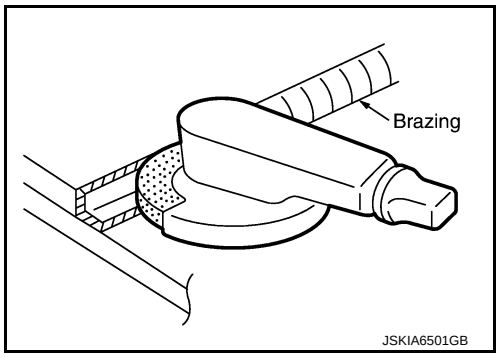
Melt the filler metal with the oxy-acetylene torch.

Remove the metal with a wire brush and separate the panel. While the filler metal is still hot, insert the tip of a screwdriver or the like between panels to prevent re-adhesion.



(b) Cutting with an air grinder

Cut off the brazed portion with the air grinder. Do not grind excessively the panel to be reused.

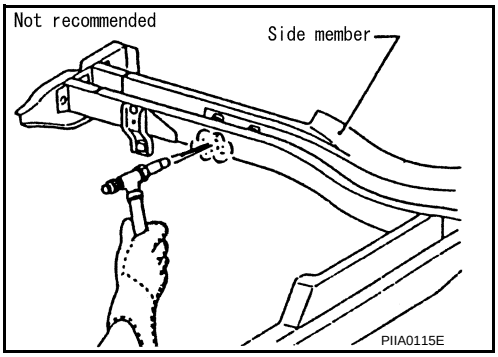


PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Precautions for High Strength Steel (HSS)

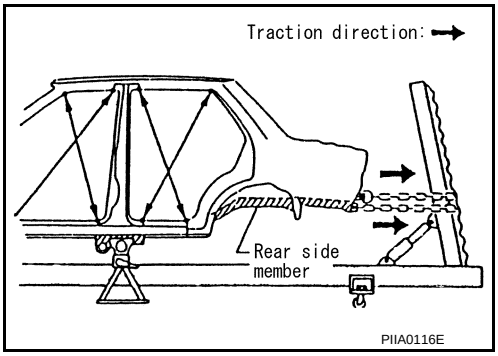
INFOID:0000000012112345

High strength steel (HSS) means the steel from 440 MPa - 979 MPa.
The strength is shown in each the Service Manual like page BRM-6, "BODY TYPES AND STRUCTURE : Uni-body" in this manual.

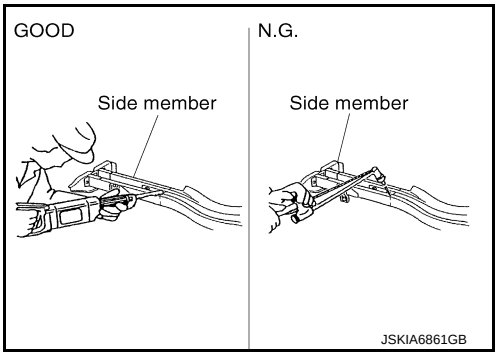
(a) The repair of reinforcements (such as side members) by heating is not recommended since it may weaken the component. When heating is unavoidable, do not heat HSS parts above 550°C (1,022°F). Verify heating temperature with a thermometer. (Crayon-type and other similar type thermometer are appropriate.)



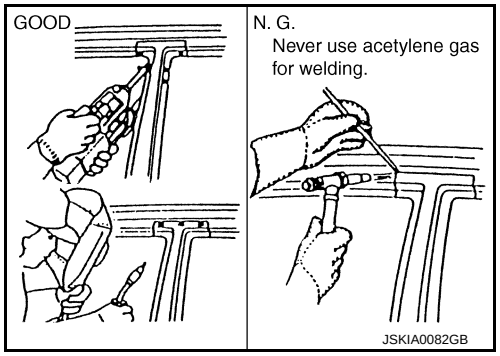
(b) When straightening body panels, use caution in pulling any HSS panel. Because HSS is very strong, pulling may cause deformation in adjacent portions of the body. In this case, increase the number of measuring points, and carefully pull the HSS panel.



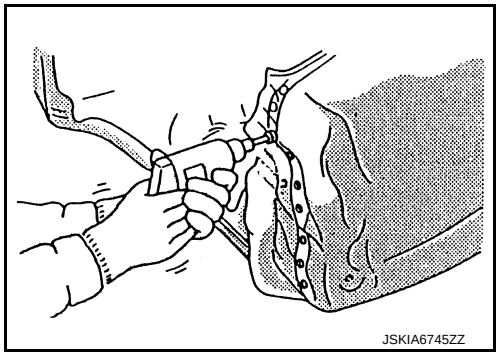
(c) When cutting HSS panels, avoid gas (torch) cutting if possible. Instead, use a saw to avoid weakening surrounding areas due to heat. If gas (torch) cutting is unavoidable, allow a minimum margin of 50 mm (1.97 in).



(d) When welding HSS panels, use spot welding whenever possible in order to minimize weakening surrounding areas due to heat.
If spot welding is impossible, use GSA welding. Do not use gas (torch) welding because it is inferior in welding strength.



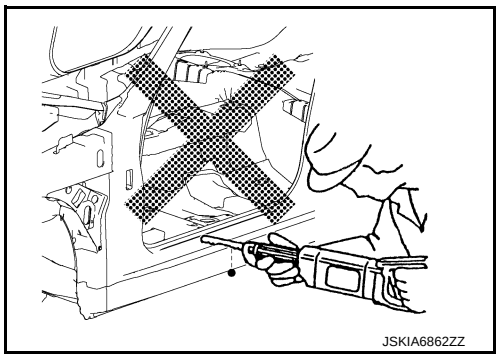
(e) The spot weld on HSS panels is harder than that of an ordinary steel panel.
Therefore, when cutting spot welds on a HSS panel, use a low speed high torque drill (1,000 rpm - 1,200 rpm) to increase drill bit durability and facilitate the operation.



PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Prohibition for Ultra High Strength Steel (UHSS)

INFOID:0000000012157585

Ultra high strength steel (UHSS) means the steel from 980 MPa or higher.
Never cut and joint the panel, plate and reinforcement made of ultra high strength steel (UHSS).
If such part is damaged, replace the part.
The strength is shown in each the Service Manual like page BRM-6, "BODY TYPES AND STRUCTURE : Uni-body" in this manual.



PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Rear Fender Hemming Process

INFOID:0000000012112344

When the rear fender and the outer wheel housing have been joined with adhesive, the panel replacement method described below is used.

1. A wheel arch is to be installed and hemmed over left and right outer wheel house.
2. In order to hem the wheel arch, it is necessary to repair any damaged or defaced parts around outer wheel house.

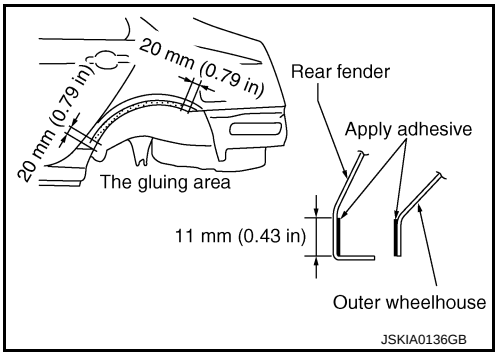
CAUTION:

Ensure that the area that is to be glued around outer wheelhouse is undamaged or defaced.

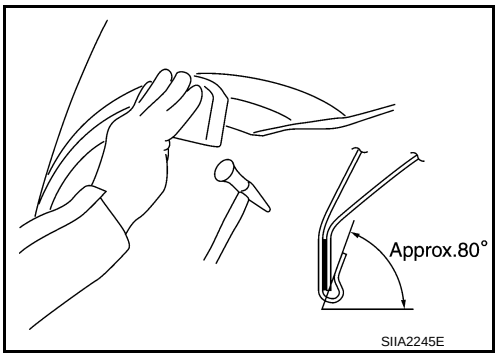
Procedure of the hemming process

(a) Peel off old bonding material on the surface of outer wheelhouse and clean thoroughly.
(b) Peel off a primer coat in the specified area where new adhesive is to be applied on rear fender. (the replacing part.)
(c) Apply new adhesive to both specified areas of outer wheelhouse and rear fender.

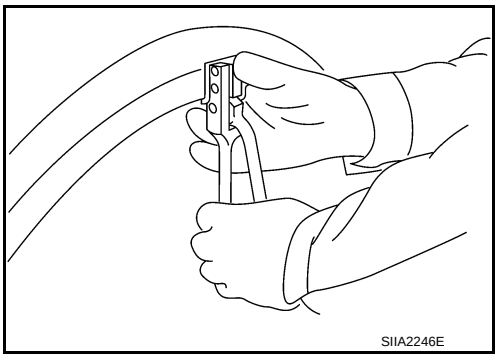
<Adhesive> 3M™ Automix™ Panel Bond 8115 or equivalent



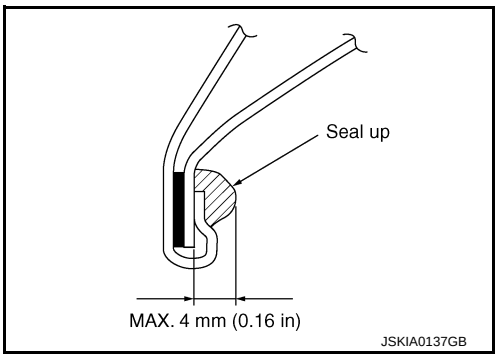
(d) Attach rear fender to the body of the car, and weld the required part except the hemming part.
(e) Bend the welded part starting from the center of the wheel arch gradually with a hammer and a dolly. (Also hem the end of the flange.)
(f) Hemming with a hammer is conducted to an approximate angle of 80°.



(g) Starting from the center, hem the wheel arch gradually, using slight back and forth motion with a hemming tool [SST: KV991-10000].



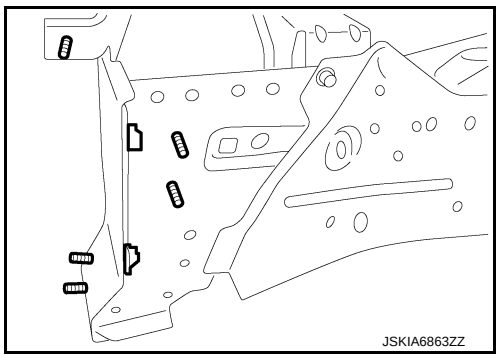
(h) Seal up the area around the hemmed end of the flange.



PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Welding Method for Stud Bolt and Nut

INFOID:0000000012157588

When stud bolts and weld nuts are not welded on the part acquired for repair, and are supplied as separate parts, use the following method to perform welding.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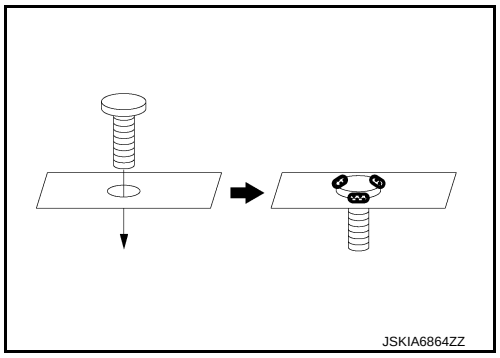
(1) FLANGE BOLT

1. Remove paint, rust, or oils on the surface of the panel.
2. Insert the bolt, temporarily tighten the matching nut of the bolt, and perform centering.
3. Weld 3 points evenly by MIG weld. [approximately 3 mm (0.12 in)]
4. Apply an appropriate anti-corrosive treatment to the respective locations.

NOTE:
The same welding method is also applied when welding on a panel surface without a through hole. Welding is performed with the bolt head surface and panel contact surface contacting.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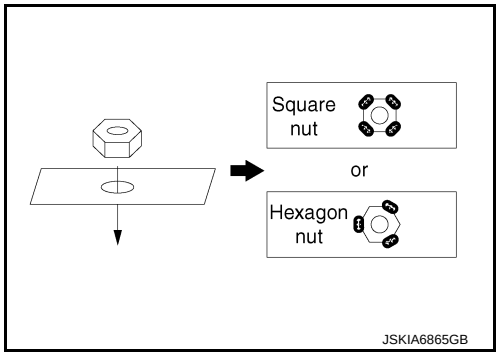
(2) WELD NUT

1. Remove paint, rust, or oils on the surface of the panel.
2. Put the nut on the panel center of the hole, temporarily tighten the matching bolt of the nut, and perform centering.
3. Weld 3 or 4 points evenly by MIG weld. [approximately 3 mm (0.12 in)]
4. Apply an appropriate anti-corrosive treatment to the respective locations.



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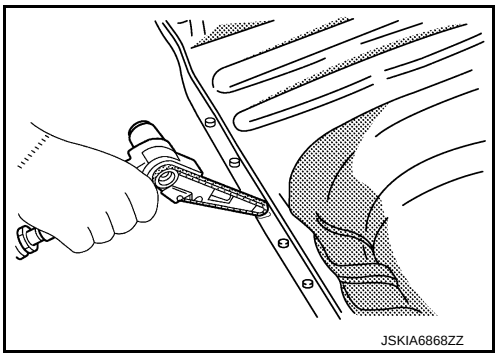
PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Preparation for Service Panel Installation

INFOID:0000000012112343

After removing the damaged panel, two operations are needed. Preparation for service panel installation and finishing of the panel mounting portion of the body.

(1) FINISHING BODY

(a) Grind clean around the area where the spot-welded panel has been removed. Thoroughly remove rust and other contamination from the mating surface.
Also, remove paint from the portion to be welded.
Any brazing metal should be thoroughly removed, otherwise welding will be impaired.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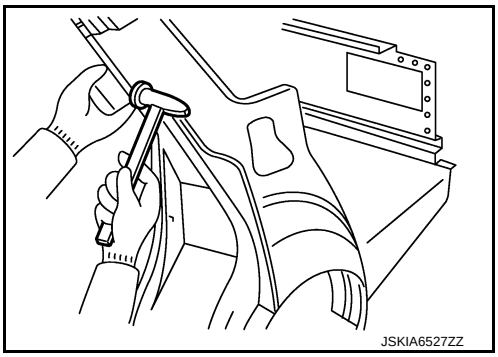
(b) Irregularities on the panel mating surface prevent the panel from being welded correctly. Using a hammer and dolly, correct the shape of the mating surface.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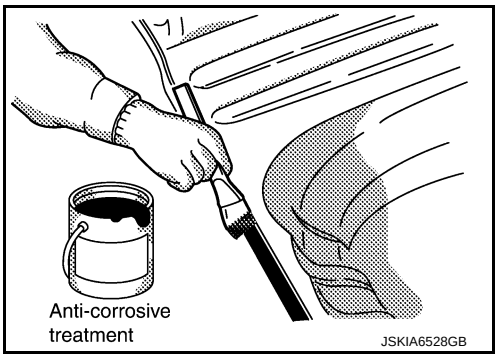
(c) Apply conductive anti-corrosive treatment [spot sealer for spot welding or weld through primer (metallic solution) for GSA welding] in places that cannot be painted in the subsequent painting process.



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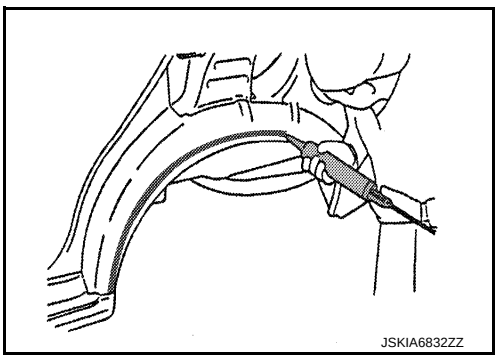
(d) If it is impossible to apply sealer after welding the service panel, sealer should be applied before welding.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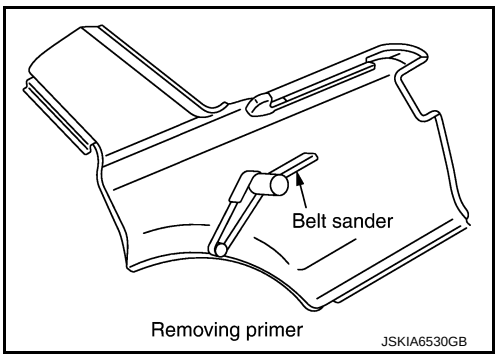
(2) PREPARATION FOR SERVICE PANEL INSTALLATION

(a) The service panel is coated with primer. Remove the primer and apply spot sealer at the portions to be welded. Do not allow the spot sealer to be forced out of the mating surface of the panel.

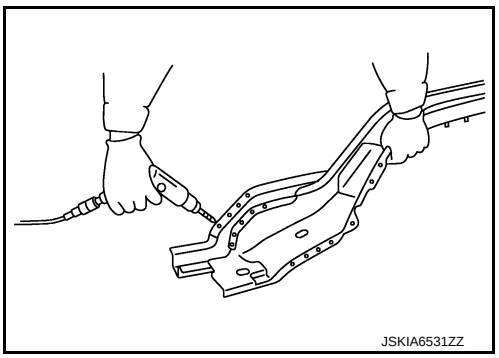


(b) Drill the service panel for plug welding, if necessary.

Refer to the Body Repair Manual of applicable model for the number of holes to be drilled for plug welding. The number of holes must be the same as the number of original spot welds. The drill holes must be spaced equally. Drill hole diameter must be changed according to panel thickness to maintain welding strength.

Plug hole diameter and panel thickness

Panel thickness	Plug hole dia.
Below 1.0 mm (0.039 in)	Below 5 mm (0.20 in)
1.0 mm - 2.4 mm (0.039 in - 0.094 in)	6.5 mm - 10 mm (0.256 in - 0.394 in)
Over 2.4 mm (0.094 in)	Over 10 mm (0.39 in)

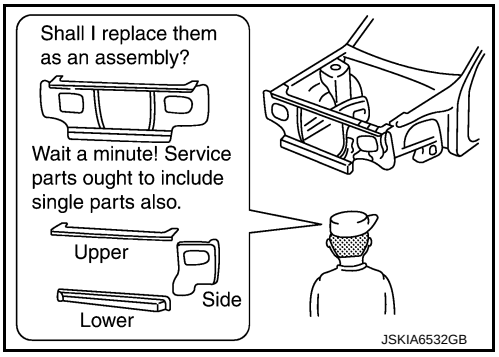


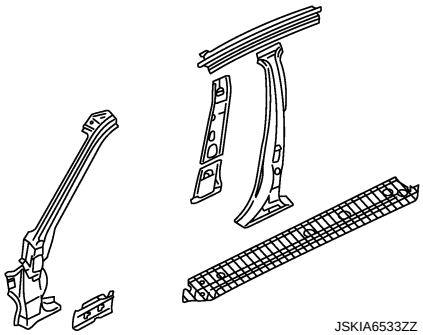
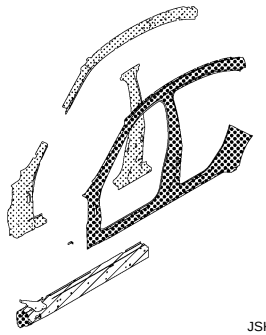
(3) UNDERSTANDING SERVICE PARTS

This is important in judging when the panel should be replaced, or in determining conditions for efficient operation.

Service parts should be prepared with reference to the Parts Catalog for each model.

The integral type outer body side panel consists of two types of service panels. These service panels need to be cut for use depending on the location and degree of the damage.



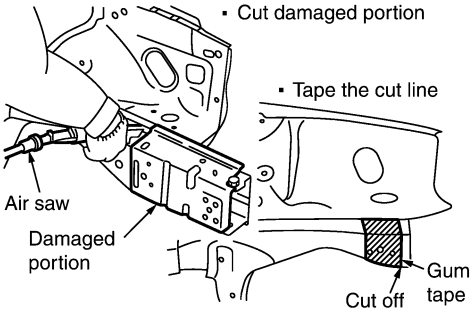
Separate type outer body side panel	Integral type outer body side panel
	
JSKIA6533ZZ	JSKIA6534ZZ

PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Example of Partial Panel Replacement

INFOID:0000000012112342

This section shows how to partially replace a damaged part. All values described here are for reference only. When there are values specified for a particular case, observe them as specified. For details, refer to the Body Repair Manual of the applicable vehicle.

(1) FRONT SIDE MEMBER



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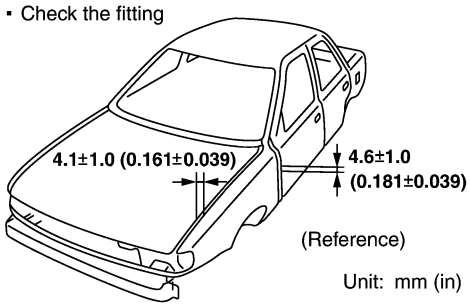
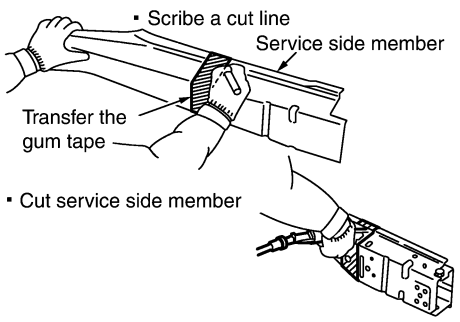
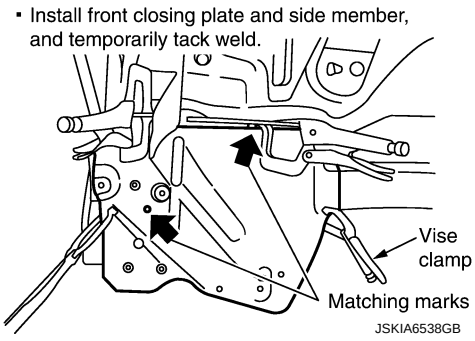


JSKIA6536GB

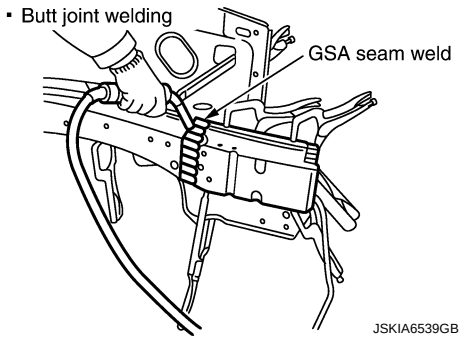


JSKIA6537GB

Butt joint weld, patch joint weld and overlapping weld methods are used in partial repair. Generally, this manual describes the butt joint method, but to increase the reliability of the weld, patch joint weld method is preferred for some partial repairs.



JSKIA6538GB



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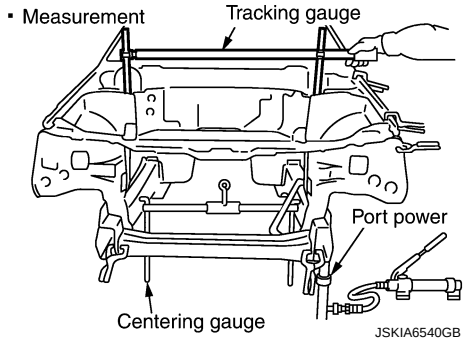
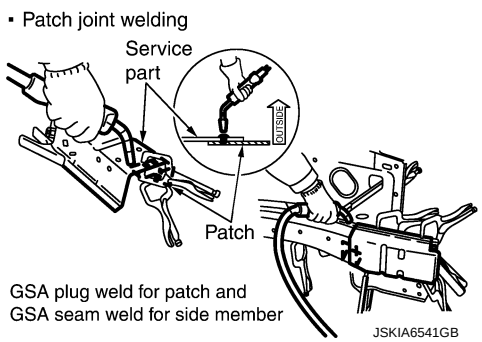


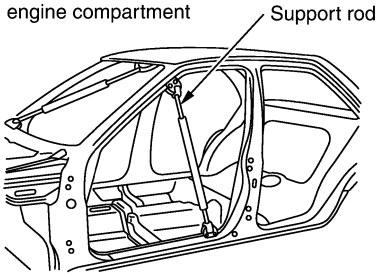
JSKIA6540GB



JSKIA6541GB

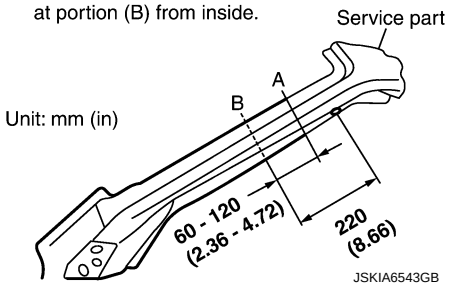
(2) FRONT PILLAR

- Support the front pillar and engine compartment



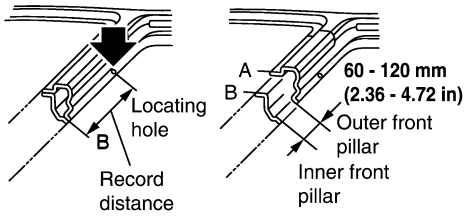
JSKIA6542GB

- Align service part and cut off
  Cut off at portion (A) from outside, and at portion (B) from inside.



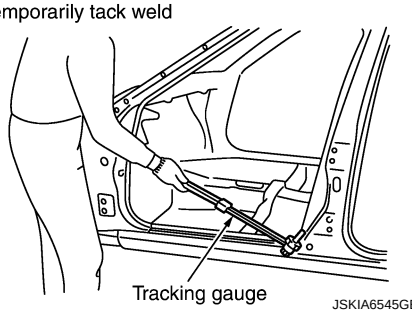
JSKIA6543GB

- Measuring and cutting



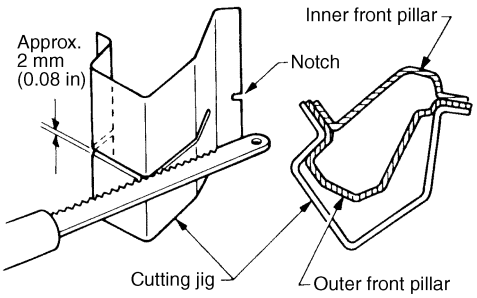
JSKIA6544GB

- Install service part and mesaure
  Temporarily tack weld



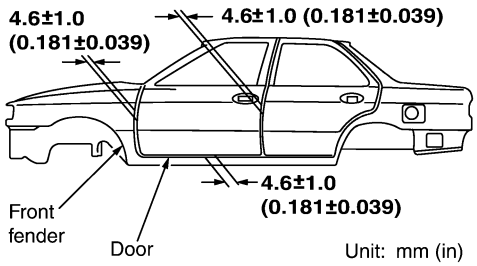
JSKIA6545GB

Cutting jig: Using a cutting jig marks it easier to cut. Also, this will permit service part to be accurately cut at joint position.



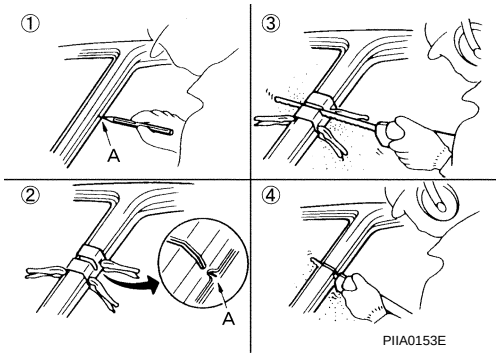
JSKIA0105GB

- Check the fitting



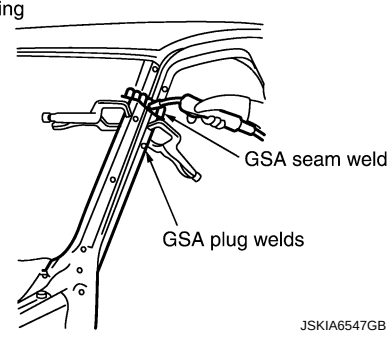
JSKIA6546GB

An example of the cutting operation and removal of the damaged area.



PIIA0153E

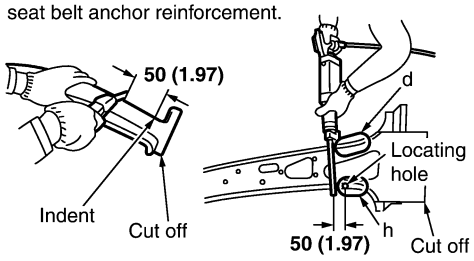
- Welding



JSKIA6547GB

(3) CENTER PILLAR

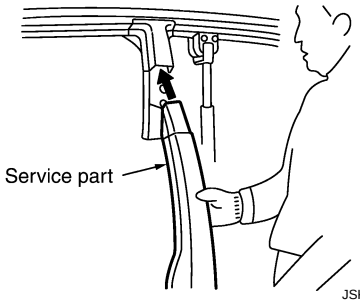
- Cut the service center pillar.
Be careful not to damage
seat belt anchor reinforcement.



Unit: mm (in)

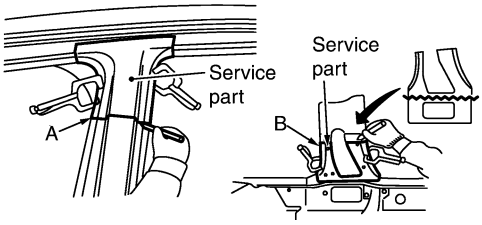
JSKIA6548GB

- Install service part.



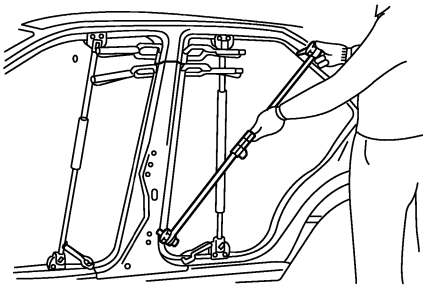
JSKIA6549GB

- Scribe cut line.



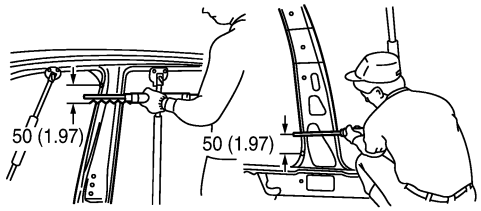
JSKIA6550GB

- Measuring



JSKIA6551GB

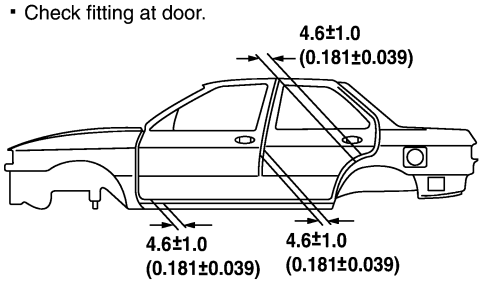
- Cut damaged portion.



Unit: mm (in)

JSKIA6552GB

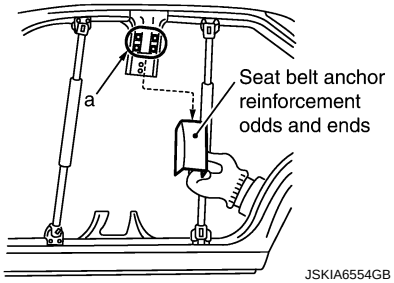
- Check fitting at door.



Unit: mm (in)

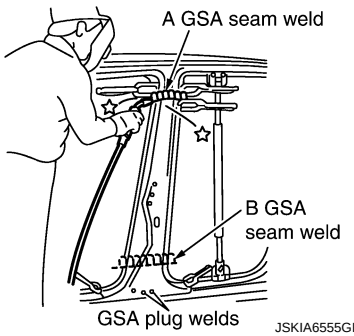
JSKIA6553GB

- Remove the center pillar and seat belt anchor reinforcement.



JSKIA6554GB

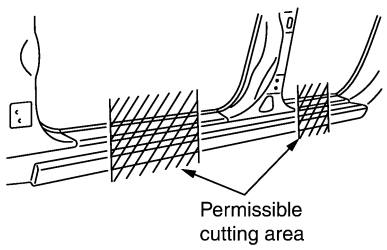
- Welding



JSKIA6555GB

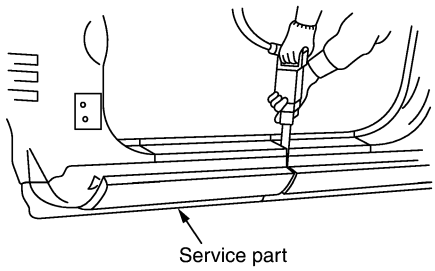
(4) OUTER SILL

- Cutting position
  For cutting, avoid outer sill brace and holes.



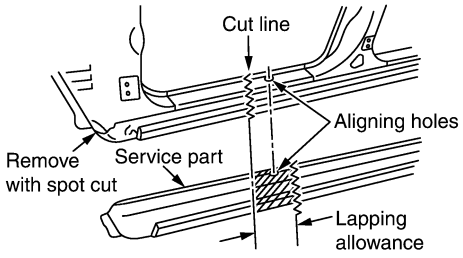
JSKIA6556GB

- Overlap cutting



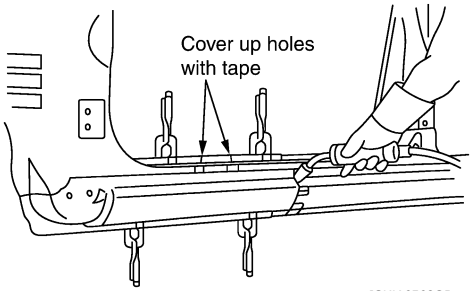
JSKIA6560GB

- Cut off damaged portion and service parts.



JSKIA6558GB

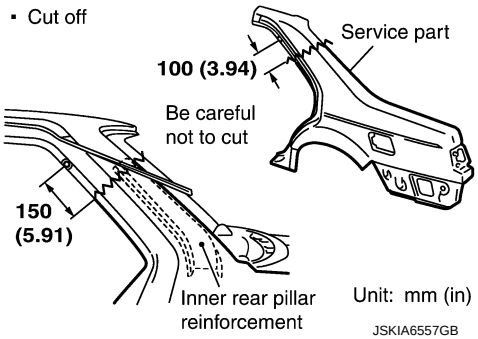
- Welding



JSKIA6562GB

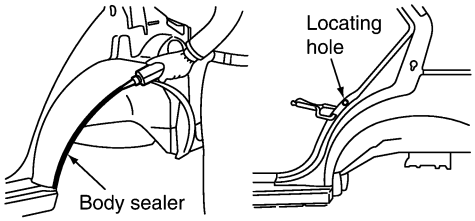
(5) REAR FENDER

- Cut off



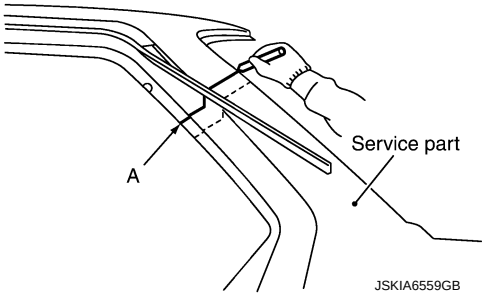
JSKIA6557GB

- Sealing and installing



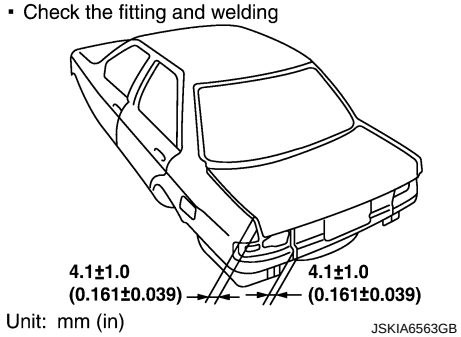
JSKIA6561GB

- Scribe cut line then cut



JSKIA6559GB

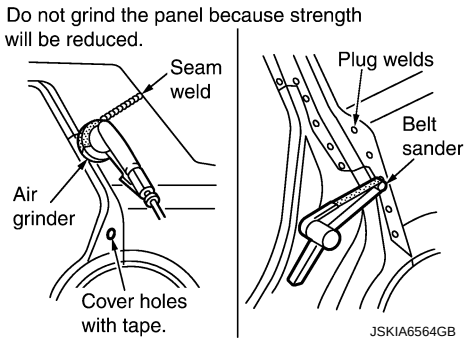
- Check the fitting and welding



JSKIA6563GB

PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Finishing the Welded Portion

INFOID:0000000012112341

(1) GRINDING	(2) CLEANING
	

PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Urethane Foam Application

INFOID:0000000012148970

Use commercially available Urethane foam for sealant (foam material) repair of material used on vehicle.

<Urethane foam for foaming agent> **3M™ Automix™ Flexible Foam 08463 or equivalent**

Read instructions on product for fill procedures.

EXAMPLE OF FOAMING AGENT FILLING OPERATION PROCEDURE

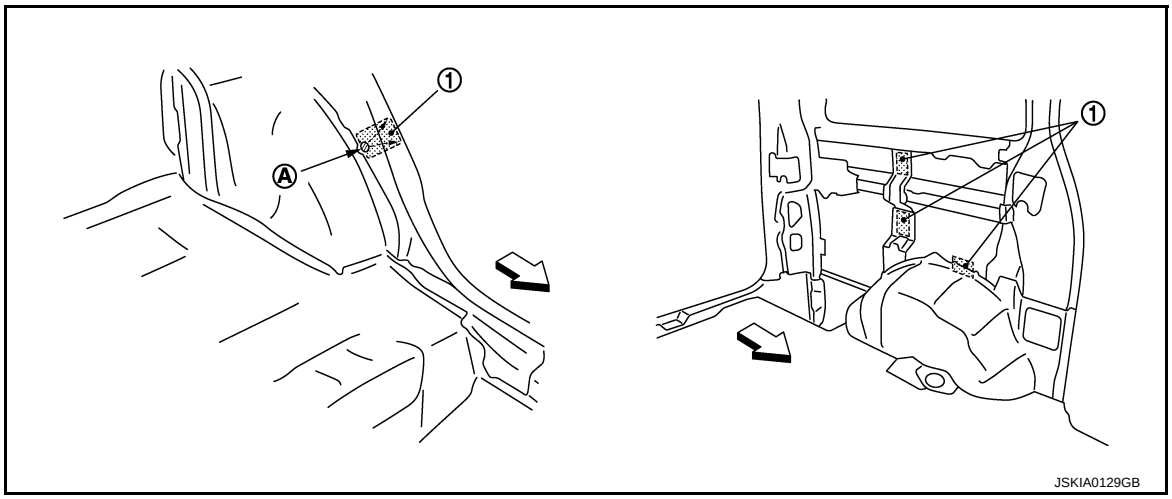
1. Fill procedures after installation of service part.

a. Eliminate foam material remaining on vehicle side.

b. Clean area after eliminating form insulator and foam material.

c. Install service part.

d. Insert nozzle into hole near fill area and fill foam material or fill enough to close gap with the service part.



① Urethane foam

Ⓐ Nozzle insert hole

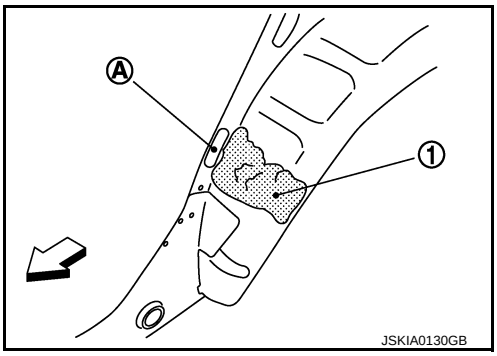
⇦: Vehicle front

2. Fill procedures before installation of service part.

a. Eliminate foam material remaining on vehicle side.

b. Clean area after eliminating foam insulator and foam material.

c. Fill foam material on wheelhouse outer side.



① Urethane foam

Ⓐ Fill while avoiding flange area

⇦: Vehicle front

NOTE:
Fill enough to close gap with service part while avoiding flange area.

d. Install service part.
NOTE:
Refer to label for information on working times.

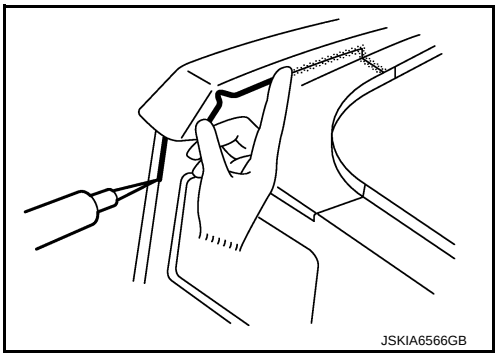
PARTIAL REPLACEMENT OF PANEL (WELDED PANEL) : Anti-corrosive Treatment

INFOID:0000000012106673

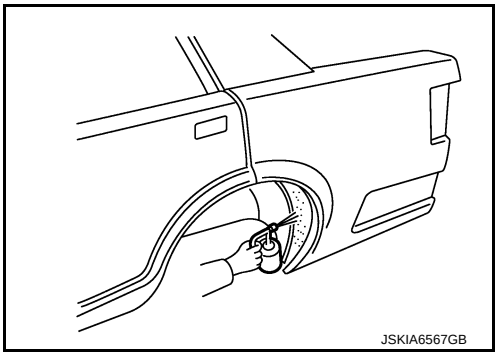
Anti-corrosive treatment may be performed on three different occasions (before welding, before painting, and after painting). This section explains anti-corrosive treatment for the latter two occasions.

(1) ANTI-CORROSIVE TREATMENT BEFORE PAINTING

- Application of body sealer
  Body sealer prevents water or mud from entering through the mating surface of the panel. It also prevents formation of corrosion. The sealer nozzle hole should be small. Use a finger or brush to shape the applied sealer. Refer to the Body Repair Manual for body sealer application points.

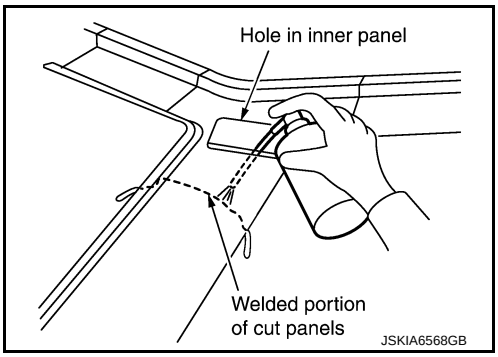


- Application of undercoating
  Apply undercoating to the underbody and inside of wheelhouse. Do not apply it to the exhaust pipe, suspension or driving portions.



(2) ANTI-CORROSIVE WAX AFTER PAINTING

Apply anti-corrosive wax to the back of the panel where painting is difficult. Insert the nozzle of anti-corrosive wax into the holes in the inner panel. Apply until the anti-corrosive wax bleeds out from panel mating surface.



USE OF BODY FILLER (PUTTY) AND GRINDING

USE OF BODY FILLER (PUTTY) AND GRINDING : Use of Body Filler (Putty) and Grinding

INFOID:0000000012119629

Panel irregularities may be corrected with a hammer and dolly. However, exact restoration of the original shape with theses tools takes a long time. Body filler may be used to restore the original panel profile. For this purpose, the panel surface is finished slightly lower than the original surface.
Filler is applied to finish the shape and also to reduce the time needed for repair.
In body repair shops, the most commonly used materials are body filler, polyester putty, and detail putty.
This section mainly describes the body filler.
Polyester putty is described in the paint manual.

USE OF BODY FILLER (PUTTY) AND GRINDING : Types of Filler and Putty

INFOID:0000000012112354

Type (Standard thickness limits)		Characteristics
Body Filler Putty (For repairing of large dents or scratches) [10 mm (0.39 in)]	Surform type	• This type of filler requires surforming (rough grinding). It will clog sandpaper if it is sanded only. • Can be thickly applied to panel. • After drying, grindability is poor as it is harder than other types.
	Light Type	• This type of filler contains tiny hollow beads. It feels gritty when applied with a spatula. • Suitable for thick application to panel • Superior grindability after application • Forms blowholes easily
	Glass Fiber or Aluminum Powder Type	• Excellent thick application to panel • Superior corrosion prevention and durability • Suitable for repairing rusty holes in panel
Intermediate Filler Putty [10 mm (0.39 in)] (For repairing of large dents or scratches)		• Good sanding characteristics. • It is difficult for fine grain pores to form in it, so poly putty can be eliminated and surfacer can be applied directly over intermediate filler.
Polyester Putty (For filling pores and sand scratches in body filler)	Spatula Type [3 mm (0.12 in)]	• Not very much thickness can be built up. • It has fine grain and good flexibility. • Since no volatile content remains, there is no depletion after baking. • Sanding characteristics are good.
	Spray Type [1 mm (0.04 in)]	• Not very much thickness can be built-up. • Since a spray gun in used, it can be applied easily to any location. • Drying time is approximately two times as long as putty applied with a spatula.
Lacquer Putty [0.1 mm (0.004 in)] (Detail putty)		• It is soft and flexible. • It cannot be used to built up low areas. • Standing characteristics are extremely good. • The thicker the built-up, the longer the drying time.
Ultraviolet Curing Putty		• Since the drying time is short (approximately 20 seconds after UV irradiation), body work can be completed in a short period of time. • This is often used for minor repairs. • Putty becomes very hard after hardening, therefore its grindability with sandpaper is not good. • It is expensive.

NOTE:
Putty film thickness limits should be decided with putty manufacturer because limits vary from maker to maker.

USE OF BODY FILLER (PUTTY) AND GRINDING : Procedure for Applying Body Filler

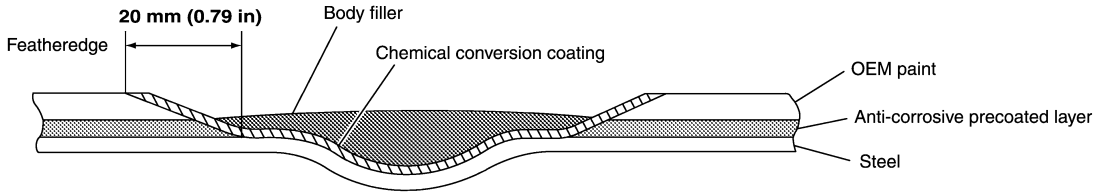
INFOID:0000000012112353

(1) REMOVAL OF PAINT

Using an air sander, remove old paint from the panel surface for better filler adhesion. Form a featheredge on the panel surface approximately 20 mm (0.79 in) wider than the correction area in order to eliminate traces of body filler application.

(2) CHEMICAL CONVERSION COATING

Body skin panels of NISSAN vehicles use anti-corrosive steel. These panels should be coated with chemical conversion coating before applying common body filler.



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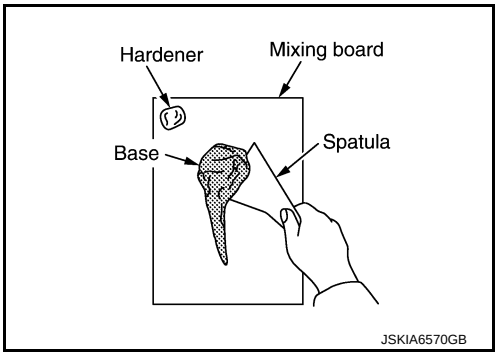
If body filler has been developed for anti-corrosive steel, chemical conversion coating will not be needed. (Please confirm this with the body filler supplier.)

(3) SPATULA MOVEMENT

Move the spatula lengthwise when applying to an oval shaped area. If applying to a round area, move the spatula in many directions as shown in the figure.



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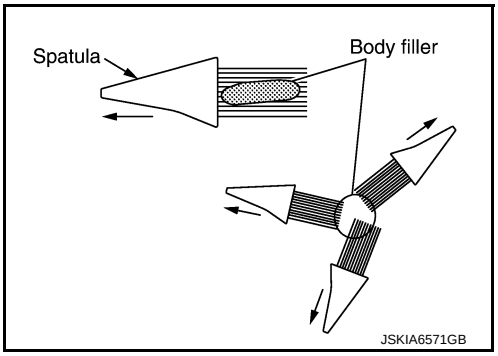

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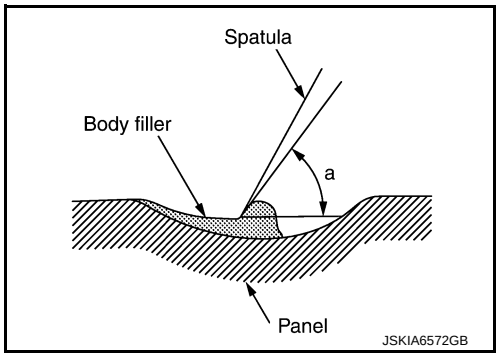
(4) APPLYING TECHNIQUE

Apply body filler in several thin layers.

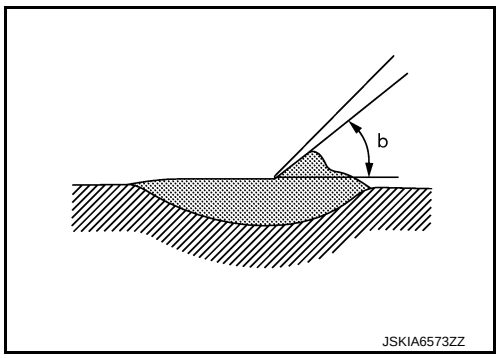
(a) Hold spatula well balanced and hold slightly standing position, then squeeze putty into scratches.

a : 60° – 90°



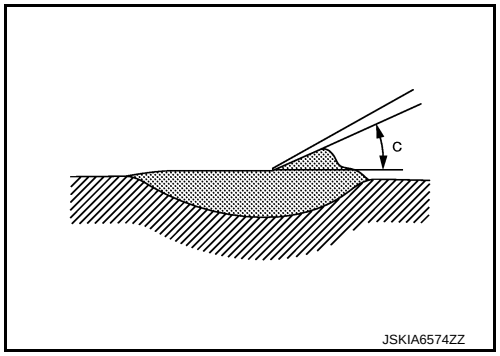
(b) Put a large amount of filler on the spatula.
Hold spatula slightly lean, then apply several times (do not put much in once) until covered above datum level.

b : 30° – 45°



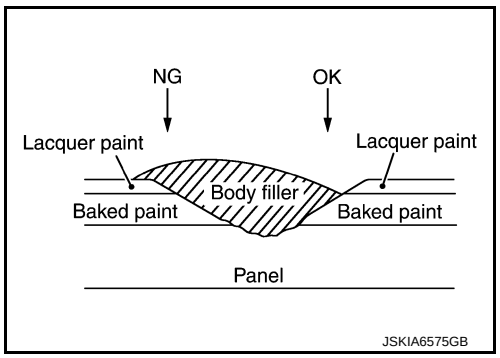
(c) Use the spatula to smooth the applied filler.
Perform finishing work for smoothening the surface. The filler surface should be slightly higher than the panel surface.

c : Less than 30°



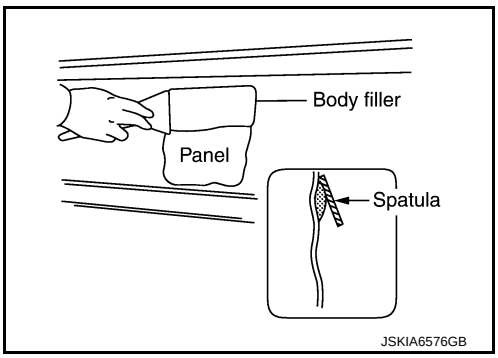
(5) PRECAUTION FOR APPLYING

Be careful not to place body filler over the old lacquer type paint. If this is done, the paint will be softened by the thinner when painting. This causes the body filler to shrink and concave will result.

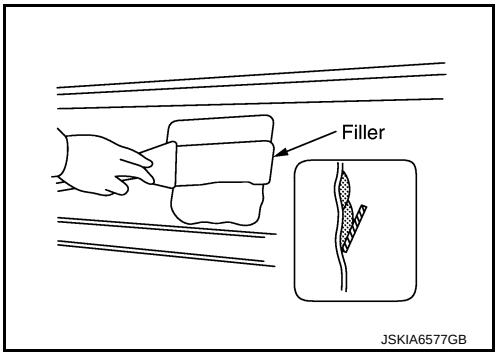


(6) APPLICATION OF BODY FILLER TO FLAT SURFACE

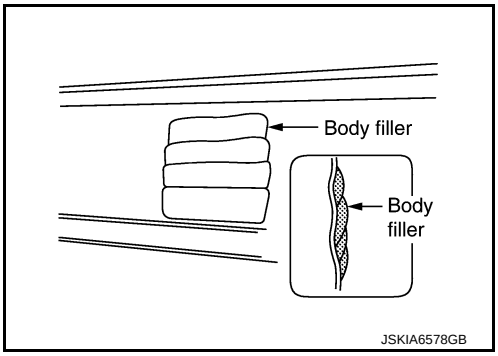
(a) Apply filler so that the corrected surface is flush with the surrounding panel surface.



(b) Apply another layer of filler to overlap 1/3 - 2/3 of the previous application to eliminate the step.

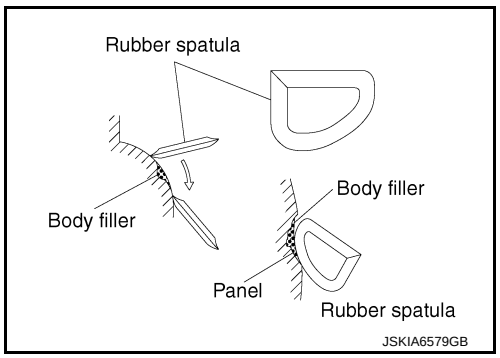


(c) Repeat (b) until the filler is correctly applied to the desired portion.



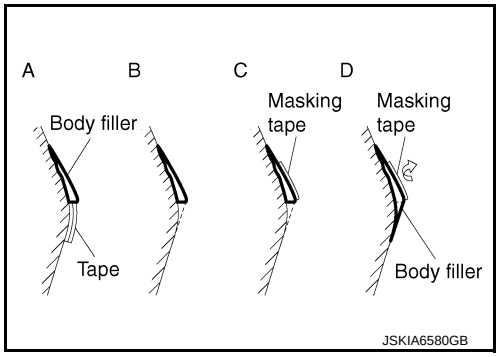
(7) APPLICATION OF BODY FILLER TO CURVED SURFACE

Use of a flexible rubber spatula is recommended for application to curved surfaces.



(8) APPLICATION OF BODY FILLER TO PRESS LINE

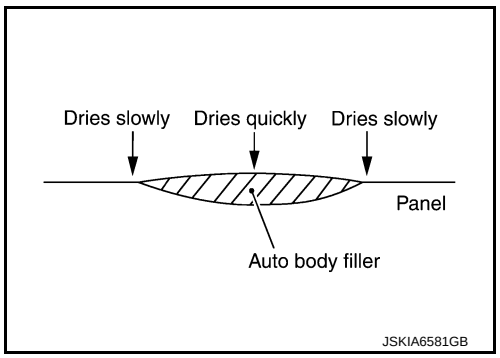
(A) Apply tape along the press line. Then apply filler to only one side of the press line.
(B) Peel the tape from the half-dried filler.
(C) Apply tape along the filled and half-dried filler line.
(D) Apply filler to the other side of the press line.



USE OF BODY FILLER (PUTTY) AND GRINDING : Drying the Body Filler

INFOID:0000000012112352

When the hardener is mixed with the base, the filler begins to harden. Heat is also generated, which accelerates hardening. For this reason, filler drying speed varies with the applied thickness.
If a thick coat of filler is applied, the generated heat remains inside, hence it hardens quickly.
Where the filler is not so thick, it hardens rather slowly because heat dissipates to the outside.



Approximately 10 - 20 minutes (at 20°C or 68°F) after application, the filler becomes hard enough to permit grinding with a surform. When the ambient temperature is low, use a panel heater or adjust the drying time. To check whether the filler is dry or not, press a thin portion with finger. If it is dry, then it is suitable for grinding.

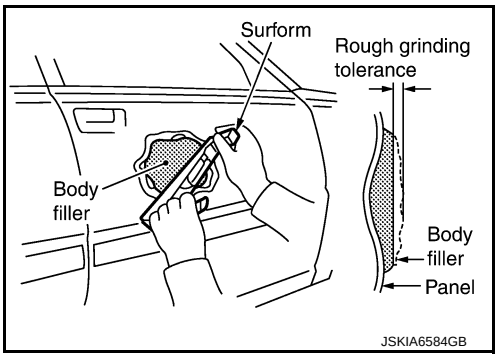
USE OF BODY FILLER (PUTTY) AND GRINDING : Grinding the Filled Area

INFOID:0000000012112350

Grind the filler when it is half-dried. Half-dried filler means the condition where the surface, if ground lightly with a surform, will produce continuous linear chips. Grinding with the surform will be difficult after the filler hardens completely.

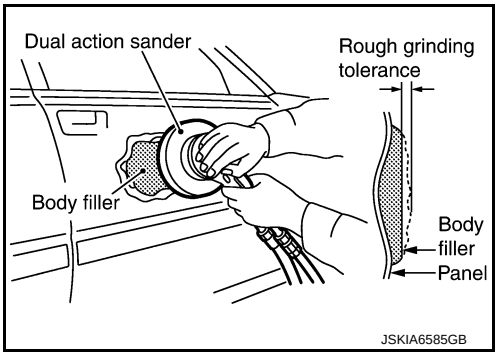
(1) ROUGH GRINDING BY SURFORM

Smooth the filler surface by grinding with the surform or the like. Grind in many different directions. Better results may be obtained if the surform is inclined 30° - 40° with respect to the direction of movement. Be careful not to damage the surrounding panel surface.



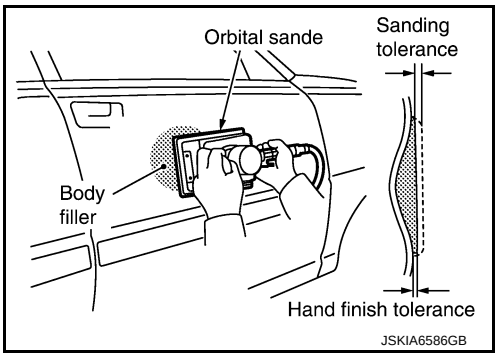
(2) ROUGH GRINGING BY AIR SANDER

Smooth the filler surface by grinding with the dual action sander or orbital sander. Grind in many different directions.
This grinding method is faster than the method using a surform. However, if the worker is not accustomed to performing this type of grinding, an uneven surface may result from excessive grinding. #60 - #80 sandpaper is used.



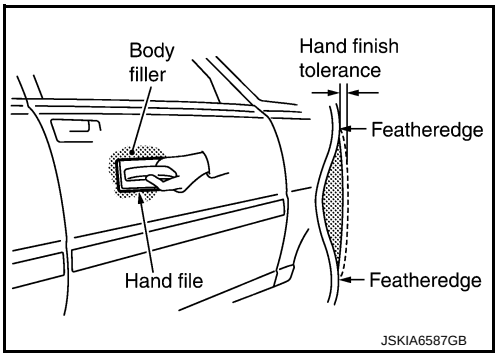
(3) SHAPING THE ENTIRE PANEL

Using an orbital sander or dual action sander, trim the shape of the filled panel. Leave the amount required for final finishing. #120 - #180 sandpaper is used.



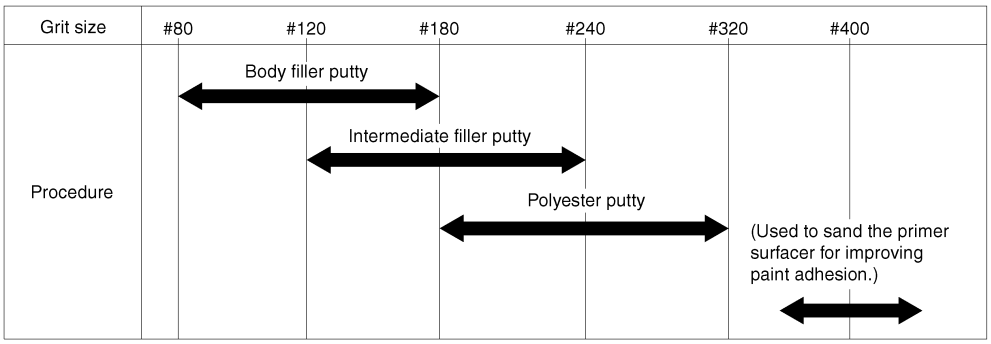
(4) FINAL FINISH BY HAND FILE

Using a hand file, orbital sander or dual action sander, smooth and form featheredge on the filler surface until it is flush with the surrounding panel. #240 - #320 sandpaper is used.



USE OF BODY FILLER (PUTTY) AND GRINDING : Sandpaper Grits

INFOID:0000000012106674



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Select a sandpaper with a grit, appropriate to the putty used. Sanding marks that occur due to sanding are removed with further sanding.

SWITCHING TO A SANDPAPER OF A DIFFERENT GRIT

Sanding marks that occur during sanding are sanded with a sandpaper of the next finer grit. When doing this, do not sand using a sandpaper of a grit two grades or more finer than the previously applied sandpaper.

NG : #80 ⇒ #180 ⇒ #320 ⇒ #400

*: Note that, if sanding with a sandpaper of a grit two grades or more finer than the last one used, removing deep sanding marks that occur during sanding with a coarser sandpaper, as well as removing any remaining deep sanding marks may take longer.

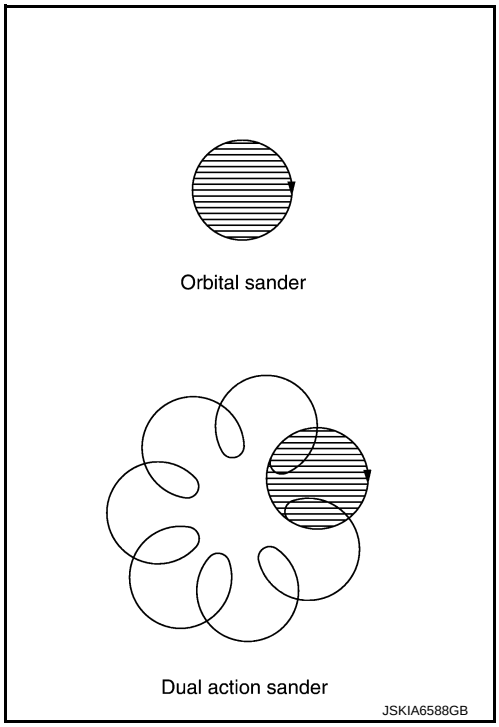
OK : #120 ⇒ #180 ⇒ #240 ⇒ #320 ⇒ #400

USE OF BODY FILLER (PUTTY) AND GRINDING : Grinding Power of Air Sander

INFOID:0000000012112349

The diameter (shown in the figure) of a circle traced by a part of the dual action sander and the orbital sander is called an orbit diameter. The larger the area shown with diagonal lines, the greater the grinding power is.
When surface accuracy is required, a sander with a smaller orbit diameter should be selected. When grinding power is required, a sander with a larger orbit diameter should be selected.

Work content	Orbit diameter
Sanding a body filler	7 mm - 10 mm (0.28 in - 0.39 in)
Sanding a primer surfacer	4 mm - 5 mm (0.16 in - 0.20 in)
Roughing surface before topcoating	3 mm - 4.5 mm (0.118 in - 0.177 in)



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REPAIR OF RUST AND CORROSION

REPAIR OF RUST AND CORROSION : Repair of Rust and Corrosion

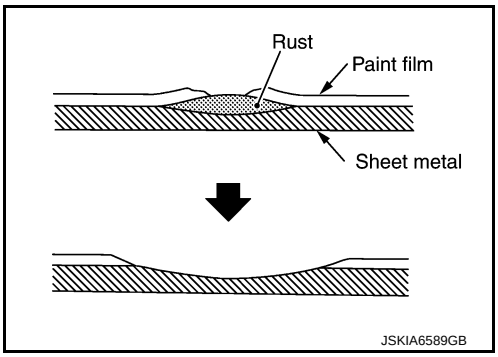
INFOID:0000000012119630

Rust on sheet metal is the result of the chemical reaction of steel to oxygen in the air, which is called oxidation. This rust, if left untreated, will increase and finally corrode and damage the sheet metal. If the vehicle is used for a long time under severe environmental conditions, rust or corrosion may form on body surfaces. When repairing rust and corrosion, it is necessary to keep rust from spreading from the repaired portion.

REPAIR OF RUST AND CORROSION : Removal of Rust Limited to the Skin Panel Surface

INFOID:0000000012112355

Grind the rusted portion with an air sander or the like.
Rust may be more extensive than it appears from the outside. Therefore, it is necessary to grind the area around rusted portion. Repair the ground out portion using body filler.

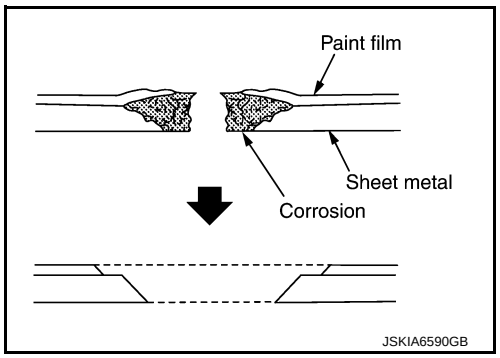


REPAIR OF RUST AND CORROSION : Repair of Corroded Panel

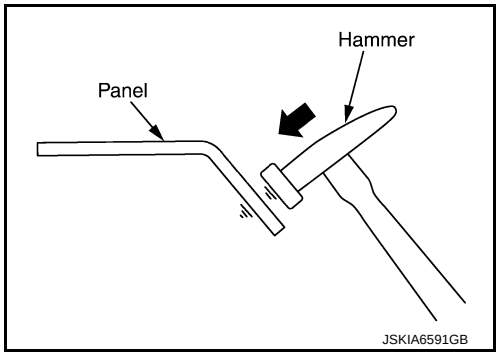
INFOID:0000000012106675

(1) FILLING WITH FIBERGLASS

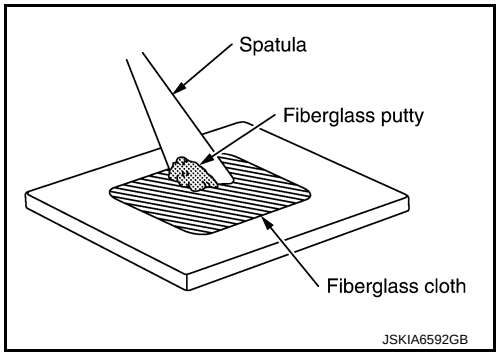
(a) Grind off the corroded portion of the panel with an air sander. If corrosion is severe, cut off the affected portion with a chisel or tinman's shears. Remove the paint from the surrounding areas.



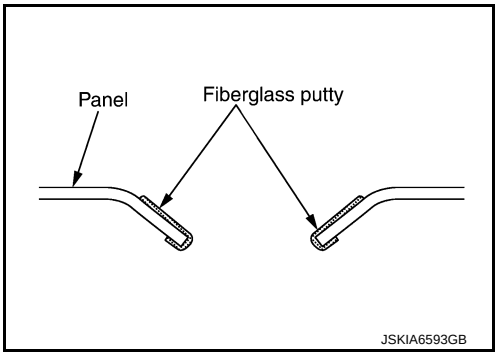
(b) Hollow the area surrounding the repair hole by tapping with a hammer and bending the panel.



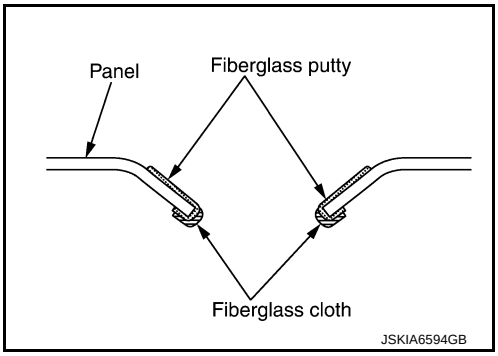
(c) Cut a piece of fiberglass cloth. The cloth should be large enough to overlap the repair hole.
Apply fiberglass putty to the cloth using a spatula until the mesh is filled. Prepare the fiberglass putty by mixing 100 parts of base with 2 to 3 parts of hardener.



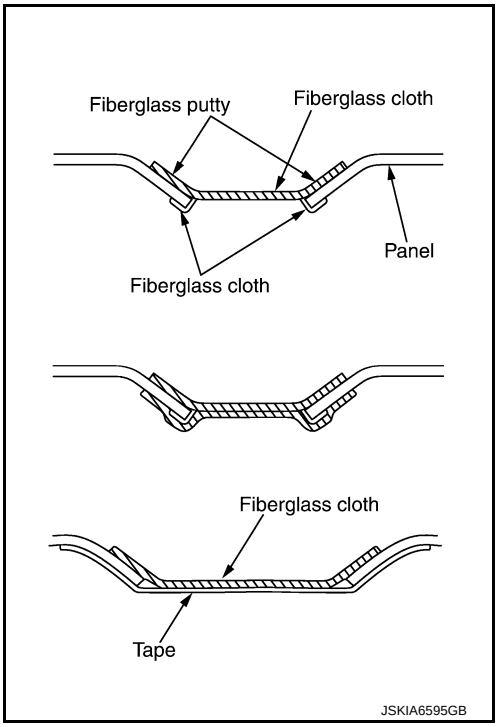
(d) Apply a thin coat of fiberglass putty to the panel where the piece of fiberglass cloth is to be attached.
Apply putty also to the edge and back of the repair hole.



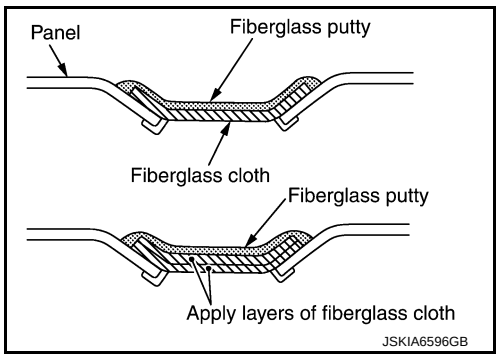
(e) Apply the piece of fiberglass cloth to the surrounding portion and the back of the repair hole.
This is necessary to prevent rust.



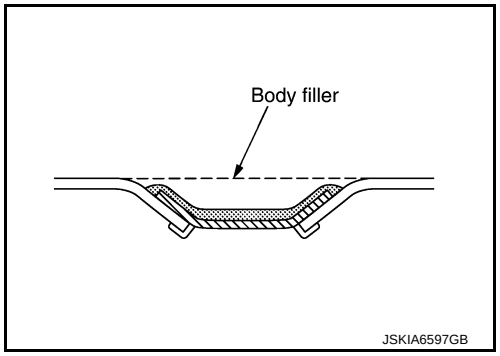
(f) Apply the piece of fiberglass cloth prepared in step (c) above to the repair hole. Press the periphery of the cloth to the panel for better adhesion. If the repair hole is large and the cloth sags in the center, support the cloth with tape applied behind the panel.



(g) Apply the fiberglass putty to the piece of fiberglass cloth. The fiberglass putty surface should be below the surrounding panel surface. If the area to be repaired is deep, use two or more piece of fiberglass cloth. In such a case, avoid thick application of fiberglass putty. Thick fiberglass putty will crack after drying.

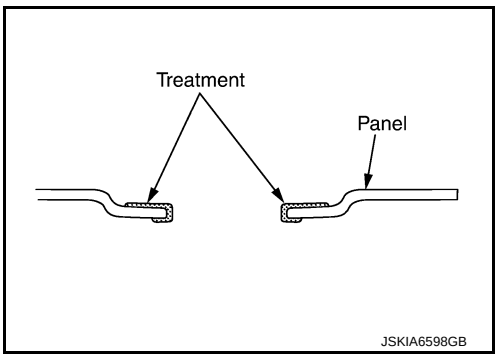


(h) Dry the fiberglass putty, and grind the surface with an air sander. Then trim the entire panel using body filler.
When force drying fiberglass putty, allow the putty to sit for approximately 20 minutes. Then heat at a temperature below 60°C (140°F). Rapid heating which causes the putty to change color must be avoided, as it will lead to cracked putty. Fiberglass putty forms blowholes easily. Body filler must be used to finish the surface of fiberglass putty.

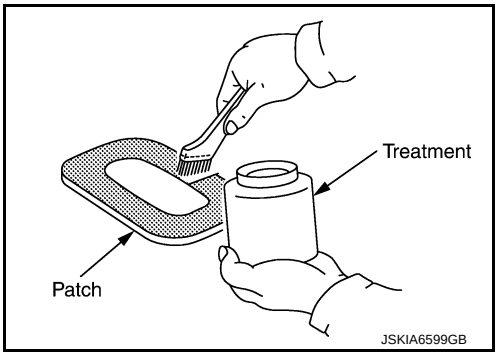


(2) PATCHING

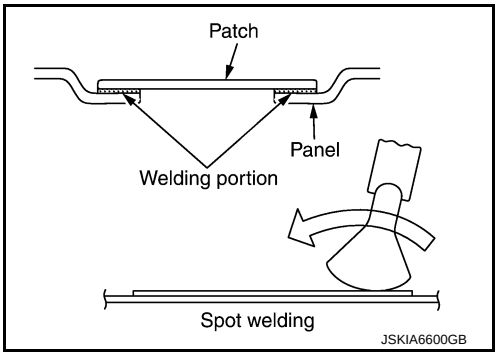
(a) Remove the corroded portion of the panel.
Remove paint from the panel around the repair hole.
Make a flange by bending the surrounding panel with pliers and hammer, then apply anti-corrosive treatment (Metallic solution).



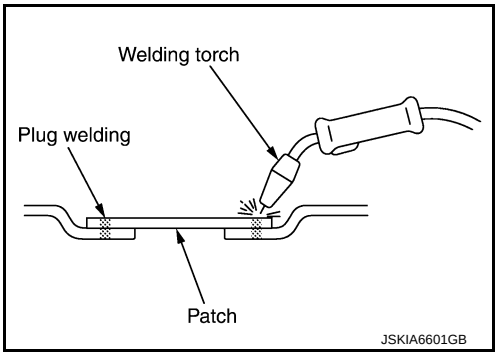
(b) Using tinman's shears, cut a patch large enough to overlap the repair hole. Apply the anti-corrosive treatment to the portion to be welded. Use of stainless steel is recommended to avoid rusting. If the repair hole is large, use a panel having the same thickness as the original panel to retain the original strength.



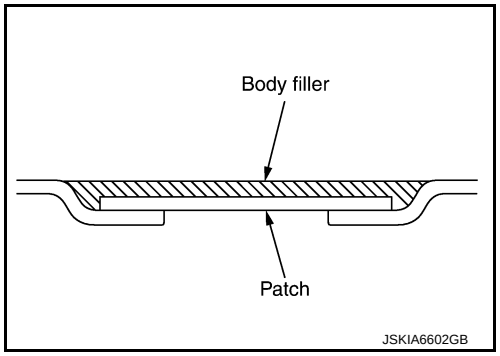
(c) Weld the patch to the repair hole. If stainless steel is used, use the MIG welding or spot welding method.



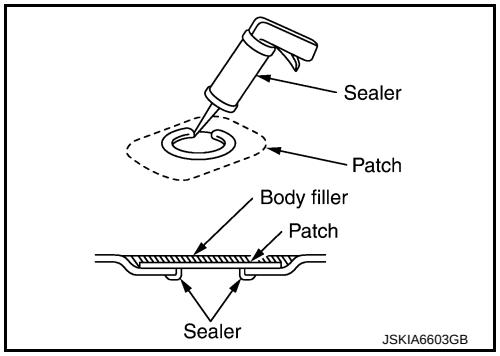
NOTE:
When welding the patch by GSA welding, use the plug welding method.



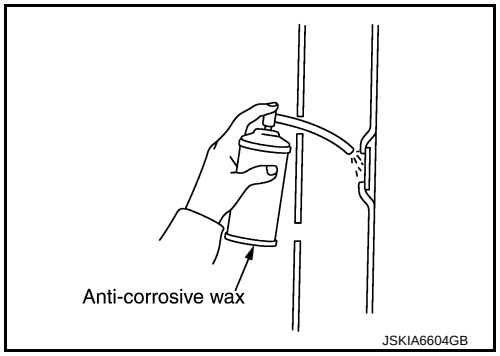
(d) Apply the body filler to the repaired portion of the panel.



(e) Apply the anti-corrosive treatment to the back of the panel. If accessible from behind, apply a sealer to the panel-to-patch mating section.



(f) If inaccessible from behind, apply an anti-corrosive wax from an inner panel opening or the like. It is also important to apply the anti-corrosive treatment to other portions in addition to the repaired portion.



EXAMPLES OF CRUSHED CAR REPAIR

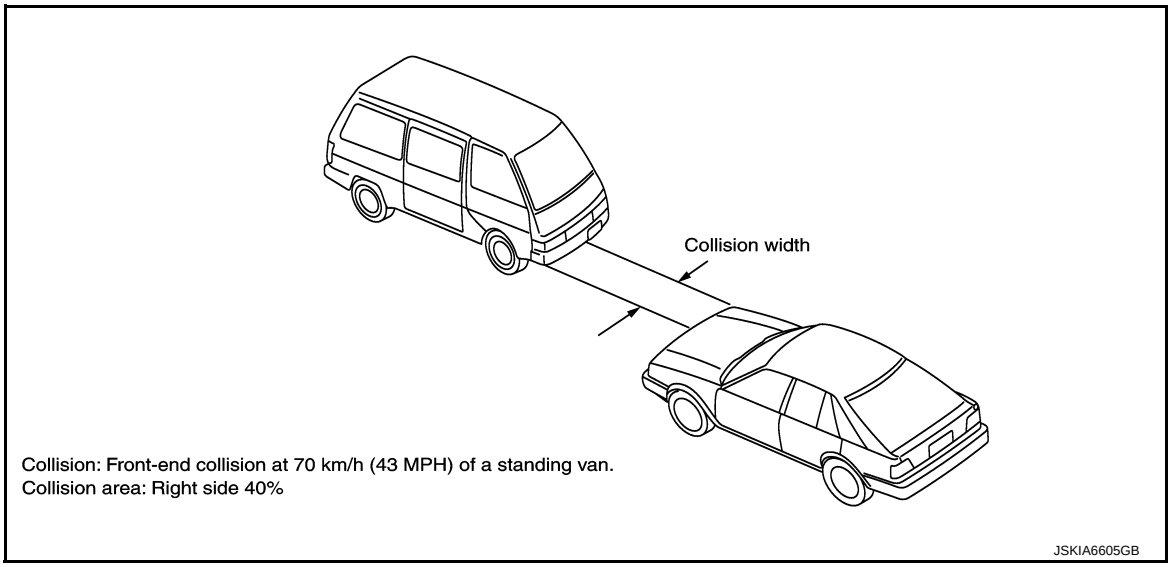
EXAMPLES OF CRUSHED CAR REPAIR : Examples of Crushed Car Repair

INFOID:0000000012119631

This section introduces repair examples up to completion of alignment of basic dimensions of a front-end crushed car using body straightening equipment.

EXAMPLES OF CRUSHED CAR REPAIR : Understanding Collision Conditions

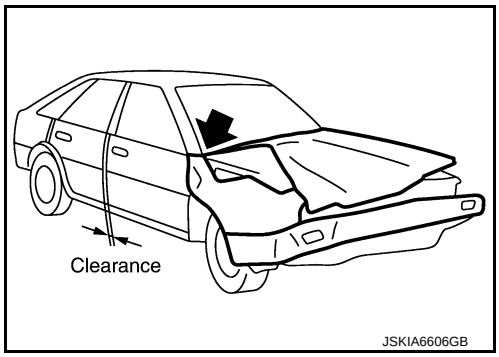
INFOID:0000000012112359



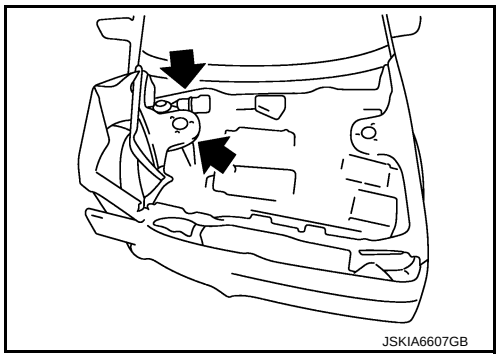
EXAMPLES OF CRUSHED CAR REPAIR : Visual Check of Damage

INFOID:0000000012112358

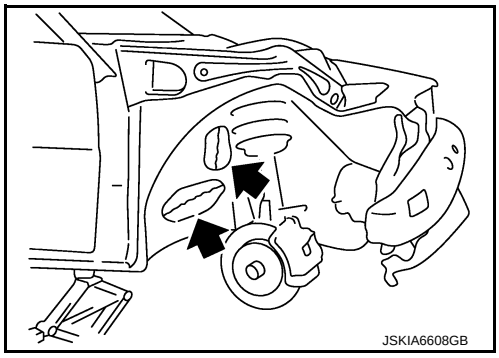
(a) The right front fender, bumper and hood were checked for damage.
The right front pillar was under pressure from a deformed hood hinge. Tire damage was not severe.
Fitting of doors was not damaged. These clearances were correct.



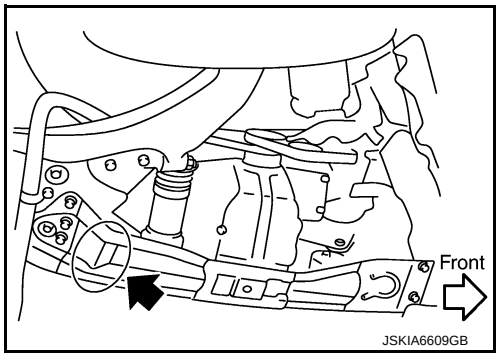
(b) The hood was removed and the engine compartment was checked for damage by looking from above.
The strut tower was deformed. Damage extended to the cowl panel due to pressure on the wiper motor.



(c) The hood, right front fender, and right front tire were removed. The hoodledge and right front side member were checked.
Cracks in the undercoating and sealant indicate that the damage extends to the dash panel.



(d) The car was raised on a single pole lift, and the underbody was checked.
The center member was bent backward. This indicates that impact was propagated to the lower dash crossmember.



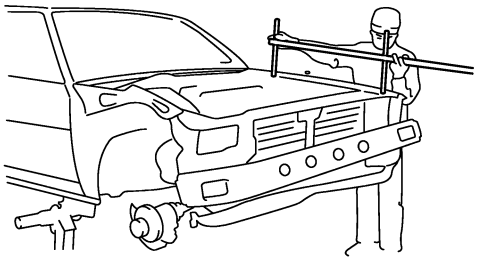
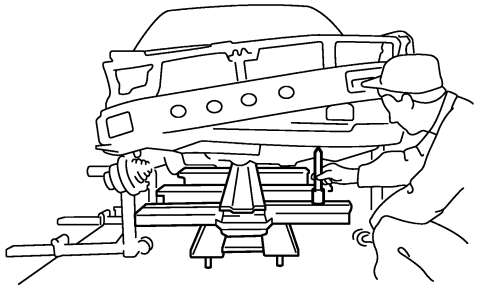
EXAMPLES OF CRUSHED CAR REPAIR : Determining Damage Using Measuring Equipment

INFOID:0000000012112357

To determine the repair method and provide efficient control of parts ordering, the parts were classified into two groups of panel components and functional parts.

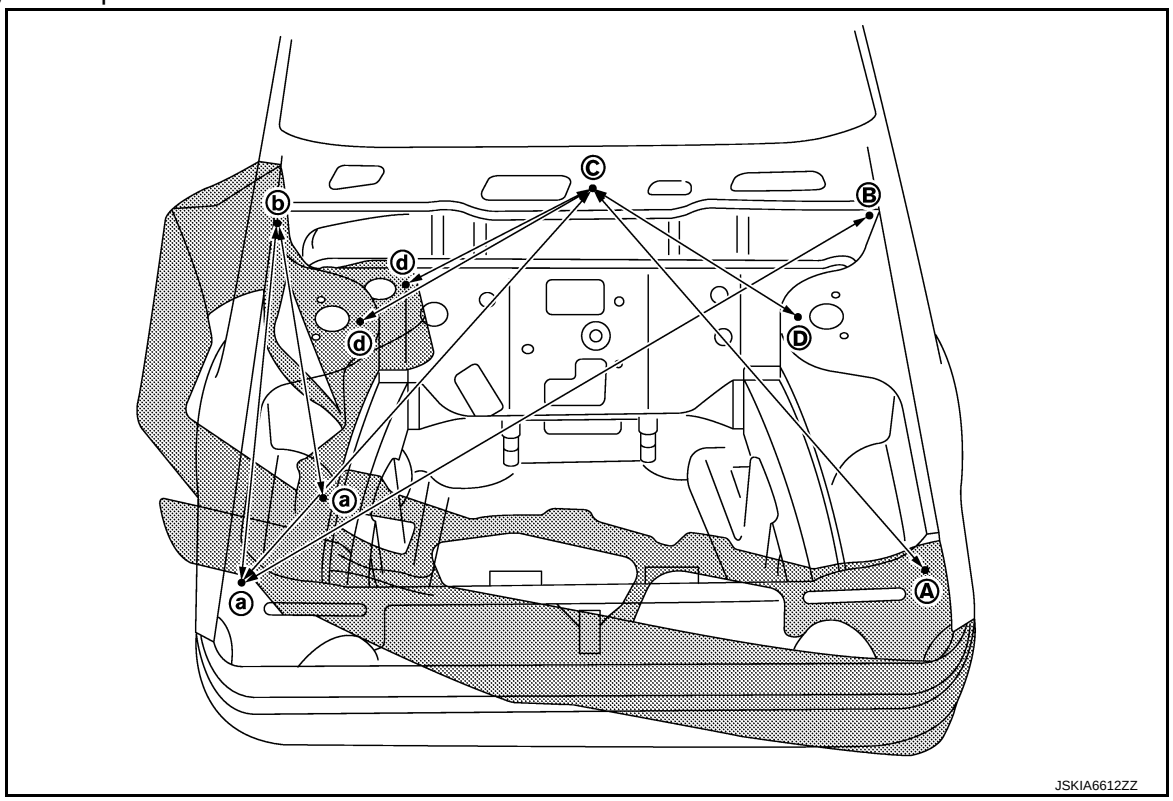
(1) MEASUREMENTS WERE MADE ACCORDING TO DIMENSIONAL DRAWING DATA.

A convex rule (steel tape) and tram tracking gauge were used to measure the engine compartment and body side dimensions. The universal measuring equipment was used for three-dimensional measurement of the underbody. Measurements will be shown in the Body Repair Manual for each model.

Measurement of engine compartment with tram tracking gauge	Measurement of underbody using universal measuring equipment
 JSKIA6610ZZ	 JSKIA6611ZZ

(2) MEASUREMENT RESULTS

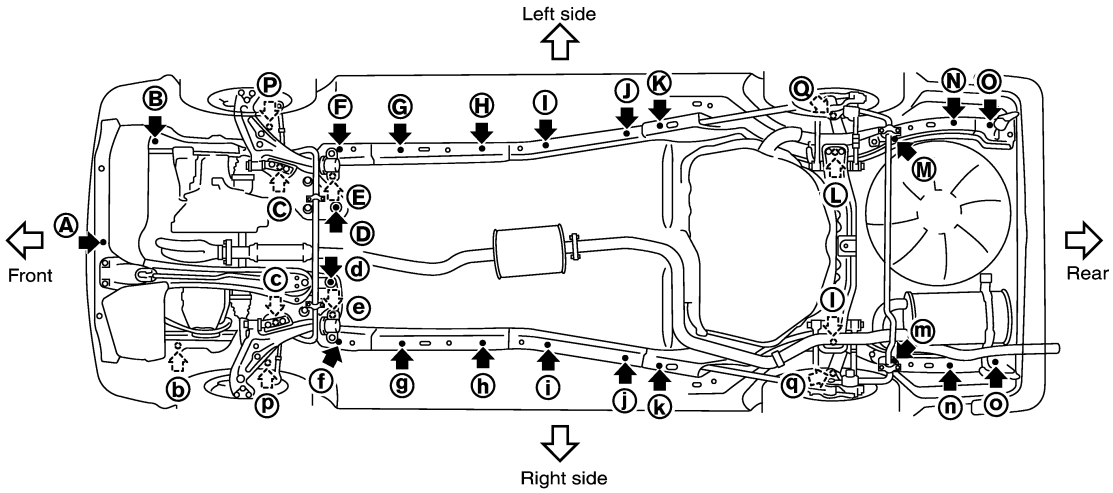
(a) Engine compartment



Unit: mm (in)

Measurement pitch	Basic dimension (1)	Dimension before repair (2)	Displacement (1) - (2)	Dimension after repair (3)	Difference (1) - (3)
(a) - (b)	881 (34.68)	658 (25.91)	223 (8.78)	880 (34.65)	1 (0.04)
(A) - (B)	881 (34.68)	878 (34.57)	3 (0.12)	881 (34.68)	0 (0)
(a) - (B)	1,572 (61.89)	1,431 (56.34)	141 (5.55)	1,573 (61.93)	-1 (-0.04)
(A) - (b)	1,572 (61.89)	1,568 (61.73)	4 (0.16)	1,573 (61.93)	-1 (-0.04)
(a) - (C)	1,119 (44.06)	920 (36.22)	199 (7.83)	1,119 (44.06)	0 (0)
(A) - (C)	1,119 (44.06)	1,110 (43.70)	9 (0.35)	1,119 (44.06)	0 (0)
(a) - (d)	623 (24.53)	502 (19.76)	121 (4.76)	624 (24.57)	-1 (-0.04)
(A) - (D)	623 (24.53)	612 (24.09)	11 (0.43)	625 (24.61)	-2 (-0.08)
(b) - (d)	347 (13.66)	310 (12.20)	37 (1.46)	346 (13.62)	1 (0.04)
(B) - (D)	347 (13.66)	347 (13.66)	0 (0)	346 (13.62)	1 (0.04)
(b) - (B)	1,338 (52.68)	1,328 (52.28)	10 (0.39)	1,338 (52.68)	0 (0)
(d) - (D)	933 (36.73)	880 (34.65)	53 (2.09)	932 (36.69)	1 (0.04)
(A) - (a)	1,267 (49.88)	1,255 (49.41)	12 (0.47)	1,267 (49.88)	0 (0)

(b) Underbody (Three-dimensional dimensions)



1. This figure shows the bottom view of vehicle.
2. X-dimension: Left-to-right direction of vehicle from the center of vehicle from the center of vehicle
   Y-dimension: Front-to-back direction of vehicle from (G) (g) point
   Z-dimension: Height
3. The reference point of measurement is at (G), (g) point.
4. Universal measuring equipment is used.

Unit: mm (in)

Measure-ment point	Basic dimensions (1)			Dimension before repair (2)			Displacement (1) - (2)		
	X	Y	Z	X	Y	Z	X	Y	Z
(B)	498 (19.61)	1,170 (46.06)	333 (13.11)	494 (19.45)	1,168 (45.98)	338 (13.31)	4* (0.16)	2 (0.08)	-5* (-0.20)
(b)	500 (19.69)	1,170 (46.06)	350 (13.78)	492 (19.37)	1,036 (40.79)	355 (13.98)	8* (0.31)	134* (5.28)	-5* (-0.20)
(P)	526 (20.71)	723 (28.46)	874 (34.41)	—	—	—	—	—	—
(p)	526 (20.71)	723 (28.46)	874 (34.41)	—	—	—	—	—	—
(C)	347 (13.66)	557 (21.93)	125 (4.92)	350 (13.78)	558 (21.97)	134 (5.28)	-3 (-0.12)	-1 (-0.04)	-9* (-0.35)
(c)	347 (13.66)	557 (21.93)	125 (4.92)	348 (13.70)	557 (21.93)	178 (7.01)	-1 (-0.04)	0 (0)	-53* (-2.09)
(G)	415 (16.34)	0 (0)	80 (3.15)	415 (16.34)	0 (0)	80 (3.15)	0 (0)	0 (0)	0 (0)
(g)	415 (16.34)	0 (0)	80 (3.15)	415 (16.34)	0 (0)	80 (3.15)	0 (0)	0 (0)	0 (0)
(J)	488 (19.21)	962 (37.87)	81 (3.19)	488 (19.21)	960 (37.80)	81 (3.19)	0 (0)	2 (0.08)	0 (0)
(j)	488 (19.21)	962 (37.87)	81 (3.19)	488 (19.21)	961 (37.83)	81 (3.19)	0 (0)	1 (0.04)	0 (0)
(M)	519 (20.43)	2,127 (83.74)	255 (10.04)	520 (20.47)	2,125 (83.66)	254 (10.00)	-1 (-0.04)	2 (0.08)	1 (0.04)
(m)	550 (21.65)	2,127 (83.74)	260 (10.24)	550 (21.65)	2,126 (83.70)	260 (10.24)	0 (0)	1 (0.04)	0 (0)
(O)	573 (22.56)	2,581 (101.61)	261 (10.28)	574 (22.60)	2,579 (101.54)	260 (10.24)	-1 (-0.04)	2 (0.08)	1 (0.04)
(o)	573 (22.56)	2.581 (101.61)	262 (10.31)	575 (22.64)	2,579 (101.54)	264 (10.39)	-2 (-0.08)	2 (0.08)	-2 (-0.08)

Measure-ment point	Basic dimensions (1)			Dimension before repair (2)			Displacement (1) - (2)		
	X	Y	Z	X	Y	Z	X	Y	Z
(A)	337 (13.27)	1,375 (54.13)	187 (7.36)	313 (12.32)	1,378 (54.25)	218 (8.58)	24* (0.94)	-3 (-0.12)	-31* (-1.22)
(a)	344 (13.54)	1,378 (54.25)	188 (7.40)	342 (13.46)	1,278 (50.31)	167 (6.57)	2 (0.08)	100* (3.94)	21* (0.83)

*: Measurement portions where deformation was large.

EXAMPLES OF CRUSHED CAR REPAIR : Determining Repair Method

INFOID:0000000012112356

Since the impact force was not fully absorbed by the front side member, and it extended to the lower dash and front pillar, replacement of many parts was necessary.
Service parts and supply units are listed in the parts catalog published for each model. Order necessary damaged parts from the service parts catalog. (For example, for radiator core support there are side, lower and upper radiator core supports in addition to the assembly.)

(1) PANELS TO BE REPLACED:

Hood, right front fender, radiator core support, right hoodledge, right hoodledge reinforcement, right front side member, right front side member closing plate, etc..

(2) PARTS TO REPLACED:

Front bumper, radiator grille, headlamps, front combination lamps, radiator, air conditioner condenser, fan motor, wiper motor, alternator, etc..

(3) PANELS WHICH MUST BE REPAIRED ARE AS FOLLOWS:

Left front side member, left front side member closing plate, left front fender, left hoodledge reinforcement, air box, lower dash, and lower dash crossmember.

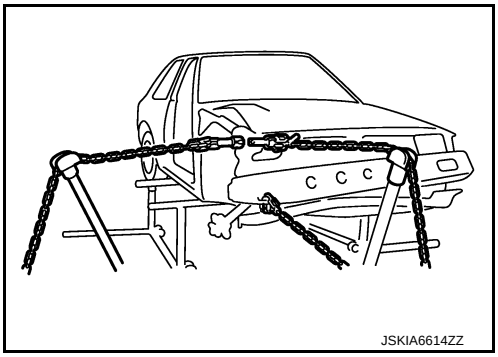
EXAMPLES OF CRUSHED CAR REPAIR : Alignment of Basic Dimensions

INFOID:0000000012106676

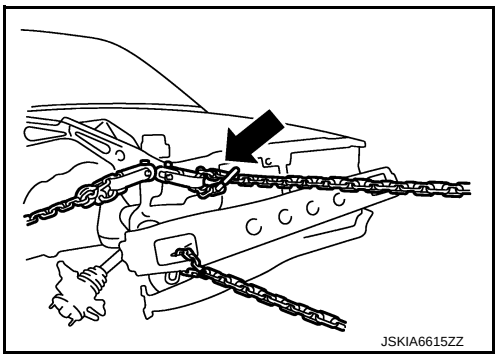
(1) PULLING WORK FOR REMOVAL OF FUNCTIONAL PARTS

The damaged body must be pulled somewhat to permit removal of engine and other components.

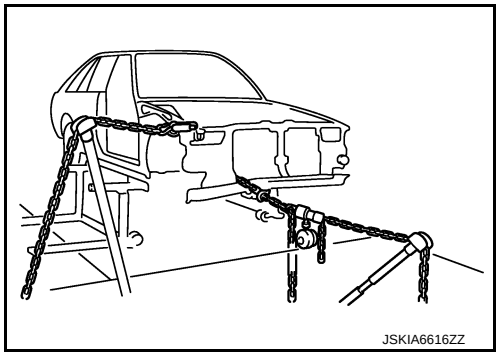
(a) The bumper reinforcement and upper portion of the radiator core support are clamped, and the body is pulled in multiple directions simultaneously.



(b) This figure shows how each clamp is attached. A chain hook should not be used when the angle is acute.



(c) The bumper reinforcement is removed, and the lower radiator core support is clamped.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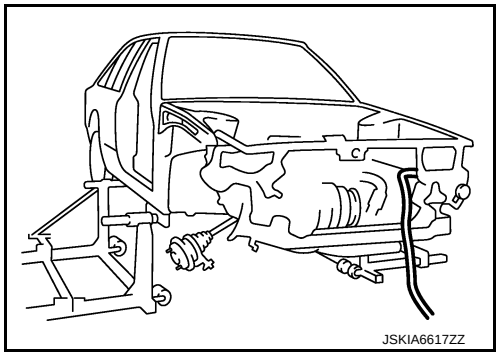
(d) The radiator, condenser, and main harness are removed.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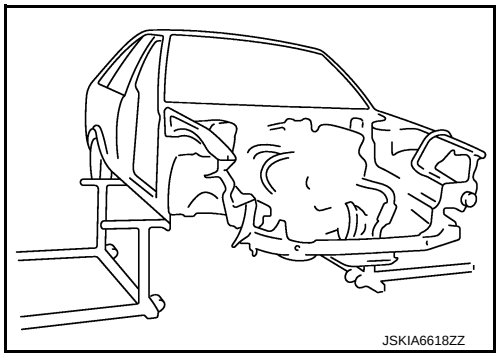
(2) REMOVAL OF ENGINE ASSEMBLY, FUNCTIONAL PARTS

(a) The upper and right side radiator core supports are cut off so that the engine can be removed easily.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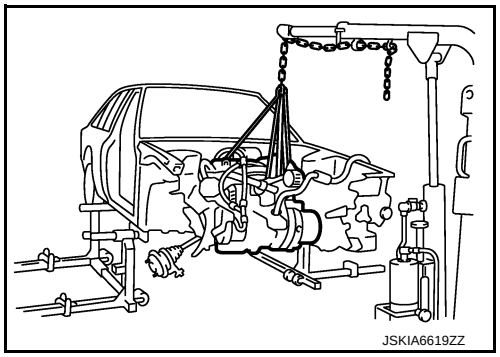
(b) The lower radiator core support is also removed.
The engine assembly is removed together with the drive shaft.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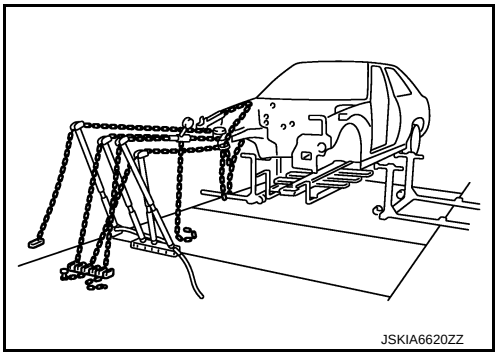
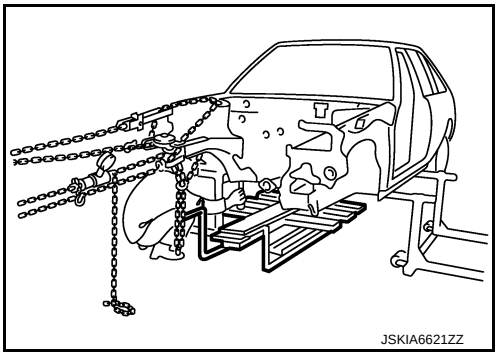
(3) ALIGNING OF BASIC DIMENSIONS

(a) Two points on the hoodledge and two points on the front side member are pulled in multiple directions simultaneously.


JSKIA6620ZZ

(b) The underbody dimensions are checked using the universal measuring equipment.
Pulling is performed carefully. Do not pull excessively.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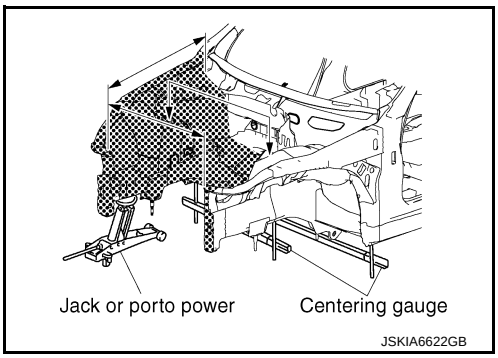
(4) INSTALLING NEW PARTS

Install the new right front side member, right hoodledge, and radiator core support with vise grip clamps. Measure the dimensions with tram tracking gauge and check the deformation with centering gauge. After temporarily tack welding, check the fitting of the hood and fender.



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FRAME REPAIR

GENERAL INFORMATION

GENERAL INFORMATION : General Information

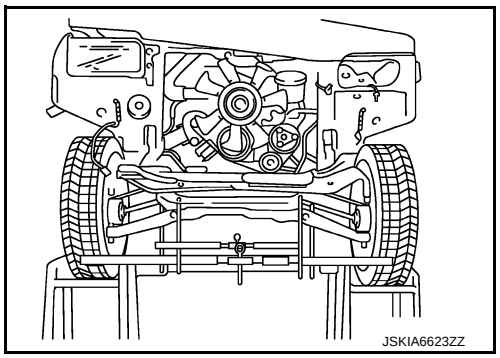
INFOID:0000000012123707

When repairing a damaged frame, pay special attention to the following contents.

GENERAL INFORMATION : Checking Damage

INFOID:0000000012123706

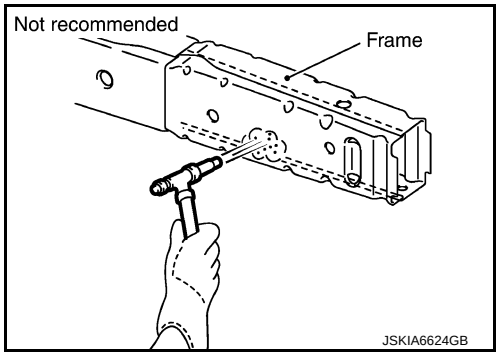
The most important point in damaged frame repair is to accurately identify the deformation status of a damaged frame by using an appropriate measurement method.
This manual describes appropriate measurement methods for various types of frame deformation, which must be referenced as a guideline for accurate measurement.



GENERAL INFORMATION : Repair by Heating

INFOID:0000000012123705

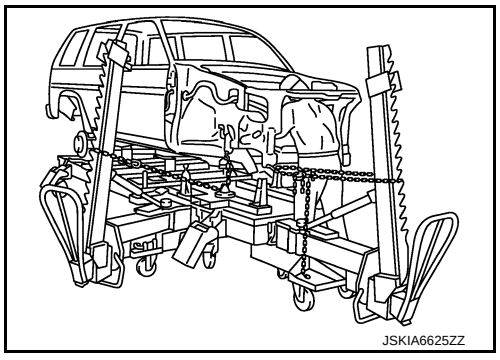
The repair of a damaged frame by heating is not recommended since it may weaken the component. When heating is unavoidable, do not heat HSS parts above 550°C (1,022°F). Verify heating temperature with a thermometer. (Crayon type and other similar type thermometers are appropriate.)



GENERAL INFORMATION : Frame Securing Method

INFOID:0000000012123704

To straighten a damaged frame, the frame must be anchored securely. This manual describes examples of appropriate frame anchoring for each type of straightening equipment as well as additional anchoring for each type of damage, which must be referenced as a guideline for secure frame anchoring.



GENERAL INFORMATION : Safety and Health

INFOID:0000000012123703

Consideration for workers' safety and health should be deemed as the most important item. In reality, it is essential that measures be established to prevent accidents and to make the work environment safer and healthier.
When performing a frame repair work, always observe the instructions described in the section “SAFETY AND HEALTH”. Refer to BRM-119, "PRECAUTIONS FOR OPERATION : Precautions for Operation".

GENERAL INFORMATION : Elimination of Residual Stress

INFOID:0000000012123702

When repairing a deformed frame, elimination of any residual stress should be given higher priority.
This manual describes the method for eliminating any residual stress, which must be referenced as a guideline for elimination of residual stress.

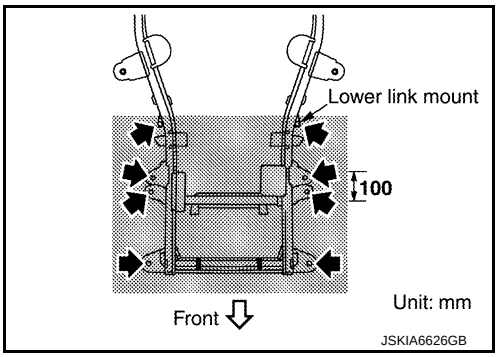
GENERAL INFORMATION : Repairable Frame Damages

INFOID:0000000012123701

In general, the following types and degrees of frame damages are considered repairable though the repairability may differ depending on the capacity of the frame straightening equipment in use.

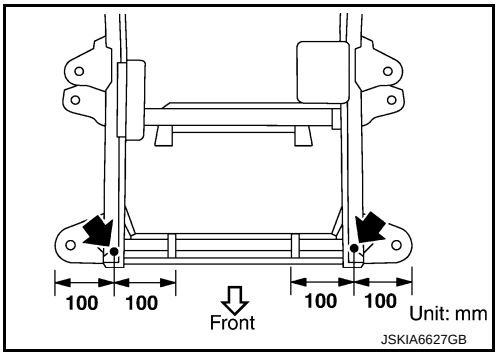
(1) LONGITUDINAL DEFORMATION

Deformation located ahead of the lower link mount, the length of which is 100 mm (3.94 in) or less in the longitudinal direction.



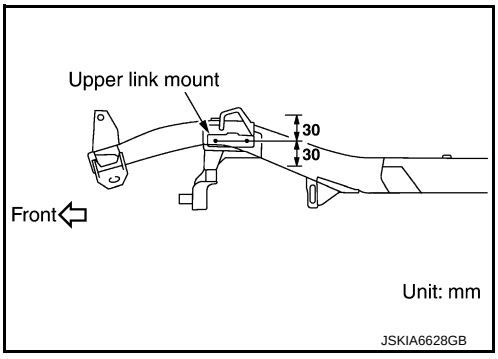
(2) SIDE-SWAY DEFORMATION

Deformation at the end of the frame that sways either leftward or rightward from the vehicle body centerline up to 100 mm (3.94 in) in length.



(3) DEFORMATION IN HEIGHT LENGTH

Deformation at the upper link mount that sways either upward or downward up to 30 mm (1.18 in).



(4) FRAME PARTIAL REPLACEMENT

If some portion in a repairable frame deformation is difficult to restore due to work hardening caused by the deformation, such a portion can be repaired by performing butt joint weld at the point specified in the Service Manual and/or the Body Repair Manual. Do not perform a butt joint weld at any points other than those specified in the Service Manual and/or the Body Repair Manual.

(5) FRAME ASSEMBLY REPLACEMENT

If the damage exceeds the repairable limits specified above, replace the frame assembly.

FRAME VEHICLE CONSTRUCTION

FRAME VEHICLE CONSTRUCTION : Frame Vehicle Construction

INFOID:0000000012123710

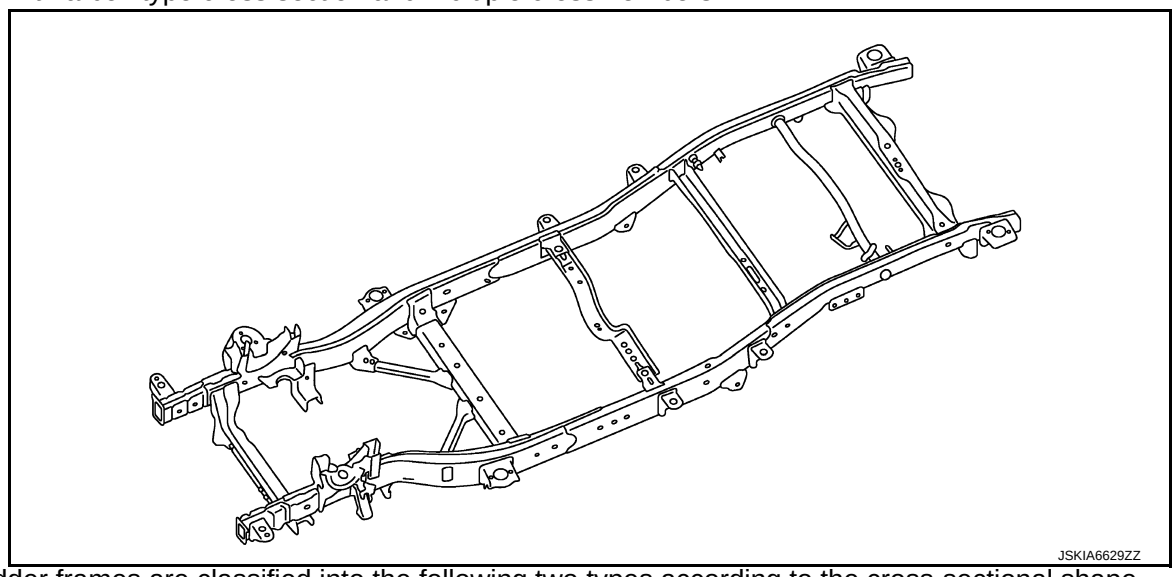
(1) FEATURES OF FRAME TYPE VEHICLE

The body is bolted to the frame via rubber bushings. Unlike uni-bodies, the suspensions and power train units are assembled to independent frames. The frames support the weights of these components and absorb any incoming impact from outside, providing a structure that prevents any vibrations and impacts from being transmitted to the body.

The frames are categorized into some types by their shapes (ladder type, backbone type, perimeter type, pipe type). Of these, the ladder type frame often used in SUVs and pickups is described below.

(2) LADDER TYPE

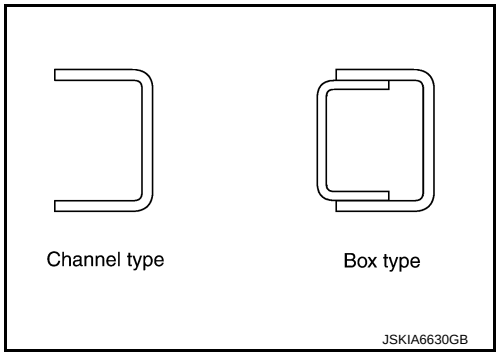
The basic configuration of a ladder frame is shown in the figure. A ladder frame is composed of two side frames with a box type cross section and multiple crossmembers.



The ladder frames are classified into the following two types according to the cross-sectional shape.

(a) Channel type
- Easy to manufacture compared to closed cross section type
- Easier unit installation
- The torsional rigidity is lower than the closed cross section type
- Used for heavy to medium duty trucks

(b) Closed box type
- Higher torsional rigidity due to closed cross section
- Higher cost than channel type
- Used for small trucks such as SUVs and pickups

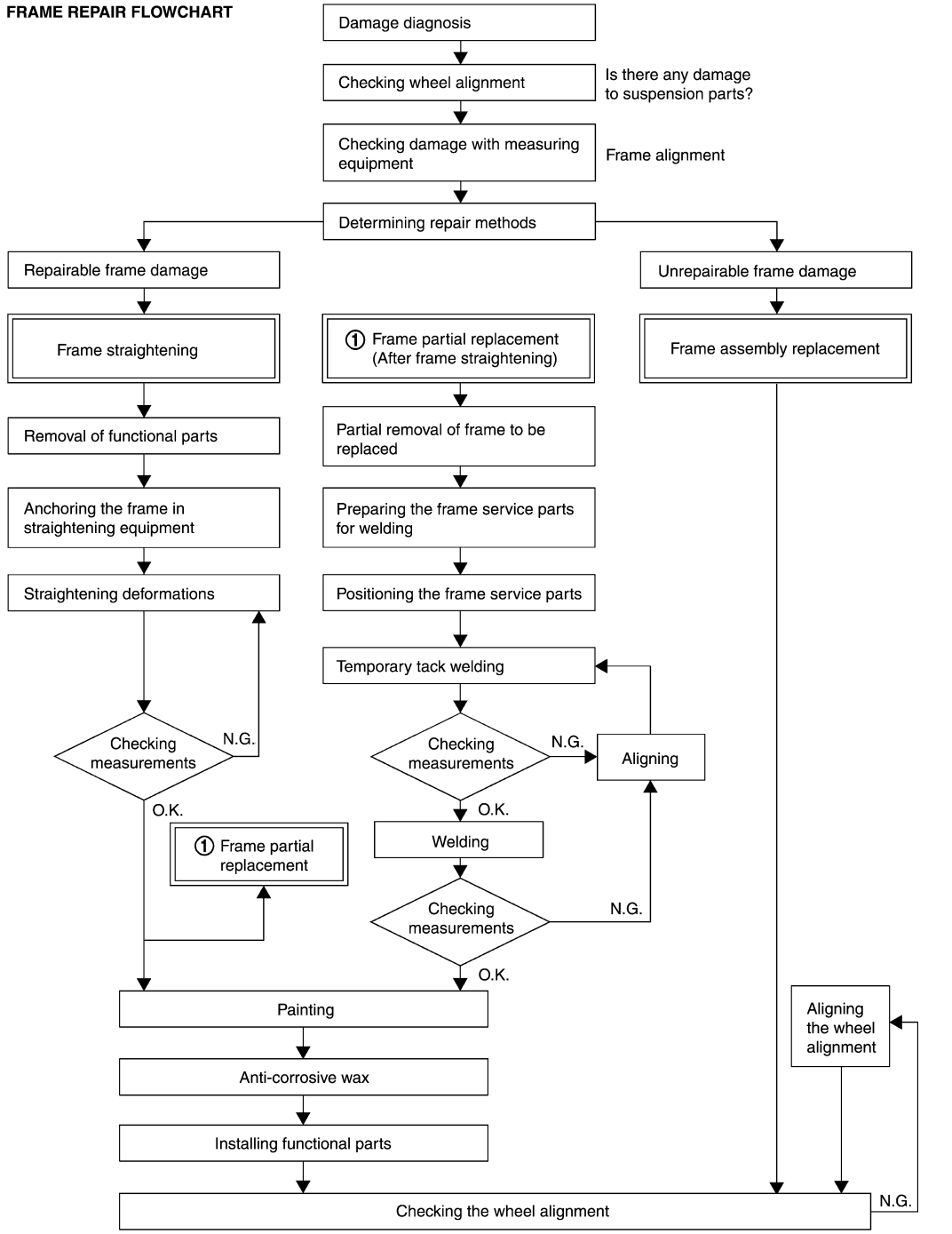


FRAME VEHICLE CONSTRUCTION : Frame Repair Procedure

INFOID:0000000012106683

In general, a task to repair a frame damaged by a traffic accident (straightening and entire or partial replacement) is performed according to the following procedure.

FRAME REPAIR FLOWCHART



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FRAME DEFORMATION

FRAME DEFORMATION : Frame Deformation

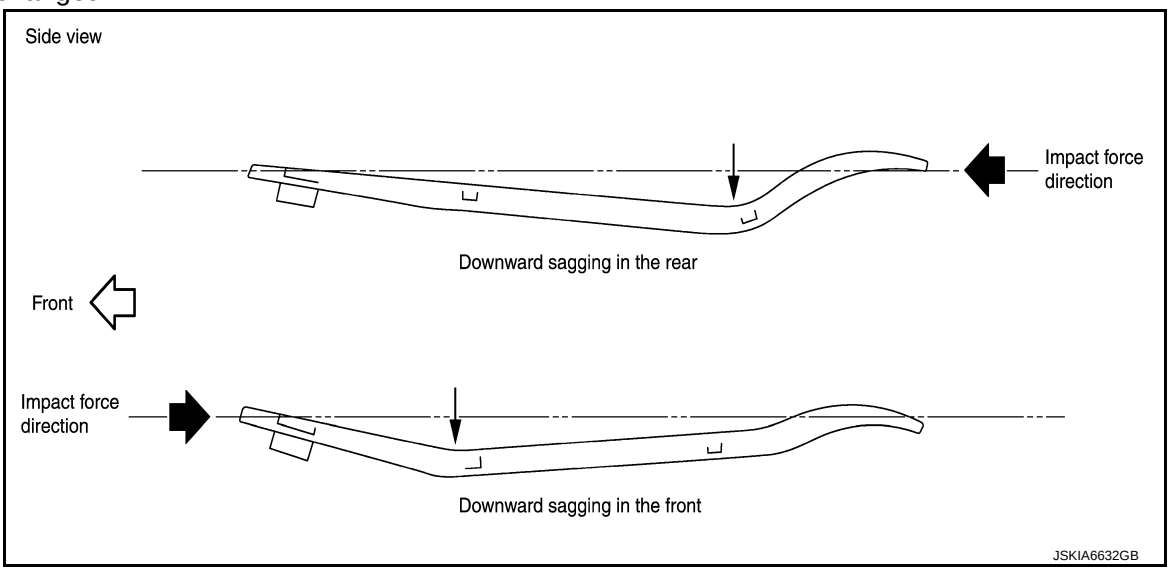
INFOID:0000000012125056

In a frame type vehicle, an independent body and frame are joined at the body mount points. Therefore, when the vehicle suffers impact from the front or rear in a collision, most of the impact is absorbed by deformation of the frame and deformation in the body is minimized. Another point different from the uni-body is that the frame and the body can be repaired separately.
Basically, frame deformations are classified into the following types.

FRAME DEFORMATION : Sagging

INFOID:0000000012123714

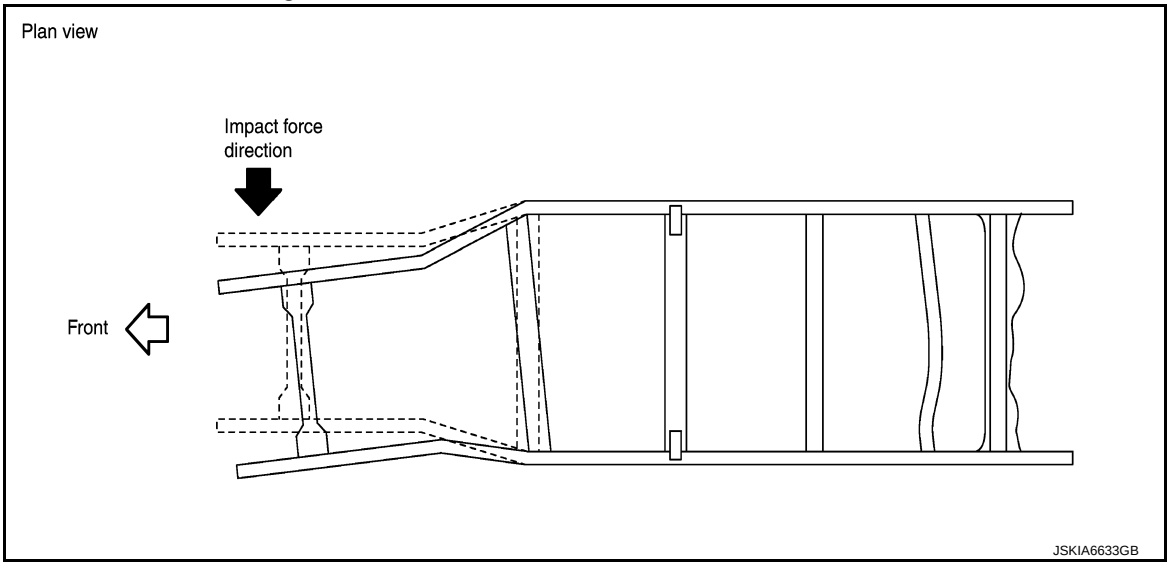
This refers to upward or downward bending of a side frame due to strong impact from the front or rear that occurs when the vehicle receives a rear-end collision or performs sudden braking with an excessive load. In the body alignment dimensions, the height dimensions and diagonal dimensions at each measurement point will be changed.



FRAME DEFORMATION : Side-sway

INFOID:0000000012123713

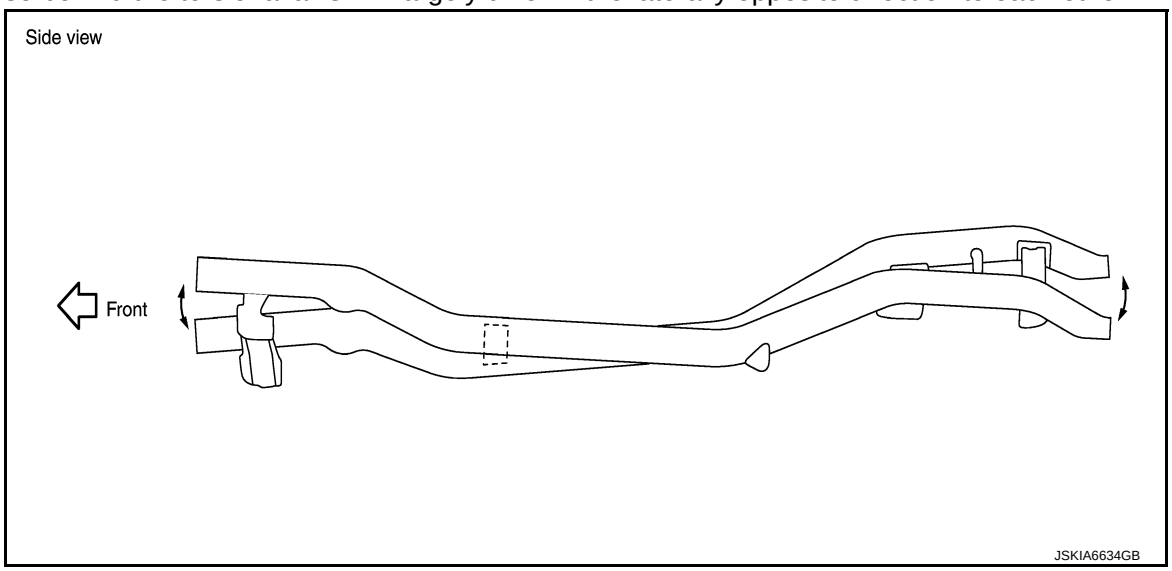
This refers to deviation of the frame centerline due to left or right sway of side frames at the bases of cross-members, which is caused by a large sidewise impact during a collision. In the body alignment dimensions, sidewise differences in the diagonal dimensions will occur.



FRAME DEFORMATION : Twisting

INFOID:0000000012123712

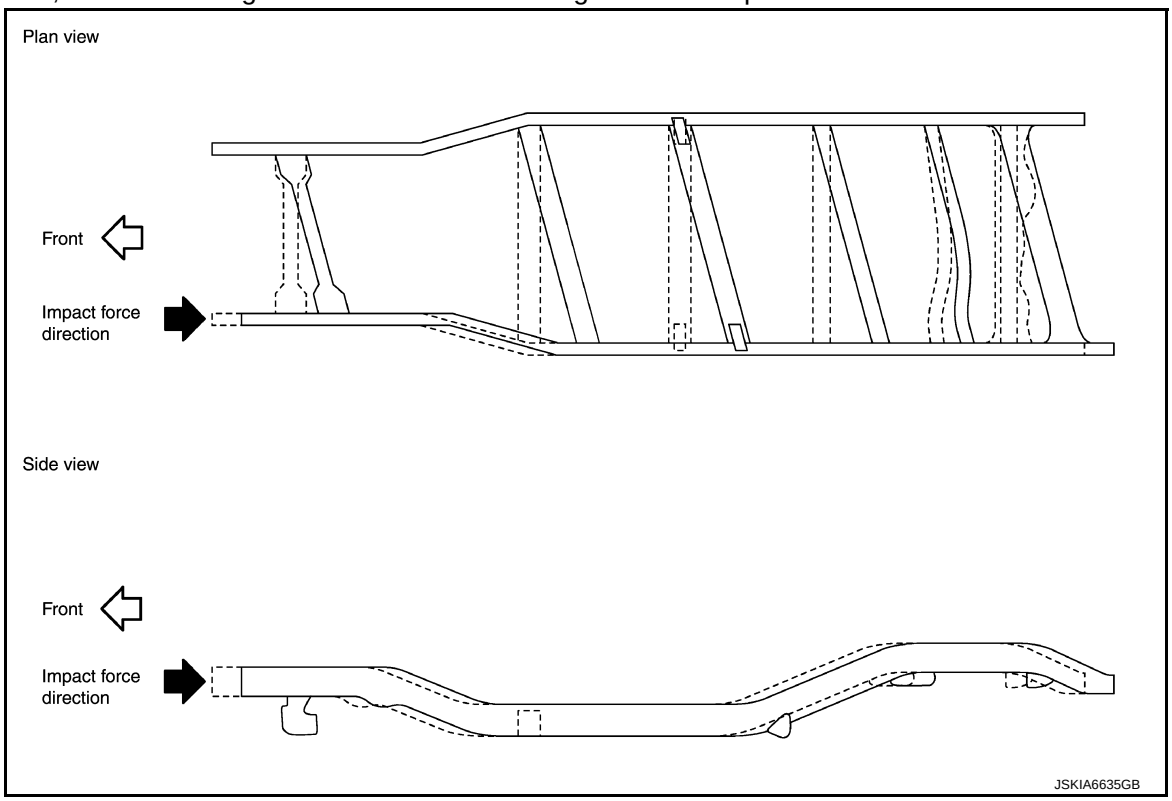
This refers to deformation of side frame-to-crossmember joints due to rollover caused by a collision accident. The right and left frames/members are twisted in the axially opposite direction to each other. In the body alignment dimensions, the height values of the side frame measurement points located ahead of the torsional axis and those behind the torsional axis will largely differ in the laterally opposite direction to each other.



FRAME DEFORMATION : Diamond

INFOID:0000000012123711

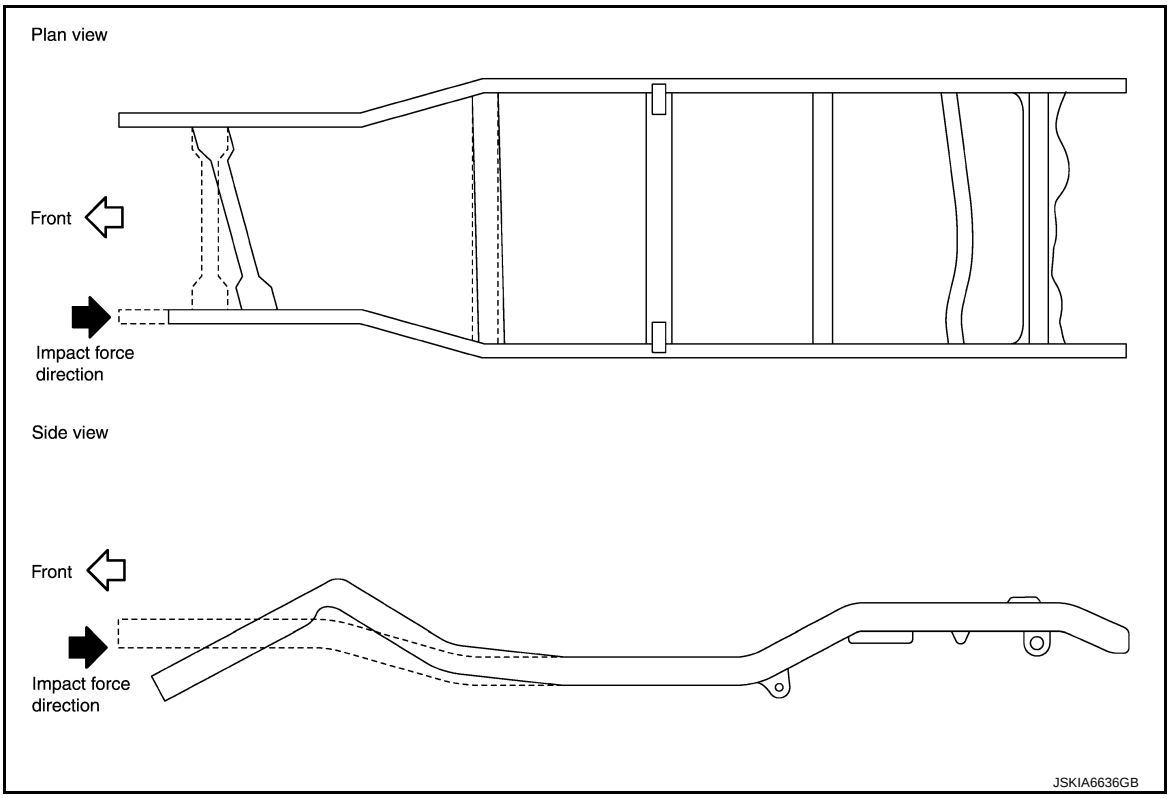
This refers to deformation at the bases of crossmembers due to a parallelism difference between the left and right frames, which is caused by a longitudinal impact upon either frame during a collision. Generally, this results in a typical diamond deformation where the frames are kept almost straight. However, if the side frames have curved structures, the frames often suffer sagging and side-sway as well. In the body alignment dimensions, the overall diagonal dimensions will change due to the parallelism difference.



FRAME DEFORMATION : Buckling

INFOID:0000000012106684

This refers to compound sagging where the side frames are crushed and crimped resulting in shortened length. It often occurs at the front end of a frame.



FRAME DEFORMATION MEASURING METHOD

FRAME DEFORMATION MEASURING METHOD : Frame Deformation Measuring Method

INFOID:0000000012125057

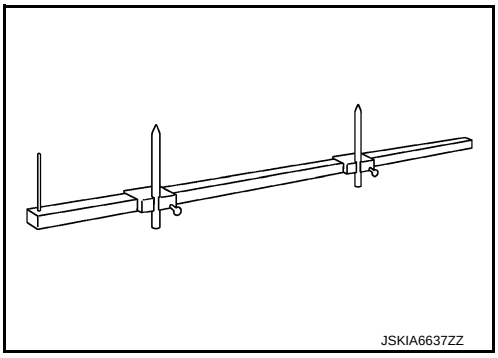
There are several methods available for measuring frame deformations, which must be selected appropriately according to the type of the straightening equipment in use, anchoring method, workshop equipment status and working environment. Typical measuring methods are outlined below.

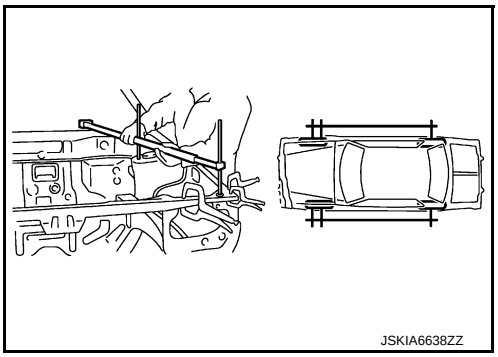
FRAME DEFORMATION MEASURING METHOD : Measurement with Manual Gauges

INFOID:0000000012123715

(1) MEASUREMENT WITH TRACKING GAUGES

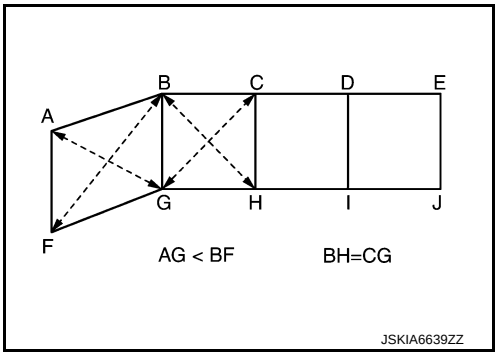
Three types of deformations, side-sway, diamond and buckling, can be measured.





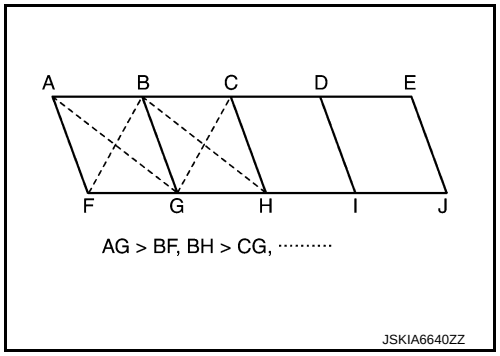
(a) Side-sway

This is checked by measuring the dimensions of the respective crossmember diagonal lines and comparing them to see if any differences are present.



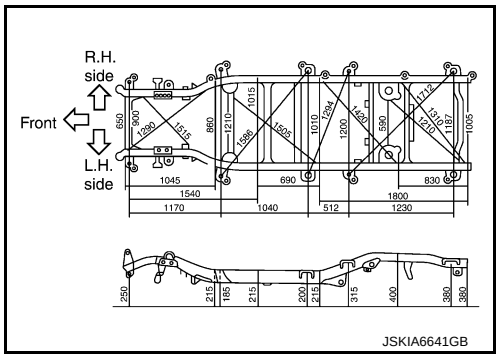
(b) Diamond

Measure the dimensions of the respective crossmember diagonal lines. If any gap is present in the length, a diamond deformation is present.



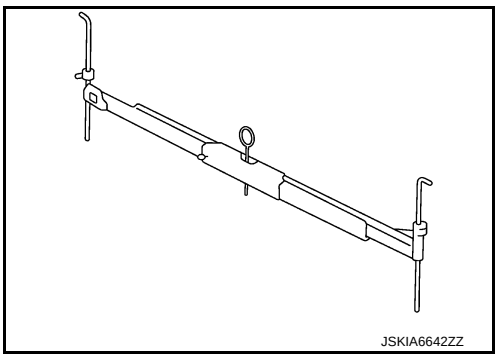
(c) Buckling

This is checked by measuring the height dimensions and length dimensions according to the vehicle body alignment section in the Service Manual or the Body Repair Manual.



(2) MEASUREMENT WITH CENTERING GAUGES

Four types of deformations, sagging, side-sway, twisting, and diamond, can be measured.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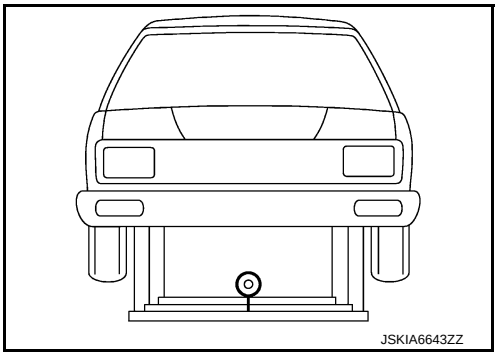
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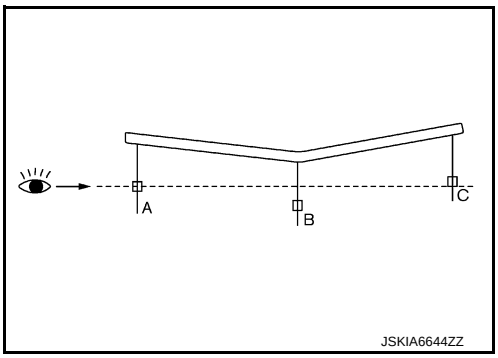
(a) Sagging

This is checked by looking through the horizontal bars of centering gauges.



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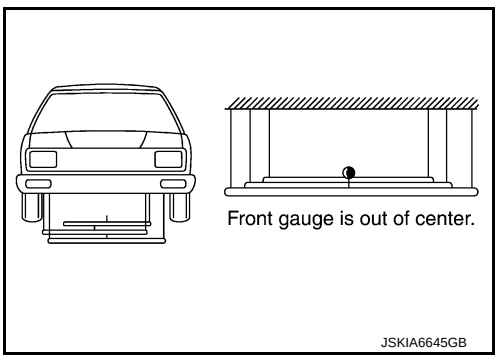
(b) Side-sway

This is checked by looking through the center pins of centering gauges attached on the frame.



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(c) Twisting

Twisting can be checked by judging whether the horizontal bar of a centering gauge attached on the frame is inclined.

(d) Diamond

Diamond deformation can be checked by identifying any displacement of the side pin of a diamond attachment attached to the center of a centering gauge on the frame or to the horizontal bar located nearby.

FRAME DEFORMATION MEASURING METHOD : Measurement with Three-dimensional Measuring Equipment

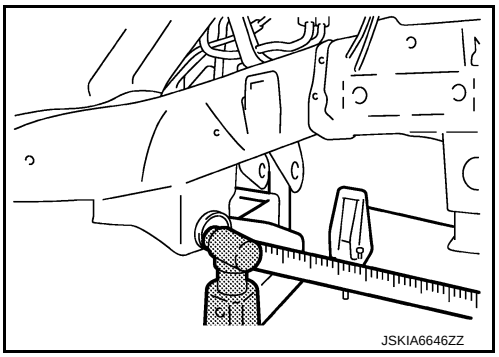
INFOID:0000000012106685

Measure the dimensions using three-dimensional measuring equipment and compare the measurements with the vehicle body alignment dimensions to identify any deformation in each direction. Several types of equipment are available, such as universal jig type, universal measuring type, laser type, computer measuring type and ultrasonic type. For the functional features of each type, refer to BRM-275, "Three-dimensional Measuring Equipment".

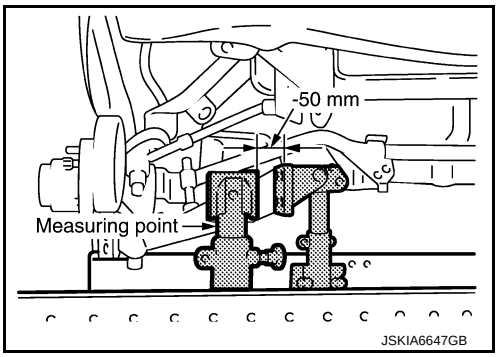
JIG TYPE

When jig type straightening equipment is used, the jig side gauge and pins are used as the dimensional references.
Three axis directions, "X" (width), "Y" (length), and "Z" (height) can be measured simultaneously.
The equipment also allows the worker to utilize any measuring point for the anchoring jig as soon as it is given reference dimensions. Therefore, even a novice can perform body repair with a high level of body alignment precision.

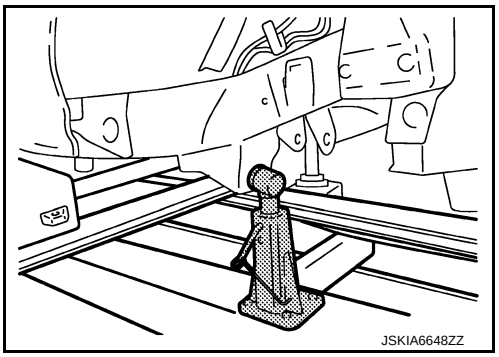
Example 1: Measurement before repair



Example 2: Measurement before repair



Example 3: Measurement after repair



FRAME SECURING

FRAME SECURING : Frame Securing

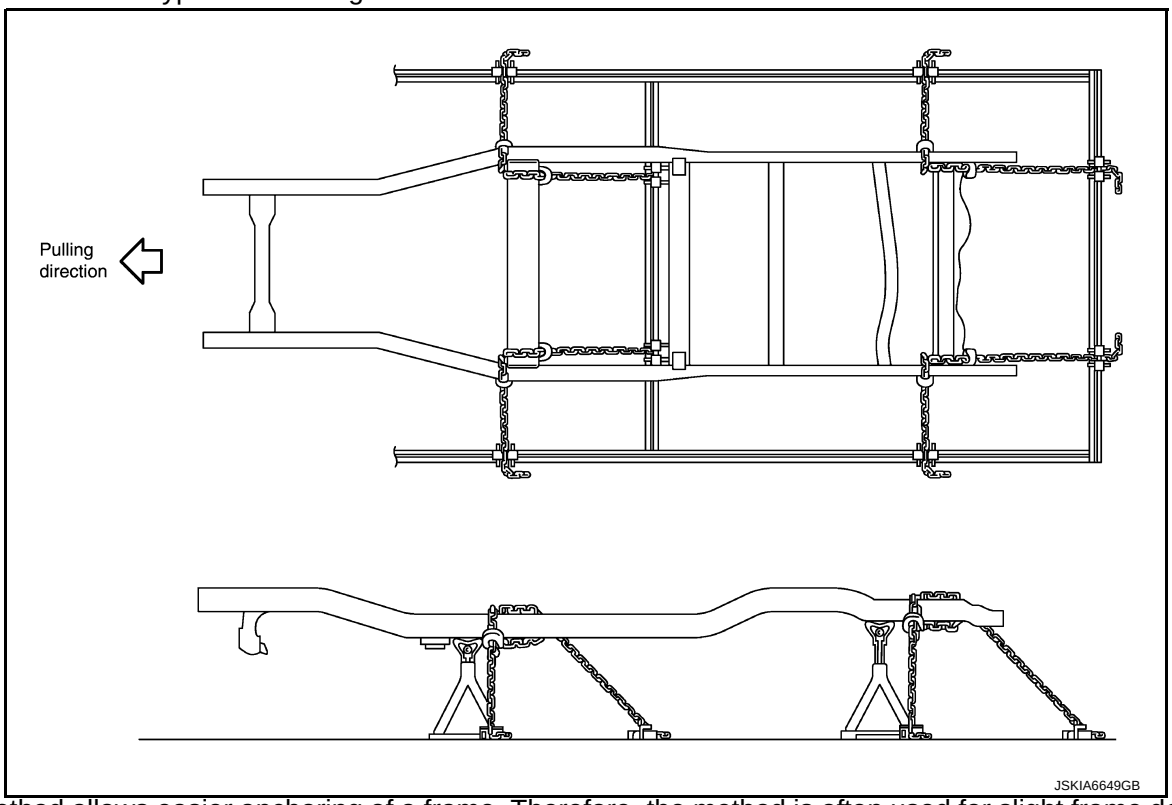
INFOID:0000000012125058

Frame repair work requires larger straightening force than uni-bodies. Therefore, the frame to be repaired must be anchored stably and securely to withstand such large force. The anchoring methods used for the frame and straightening equipment (puller) must be carefully selected according to the degree of the damage and the facility environment of the body shop. Typical frame anchoring methods are explained below.

FRAME SECURING : Anchoring by Rigid Racks and Chains

INFOID:0000000012123716

Place the frame on rigid racks and pull the high strength/rigidity portions with chains. Thus, secure the frame tightly in the vertical direction. The rigid racks sustain the frame from below and the tensioned chains restrict any upward movement.
The figure shows a typical anchoring method.



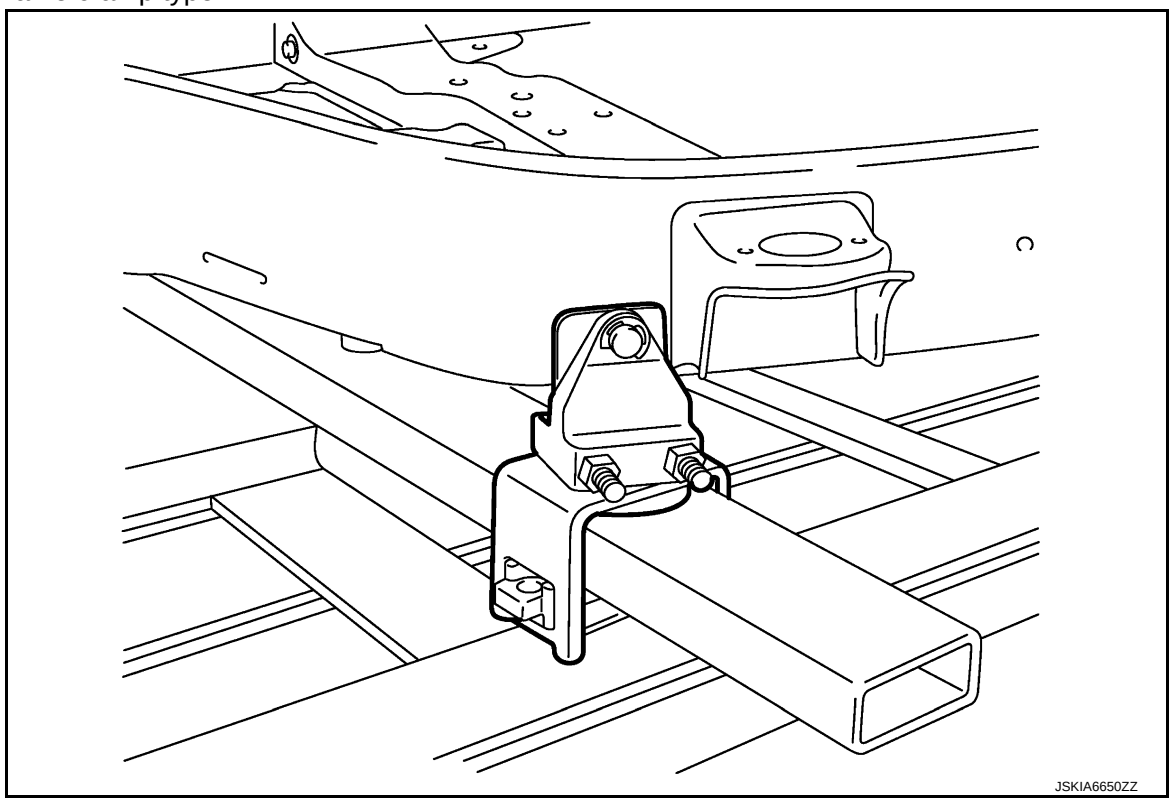
This method allows easier anchoring of a frame. Therefore, the method is often used for slight frame deformation, in other words, when the required pulling force is relatively small. It is useful to perform short-time pulling with the cabin mounted on the frame. However, to transmit the pulling force efficiently and thus perform effective repair, another method is recommended. Remove the tires from the frame and sustain the frame with rigid racks from below.

FRAME SECURING : Anchoring with Frame Attachments

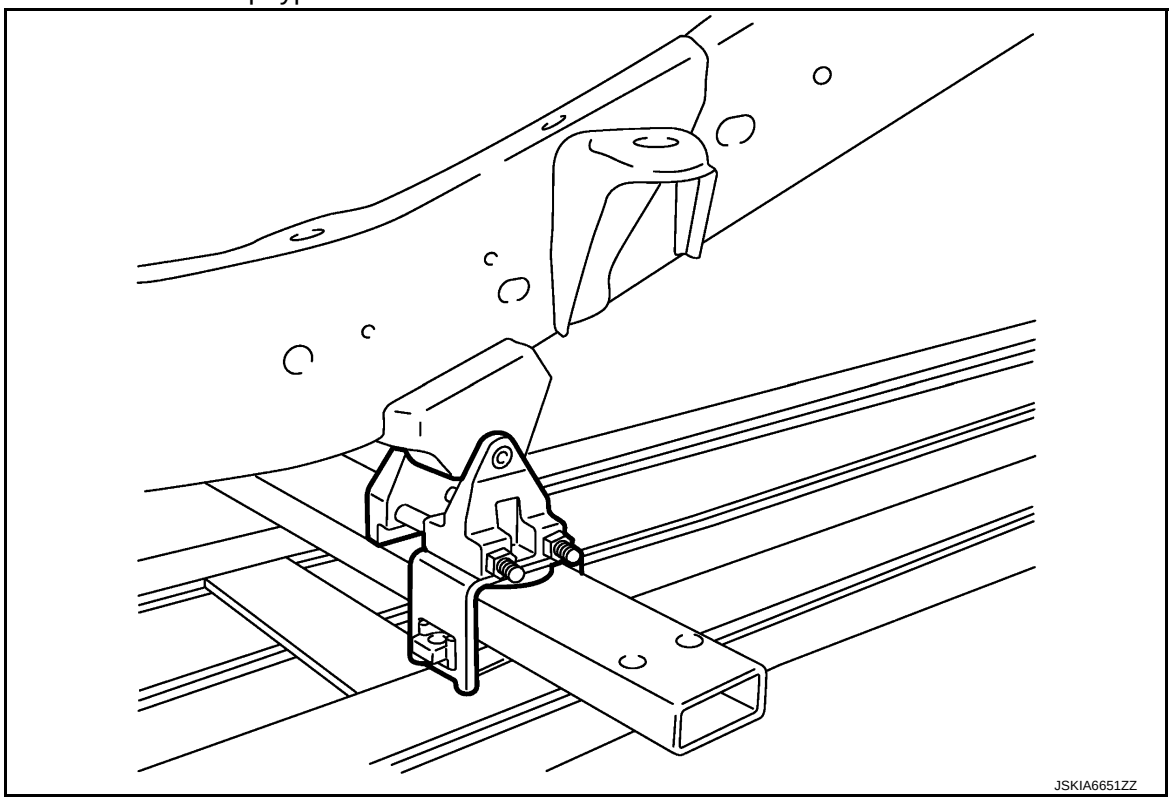
INFOID:0000000012106686

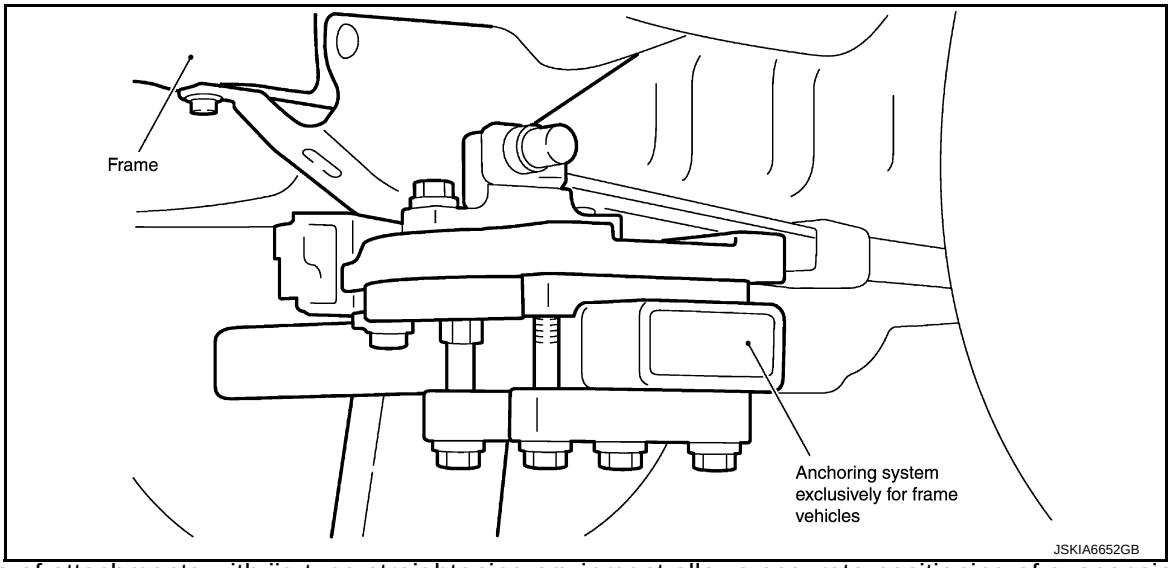
A difference between the frame anchoring and the uni-body anchoring is that the frame itself is held down. (For the basic anchoring methods for uni-bodies, refer to BRM-143, "REPAIR TECHNIQUES USING BODY STRAIGHTENING EQUIPEMENT : Securing the Vehicle".)
Frame straightening equipment makers offer the attachments for frame anchoring including those intended for any vehicle model and those dedicated for particular vehicle models. Generally speaking, an attachment allows the clamp height/position/angle, etc. to be adjusted so that it can be aligned at any desirable position.
The attachments are largely divided into the following two types.

- Side frame cramp type



- Suspension bracket cramp type





The use of attachments with jig type straightening equipment allows accurate positioning of suspension components, which are considered difficult to repair.

However, you should not completely rely on anchoring with attachments. Supplemental anchoring with chains and belts should also be used as necessary according to the required straightening.

FRAME STRAIGHTENING WORK

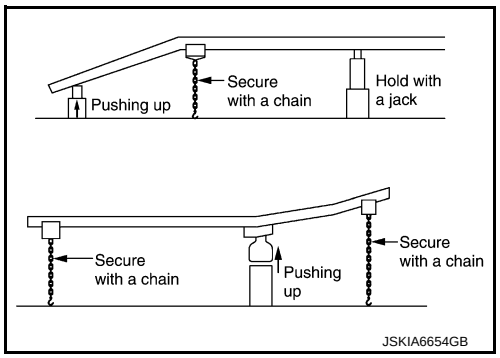
FRAME STRAIGHTENING WORK : Frame Repair Method according to Deformation Type

INFOID:0000000012123722

The basic repair procedures are described below for the respective frame deformation types previously outlined.

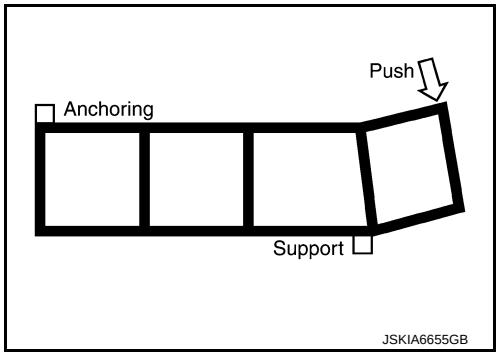
(1) SAGGING REPAIR METHOD

For sagging, any vertical bending of the frame must be straightened. The entire frame must be measured accurately to see if only a single side of the frame is distorted or both sides are distorted.



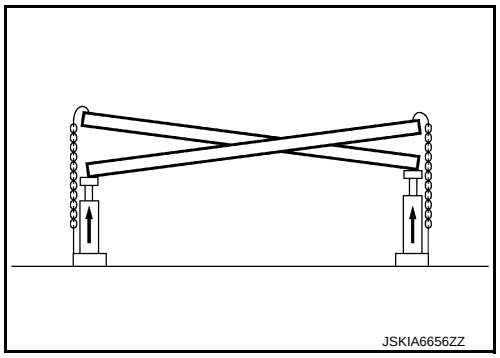
(2) SIDE-SWAY REPAIR METHOD

For side-sway, any lateral bending of the frame at the bases of crossmembers must be straightened.
When straightening side-sway at the front end of the frame, first anchor the frame so that it does not move rearward during straightening work, by placing hydraulic equipment appropriately as shown in the figure.



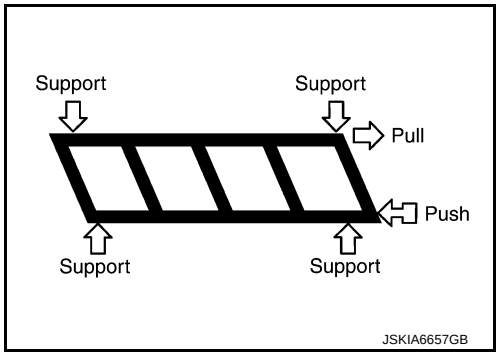
(3) TWISTING REPAIR METHOD

To straighten twisting, proceed as shown in the figure.
While pulling, eliminate any residual stress by hammering.



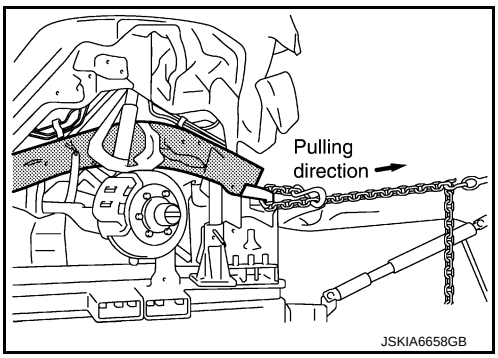
(4) DIAMOND REPAIR METHOD

For diamond deformation of a frame, any longitudinal bending at the crossmember-to-frame joints must be straightened.
Specifically, push one side of the frame and pull the other side.
To prevent lateral sway of the frame during straightening, support the frame sides with hydraulic equipment.



(5) BUCKLING REPAIR METHOD

For buckling, anchor the undamaged portion behind the damage point with as many jigs or anchoring devices as possible and then pull out the front portion of the damaged area in the horizontal direction. It is important to measure and identify the damaged range accurately and set up the frame anchoring points appropriately.



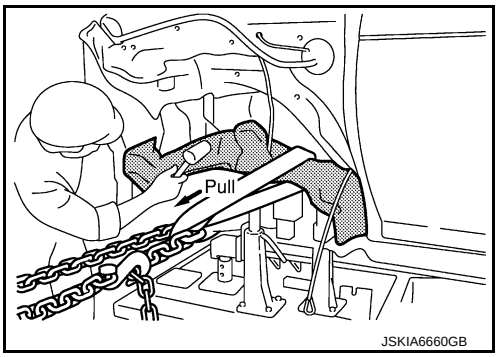
(6) REPAIRING PROCEDURE FOR COMPOUND DEFORMATION

If multiple types of deformations such as sagging, side-sway, twisting and diamond occur in the frame, first straighten the sagging and side-sway, then straighten the twisting and diamond. It should also be noted that side frames generally must be straightened before crossmembers are straightened.

FRAME STRAIGHTENING WORK : Precautions for Frame Repair

INFOID:0000000012123721

To eliminate any residual stress from the frame, always perform hammering during straightening work. This is extremely important because residual stress removal is more difficult in frames than in side members of uni-body vehicles. Any wrinkles generated in the frame and residual stress in the frame must be eliminated by tapping on the applicable portions with a hammer during straightening work. Complete elimination of residual stress is particularly important for straightening of twisting.



FRAME STRAIGHTENING WORK : Cut and Butt Joint Weld

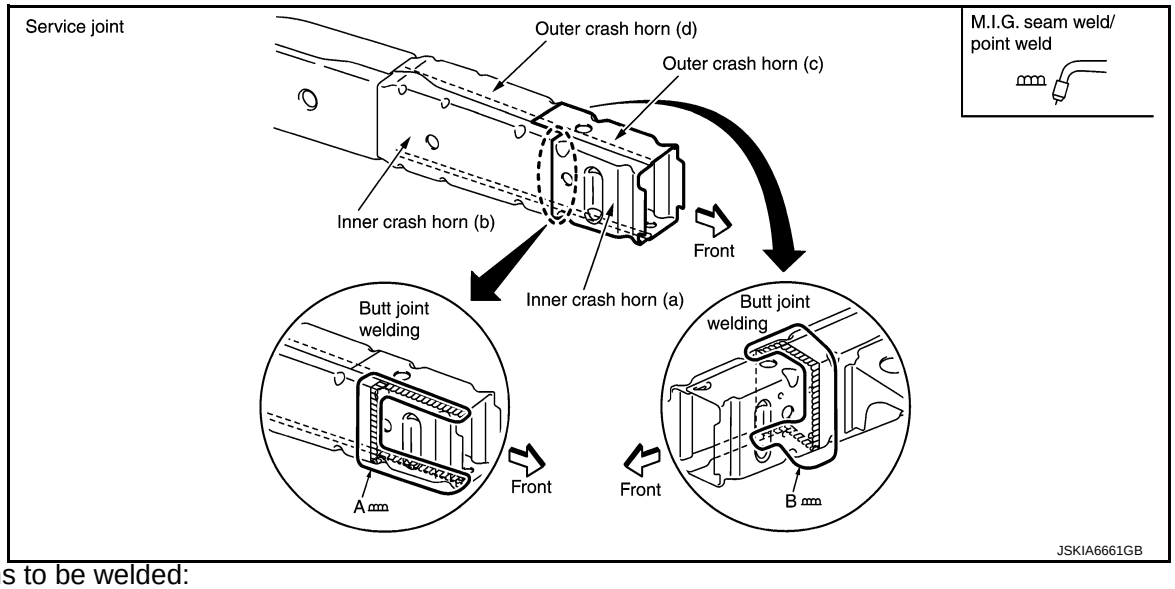
INFOID:0000000012106687

Damages that are considered difficult to repair by frame straightening work, such as a deformed crash horn, may be restored by a butt joint weld only if the Service Manual and/or the Body Repair Manual instructs so. As an example, the butt joint weld procedure for A60 is outlined below.

(1) CRASH HORN (Partial replacement)

(Work after 1st crossmember has been removed.)

Service Joint



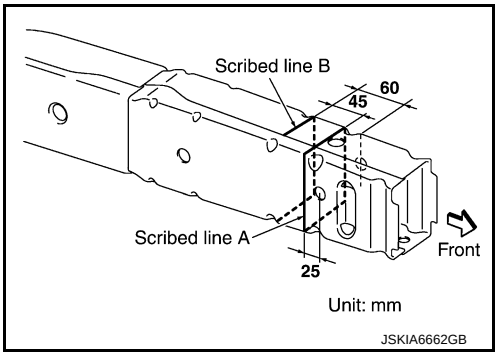
Portions to be welded:

A: Inner side rail crash horn (a), inner side rail crash horn (b) and outer side rail crash horn (c)

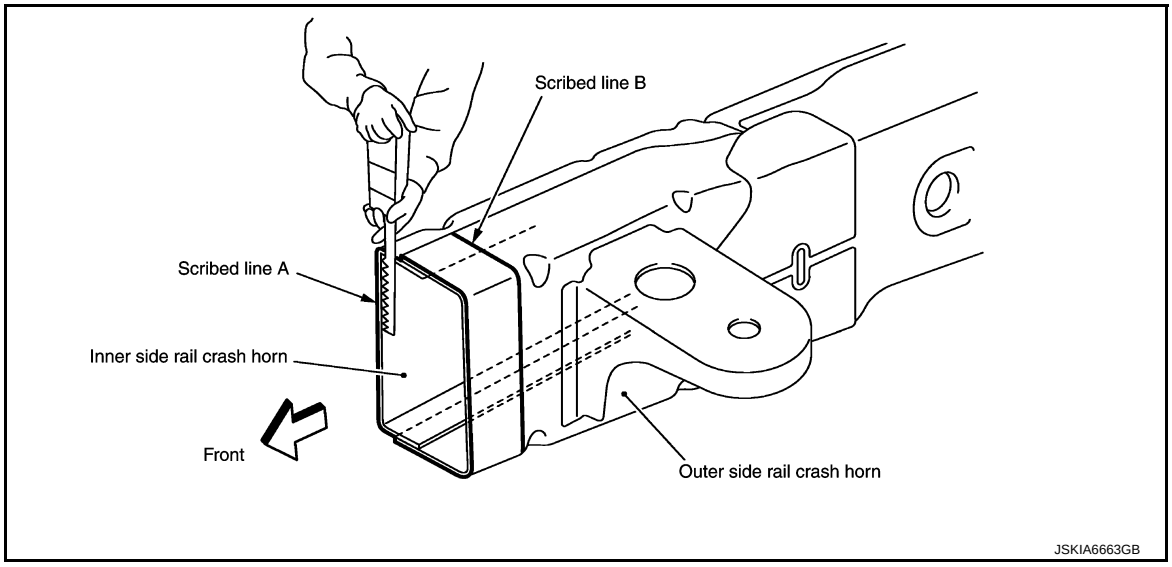
B: Outer side rail crash horn (c), outer side rail crash horn (d) and inner side rail crash horn (b)

(2) REMOVAL

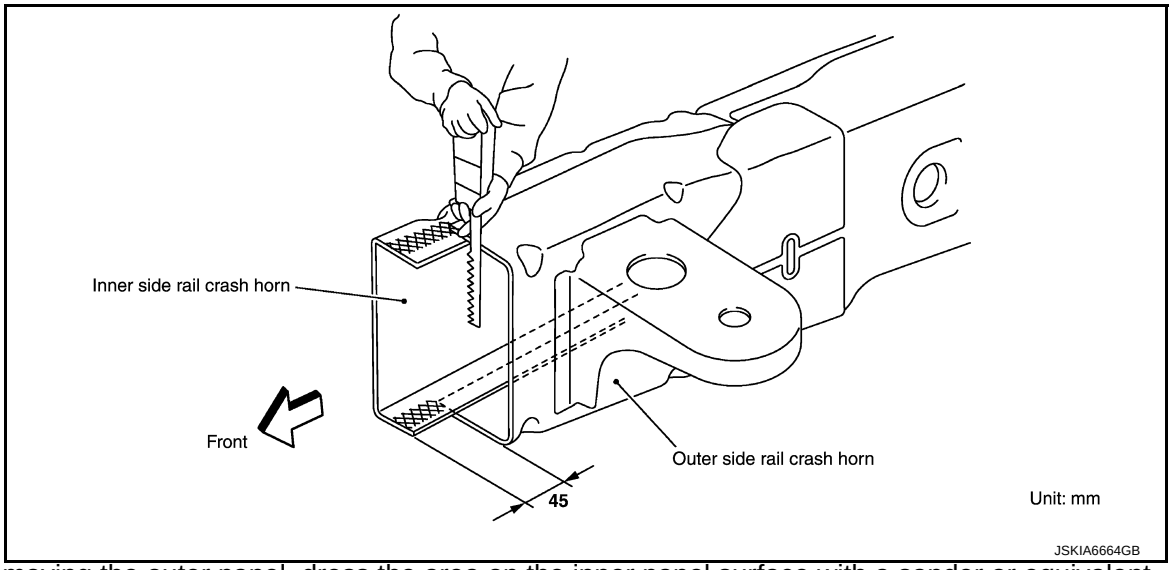
(a) Scribe a straight line on the outer side rail crash horn and inner side rail crash horn along the hole center as shown in the figure.



(b) Cut off the outer side rail crash horn and inner side rail crash horn along scribed line (A). Do not cut on the hole.



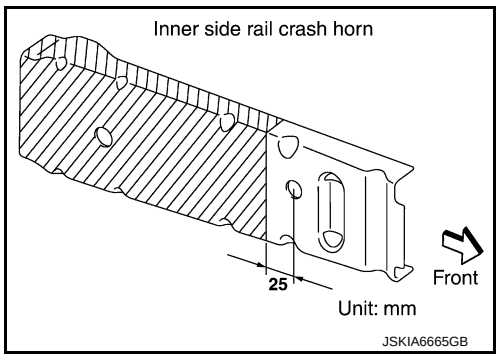
(c) Cut the inner side rail crash horn at 45 mm (1.77 in) backward from cut position of cut line (A) [along line (B)].



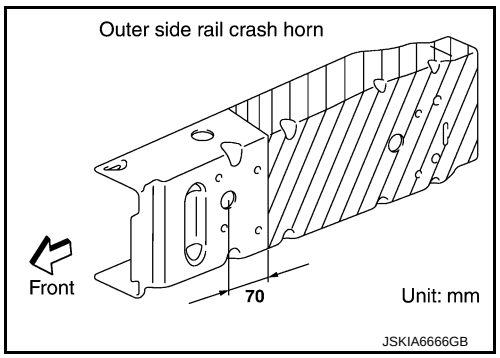
After removing the outer panel, dress the area on the inner panel surface with a sander or equivalent.

(3) INSTALLATION

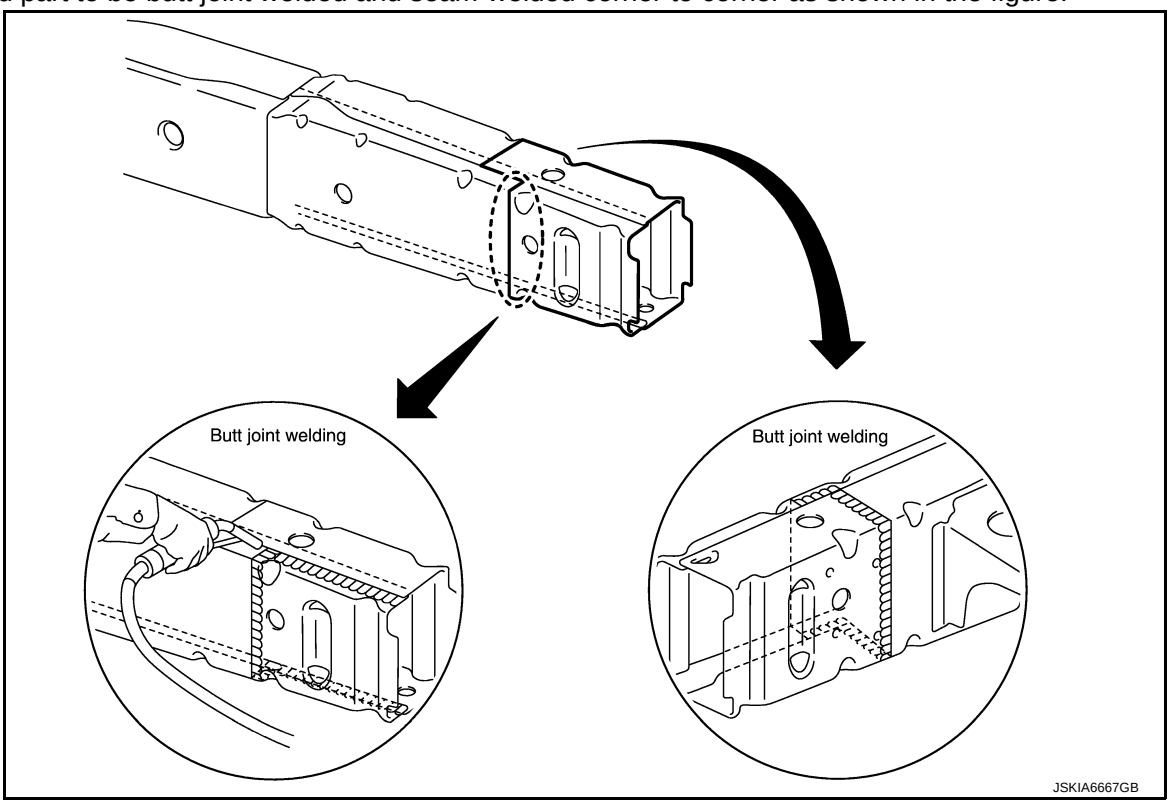
(a) Scribe a straight line on the inner side rail crash horn along the hole center as shown in the figure.
Cut off the inner side rail crash horn along the scribed line.



(b) Scribe a straight line on the outer side rail crash horn along the hole center as shown in the figure.
Cut off the outer side rail crash horn along the scribed line.



(c) Weld part to be butt joint welded and seam-welded corner to corner as shown in the figure.



(4) PRECAUTIONS FOR WELDING

(a) When tack welding is finished, always verify that the crash horn is assembled in the proper dimensions before starting final welding.

(b) Before starting welding work, always remove the components around the weld points. If it is difficult to remove the components, cover them with a fireproof sheet to avoid attachment of any weld spatters and subsequent damage to the surrounding portions.

(c) After painting, spray a sufficient amount of anti-corrosive wax to the rear side of the weld points through the holes near the weld points.

CONCLUSION

CONCLUSION : Conclusion

INFOID:0000000012106688

When repairing a frame deformed by a collision, every body repair technician must always keep in mind that the original frame performance of the vehicle (running performance and anti-collision safety) should be restored so as to offer the maximum customer satisfaction. For that purpose, we hope that every technician reads and understands this manual as well as the Service Manual and the Body Repair Manual so as to repair appropriately and safely. In particular, extreme care must be taken when an oxy-acetylene welder flame is used for repairing a frame deformed by a collision. Careless work on any heated portions without temperature control may result in deterioration of the running performance and anti-collision safety. To prevent such problems, every body repair technician should be aware of the importance of understanding the contents of this manual before frame repair, identifying the frame deformation accurately, and adopting an appropriate repair procedure.

ALUMINUM REPAIR

SHEET METAL WORK (ALUMINUM)

SHEET METAL WORK (ALUMINUM) : Sheet Metal Work (Aluminum)

INFOID:0000000012125060

Repairing aluminum alloy panels is basically the same as repairing steel panels. Special considerations for repairing aluminum alloy are listed below.

SHEET METAL WORK (ALUMINUM) : Sanding

INFOID:0000000012123732

Aluminum alloy panels are softer than steel plates. It is important to select the proper type and grade of sanding disc. Also, care must be taken not to overgrind the surface.
Because aluminum powder is light and tends to float in the air, eyes and respiratory parts of the body must be fully protected during grinding work.

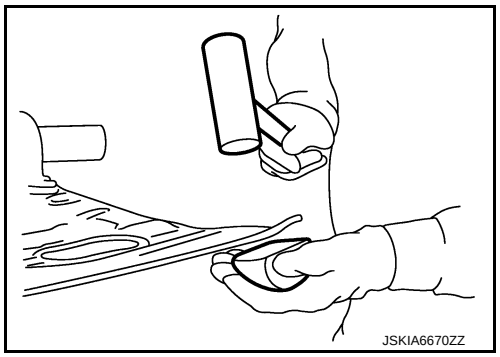
Application examples

Tool	Coarse	Application
Disc sander	Approx. #120	• Removal of old paint • Sanding aluminum surface
Double action sander	Approx. #120 - #180	• Make featheredge • Removal of putty

SHEET METAL WORK (ALUMINUM) : Hammering

INFOID:0000000012123731

Elongation of aluminum alloy during hammering will be greater than with steel plates. Therefore, a wooden or plastic hammer should be used with a softer blow to prevent stretching and work hardening of panels. Observe the following in case body filler is applied after hammering.
Apply wash primer and let it dry for 1 hour at 20°C (68°F) before applying body filler.
Use putty that can be used for aluminum panels. Do not perform forced drying because the coefficient of linear expansion is twice as much as that of sheet steel.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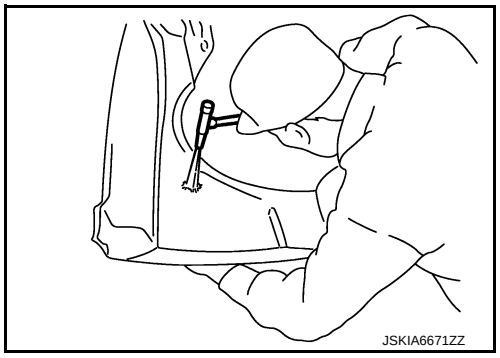
SHEET METAL WORK (ALUMINUM) : Heating Repair

INFOID:0000000012123730

While hammering work is being performed during the rough repair stage, the area needs to be heated. First, cover your hand with a glove (cloth material), and then place hand on the reverse side of the panel near the repair area. Apply heat to the entire repair area using a gas burner (oxy-acetylene gas welder) until your covered hand feels heat.

WARNING:
The panel may crack when hammered without sufficient heat being applied.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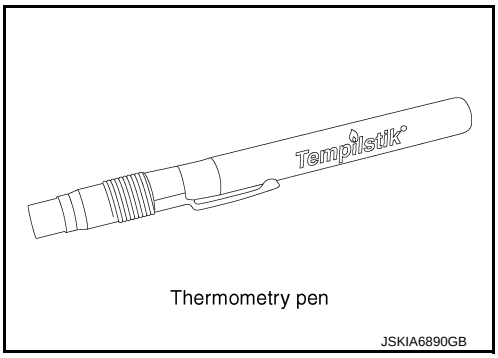
SHEET METAL WORK (ALUMINUM) : Shrinking

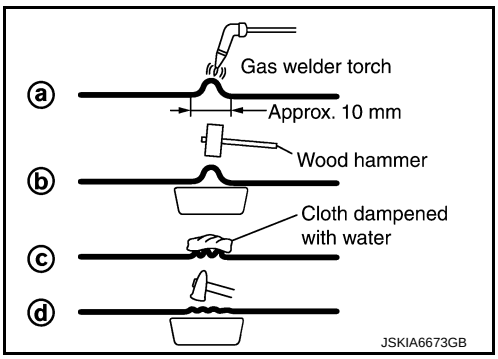
INFOID:0000000012123729

(1) FLAME SHRINKING

- The area should be heated to approximately 250°C.
  Aluminum alloy panels do not turn red when heated like steel plates. Prior to heating up the panel you are trying to repair, first practice with a scrap piece to get a good idea of how much heat is needed. This way the number of passes with the gas burner needed to achieve the correct temperature can be determined.
- A thermometry pen may be applied to the repair area before heat application. Apply the thermometry pen to the heated part. Check if the thermometry pen is melted to judge if the temperature on the heated area is within the range of the specified temperature. When measuring temperature, use two thermometry pens of different specified temperatures. This allows the top and bottom of the temperature range to be judged accurately.
  (Example: Tempilstik or equivalent)

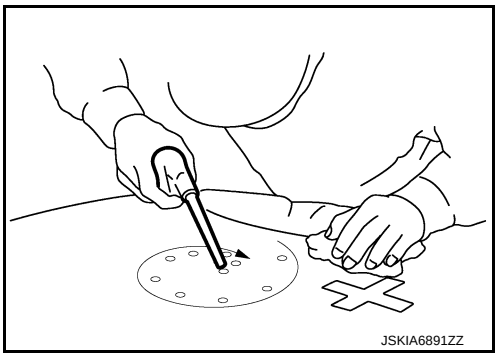


- The heat conduction efficiency of aluminum alloy panel is approximately twice that of steel plate, which allows heat to be absorbed and released at a faster rate. Hammering [(b) in the figure] and rapid cooling work [(c) in the figure] must be performed while the area is still hot.
- Don't use a shrinking hammer because it causes a crack.



(2) SHRINKING BY ELECTRIC WELDING

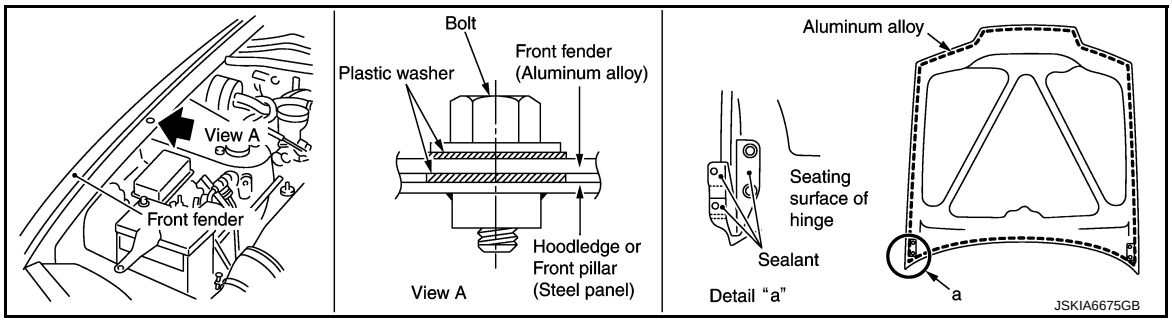
Shrinking with an electric welder is easier than with a gas burner, however this method leaves spark marks, scratches, carbon deposits, and oxide film on the panel surface.
For this reason, as an undercoating preparation, the panel surface must be cleaned using silicon off and a stainless steel wire brush.
When spark marks and scratches are large, the impurities are first completely removed using a wire brush, and then wash primer and putty are applied.



SHEET METAL WORK (ALUMINUM) : Precautions during Assembly

INFOID:0000000012106690

When installing parts, insulating materials such as resin washers (bolts at front fender) and anti-corrosion sealant (hood hinges) are inserted between the aluminum alloy panel and steel plates to prevent contact corrosion which occurs where different metals touch.



WELDING (ALUMINUM)

WELDING (ALUMINUM) : Welding (Aluminum)

INFOID:0000000012125061

To repair a crack or a hole in a steel plate, welding is usually used. Either oxygen and acetylene gas welding, arc welding, or brazing is commonly used. For aluminum alloy panels, TIG or MIG welding, which use inert gases (argon gas) as a shield gas, are usually used. This is because aluminum alloy has the following special features.

- Its melting temperature is lower than iron, however the specific heat and latent heat are higher. It also has good conductivity. For these reasons, a large amount of heat must be applied in a very short time.
- The melting point of aluminum alloy oxidized film is 2,020°C (3,668°F). In order to remove this film, cleaning by argon welding (TIG welding, MIG welding) or flux treatment is required.
- Not removing oxidized films results in incomplete fusion or blowholes.
- Heat expansion and contraction is approximately twice that of iron, which allows for easy distortion by welding.

WELDING (ALUMINUM) : Comparision of Chemical and Physical Properties between Aluminum and Iron

INFOID:0000000012123737

Property	Aluminum alloy	Iron	Effect of welding
Melting temperature °C (°F)	560 - 640 (1,040 - 1,184)	600 × 2.5 (1,112 × 2.5)	• Aluminum alloy melts before it turns red. • This makes it difficult to judge the temperature.
Heat conduction efficiency cal/cm/sec/°C (BTU in/m^2/h/°F)	0.28 (812.69)	0.28 × 0.57 (812.69 × 0.57)	Large amount of heat in a short time required for welding.
Modulus of elasticity kg/mm^2 (lb/in^2)	7,000 (9,646,875)	7,000 × 3 (9,646,875 × 3)	Easily deformed and very fragile.
Coefficient of linear expansion (10^{-6})	23.8	23.8 × 0.5	
Conductivity (%)	30	30 × 0.52	Large current flow is required when compared to iron.
Oxidized film	Al_2O_3	Fe_2O_3	The melting point of aluminum alloy oxidized film is 2,020°C (3,668°F). In order to remove this film, cleaning by argon welding or flux treatment is required.

WELDING (ALUMINUM) : Filler Metal

INFOID:0000000012123736

For a filler metal, TIG welding rods and MIG welding electrode wires are available. Use filler metal that is suitable to the parent metal.

Main selection standards of filler metal

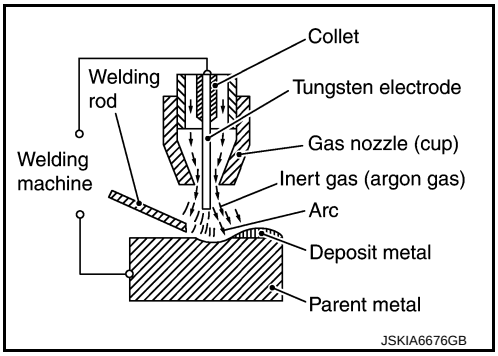
Parent metal	Filler metal
Front fender, hood: 5000 series, 6000 series	A5356
Door: 6000 series	A5356

WELDING (ALUMINUM) : TIG Welding

INFOID:0000000012123735

TIG is the abbreviation for tungsten inert gas shielded arc welding. TIG has the following special features.

Special features
- Initial cost of the equipment is low, as is maintenance expense.
- For ordinary electric power, high frequency alternating current is used.
- Easy to learn in a short time.
- Excellent strength and anti-corrosion properties.
- Ideal for welding instruction and training.



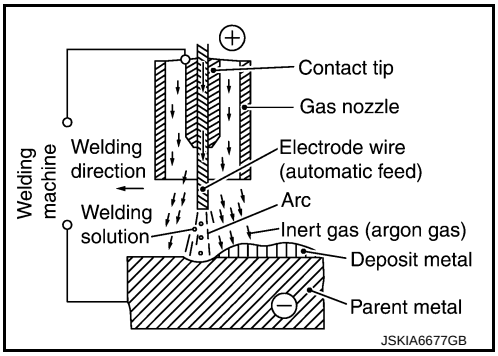
WELDING (ALUMINUM) : MIG Welding

INFOID:0000000012123734

MIG is the abbreviation for metal inert gas shielded arc welding. MIG welding has the following special features.

(1) NORMAL MIG WELDING

MIG welding is the most commonly used welding method. As shown in the figure, a wire serving as an electrode is continuously fed into the welding area, and an arc is generated between the wire tip and the parent metal. Normally, an electrode wire measuring 1.2 mm - 1.4 mm (0.047 in - 0.055 in) in diameter, with an electrical current of 110 A - 360 A, is used for welding a plate having a thickness of 2 mm (0.079 in) or more.



(2) SHORT ARC MIG WELDING METHOD

When welding a thin plate, a short arc welding method is generally used.
- As shown in the figure, a short circuit and arc pattern is repeated.
- When compared to ordinary MIG welding, using this short circuit transient method requires less heating, and therefore welding of a thin plate measuring 1 mm (0.04 in) in thickness can be accomplished.
- The short arc welding conditions are shown below.
  For the torch in the short arc welding, a thin wire measuring 0.8 mm - 1.2 mm (0.031 in - 0.047 in) in diameter and wound in a small spool is installed.

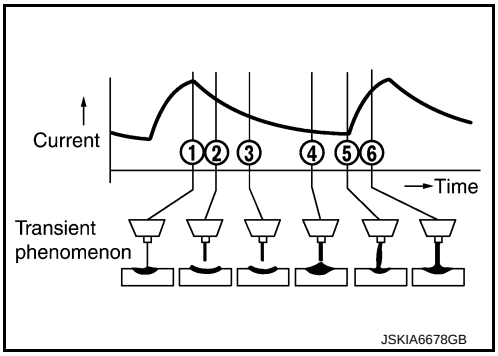
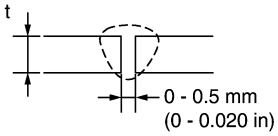
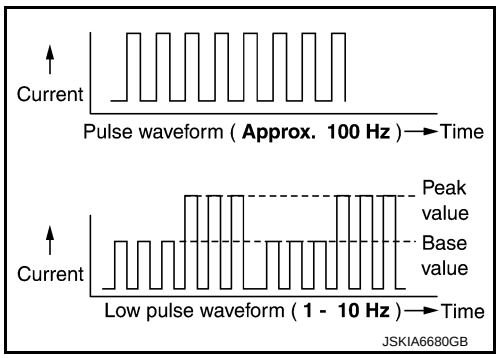


Plate thickness t = mm (in)	Shape of welding	Current (A)	Voltage (V)	Argon flow rate ℓ (US gal, Imp gal)/ min	Welding speed mm (in)/min
1 (0.04)		45	12	13 (3-3/8, 2-7/8)	600 (23.62)
2 (0.08)		85	15	15 (4, 3-1/4)	600 (23.62)
3 (0.12)		120	22	15 (4, 3-1/4)	600 (23.62)

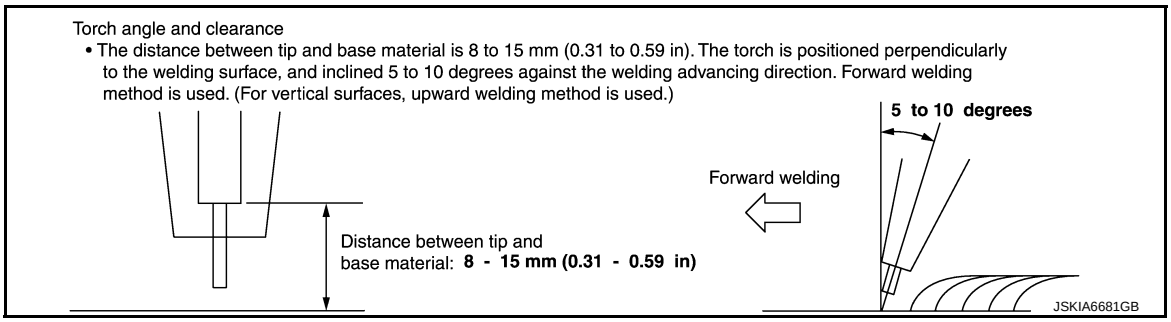
(3) PULSED ARC WELDING METHOD

To enable spray transfer, even in the current range, which is equivalent to or lower than the critical current (spray transfer limiting current), pulse waveform is added to this welding method. Because this method allows stable penetration and bead shape while preventing heat gain, it is suitable for thin plate welding.



LOW PULSE FUNCTION

- In addition to the pulse function, this function makes it easier to create imbricate bead shape.
- It is effective in preventing burn through during the thin plate welding and the welding of panels with a gap present in between.



WELDING (ALUMINUM) : MIG Welding Method

INFOID:0000000012123733

(1) PLUG WELDING

MIG plug welding method is used to repair the spot welded portions.
Keep the upper panel and lower panel tightly together. Before welding, contact closely the points to be plug welded.
Observe the welding condition described in the Body Repair Manual.

(a) Welding condition (plug welding)
Basically, the following welding conditions are intended for horizontal welding. Therefore, depending on the welding direction, adjustment may be necessary.

• Two-sheet plug welding conditions

• **Welding wire** **A5356-WY 1.2 mm (0.047 in)**
• **Low pulse function** **Use 5Hz**

Upper panel T mm (in) / Lower panel T mm (in)	1.0			2.0			3.0			4.0			5.0		
	Diameter mm (in)	Current (A)	Voltage (V)	Diameter mm (in)	Current (A)	Voltage (V)	Diameter mm (in)	Current (A)	Voltage (V)	Diameter mm (in)	Current (A)	Voltage (V)	Diameter mm (in)	Current (A)	Voltage (V)
1.0 (0.039)	8.0 (0.315)	100 (3.94)	18 (0.71)	8.0 (0.315)	100 (3.94)	18 (0.71)	8.0 (0.315)	120 (4.724)	19 (0.75)	8.0 (0.315)	160 (6.30)	19 (0.75)			
2.0 (0.079)	8.0 (0.315)	150 (5.91)	19 (0.75)	9.0 (0.354)	180 (7.09)	20 (0.79)	9.0 (0.354)	180 (7.09)	20 (0.79)	9.0 (0.354)	190 (7.48)	20 (0.79)	9.0 (0.354)	200 (7.87)	20 (0.79)
3.0 (0.118)	8.0 (0.315)	180 (7.09)	20 (0.79)	9.0 (0.354)	180 (7.09)	20 (0.79)	11.0 (0.433)	200 (7.87)	20 (0.79)	11.0 (0.433)	210 (8.27)	21 (0.83)	11.0 (0.433)	210 (8.27)	21 (0.83)
4.0 (0.157)	8.0 (0.315)	180 (7.09)	20 (0.79)	9.0 (0.354)	190 (7.48)	20 (0.79)	11.0 (0.433)	210 (8.27)	21 (0.83)	12.0 (0.472)	220 (8.66)	22 (0.87)	12.0 (0.472)	220 (8.66)	22 (0.87)
5.0 (0.197)				9.0 (0.354)	200 (7.87)	20 (0.79)	11.0 (0.433)	220 (8.66)	22 (0.87)	12.0 (0.472)	230 (9.06)	23 (0.91)	13.0 (0.512)	230 (9.06)	23 (0.91)

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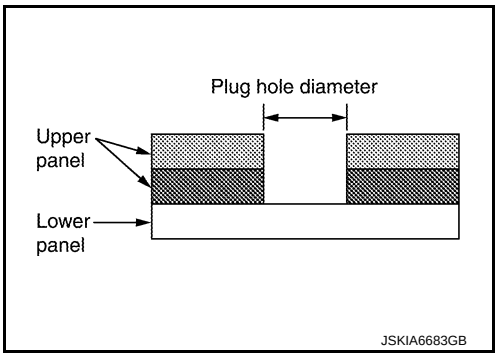
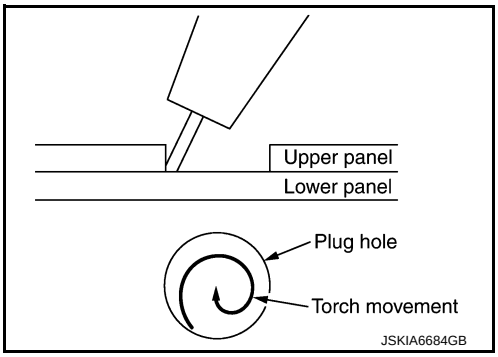
(b) Three-sheet plug welding condition
Consider the total thickness of two upper panels as the upper panel thickness. Using this thickness, apply the two-sheet plug welding conditions to set plug hole diameter, current, and voltage.



(c) Torch movement
• Thickness of lower panel

1.4 mm (0.055 in) or less

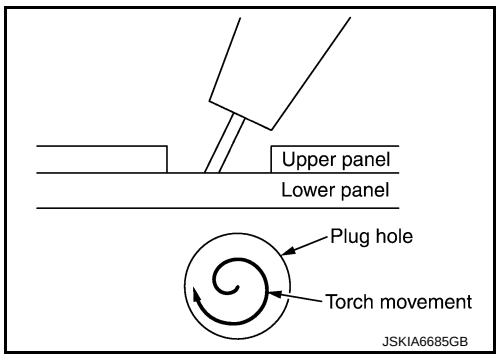
Weld from the plug hole circumference toward the center in a circular motion.



- Thickness of lower panel

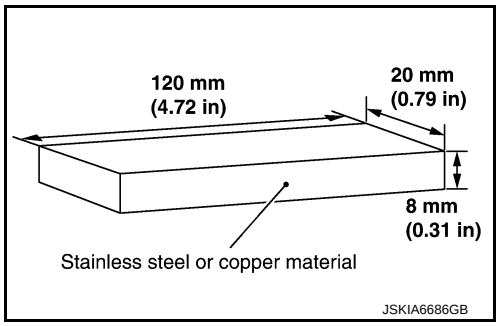
1.5 mm (0.059 in) or more

Weld from the plug hole center toward the circumference in a circular motion.



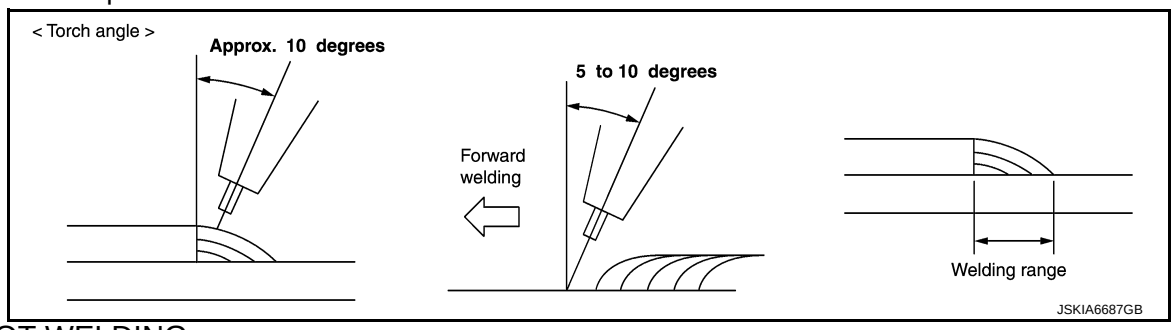
(d) Backing block

When thin panels are plug welded, a backing block, as shown in the figure, is placed on the underside of the panels, and fixed onto the plug hole side with a clamp.
This is to prevent thin panels from burning through.
For locations where backing strips cannot be applied, be careful not to burn through.



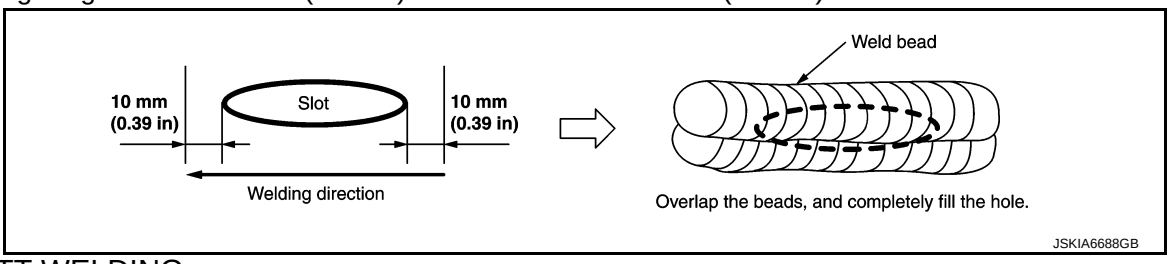
(2) FILLET WELDING

- Before welding, contact closely the points to be fillet welded.
- Observe the welding conditions and lengths specified in the Body Repair Manual.
- Set the welding range for the fillet welding cross section so that it is same as the panel thickness or wider. When the panels have different thicknesses, perform welding according to the welding conditions applicable to the thinner panel.



(3) SLOT WELDING

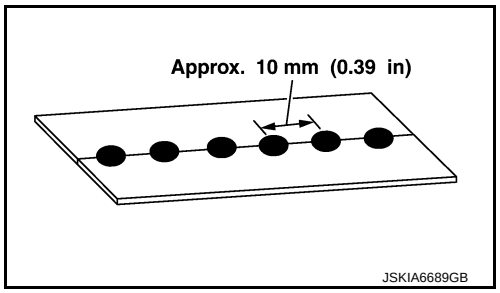
- Before welding, contact closely the points to be slot welded.
- Observe the welding conditions specified in the Body Repair Manual.
- Welding range is from 10 mm (0.39 in) before the slot to 10 mm (0.39 in) after the slot.



(4) BUTT WELDING

Observe the welding conditions specified in the parts replacement procedure.

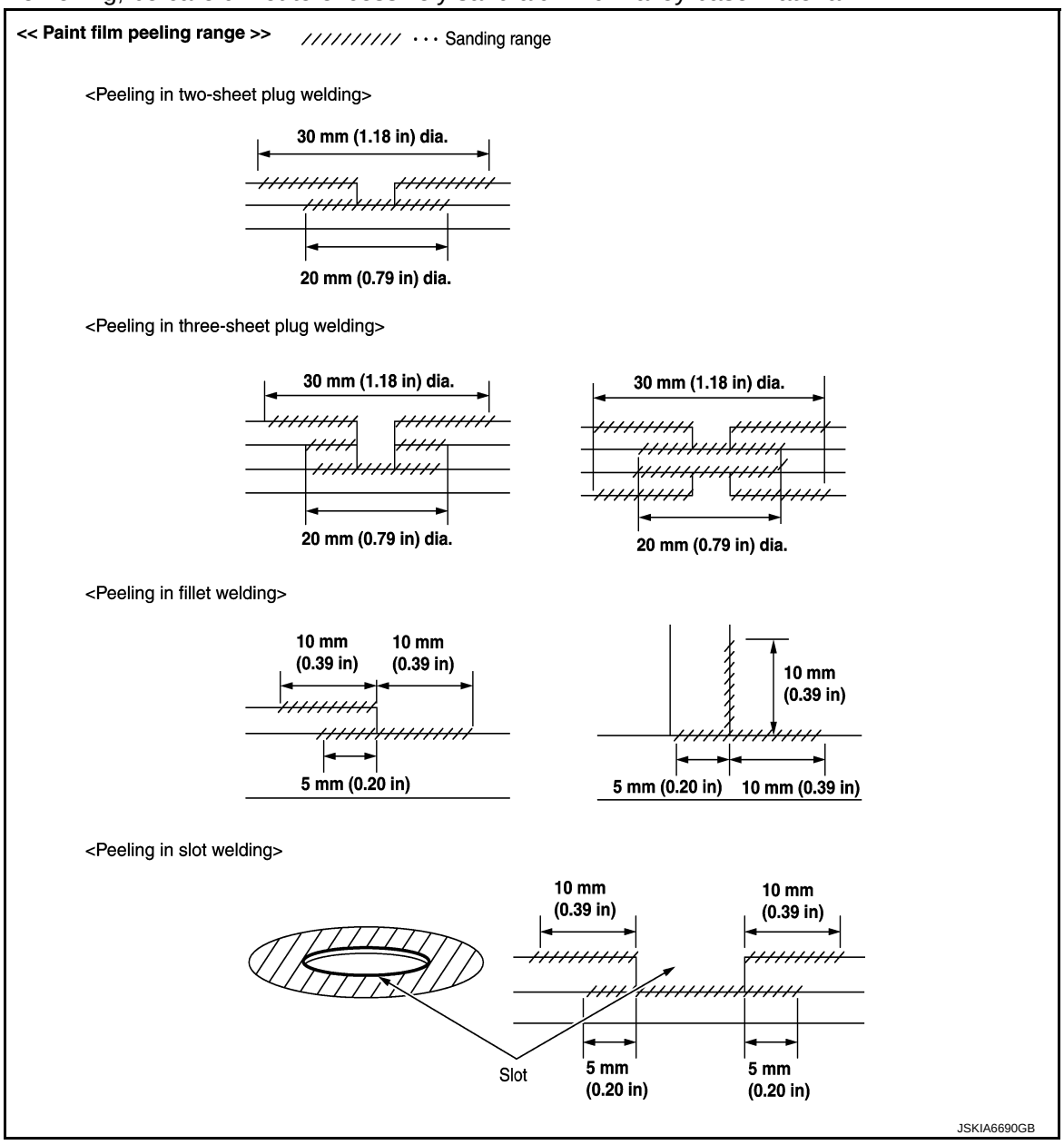
1. Tack welding: Temporarily, but securely weld at approximately 10 mm (0.39 in) intervals.
2. Remove aluminum oxides and magnesium oxides generated at tack welded points. Not doing so results in a welding malfunction.
3. Regular welding.



WELDING (ALUMINUM) : Precautions during Welding

INFOID:0000000012106691

- Wear long sleeved work uniform, work cap, and safety shoes. Wear safety goggles, gloves, earplugs, and dustproof respirator if necessary.
- MIG arc welding for aluminum plates emits sparks. Do not stare directly at them. Before working, be sure to wear protectors to avoid getting burned.
- Always perform pre-treatment of the parent metal.
  Dirt and oxidization film on the parent metal will cause defective welding. The following pre-treatment should be performed prior to welding. Oil film should be cleaned using Silicon Off or white gasoline.
  Surface should then be polished using a thin wire stainless steel brush.
  Oxide film is reproduced in approximately 30 minutes to 1 hour.
  Therefore, it is best to perform the pre-treatment immediately before welding.
  Even if pre-treatment for various locations has already been performed, it is necessary to use a wire brush again immediately before welding.
- Use filler metal (welding rod or welding wire) that is suitable for the parent metal.
- Filler metal used for aluminum welding flows easier than for steel welding, and therefore the welding surface should be in the horizontal position.
- For TIG and MIG welding, even a 0.5 m/s (1.6 ft/s) breeze will greatly effect the seal. When performing welding outside, select a place where dust and moisture are minimized. A shelter should be constructed for protection from wind or rain.
- Remove paint film of the welding portions and electrodeposition coating of the service parts using a disc sander.
  When removing, be careful not to excessively sand aluminum alloy base material.

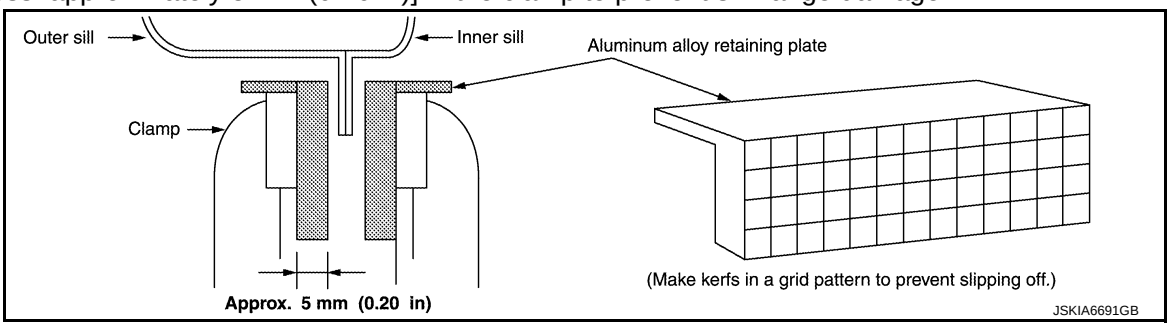


BODY STRAIGHTENING (ALUMINUM)

BODY STRAIGHTENING (ALUMINUM) : Securing the Vehicle

INFOID:0000000012123739

When fixing the aluminum body to the body straightening equipment, set an aluminum alloy retaining plate [thickness: approximately 5 mm (0.20 in)] in the clamp to prevent sill flange damage.



BODY STRAIGHTENING (ALUMINUM) : Frame Straightening

INFOID:0000000012106692

- Buckling portions have been work hardened. When straightening frames, straighten by pulling out while heating with oxy-acetylene gas welder. Unlike steel plates, aluminum alloy does not change color even when heated. Use a noncontact type thermometer or thermometry pen to control the temperature. Be careful not to overheat.
  <Reference> Melting point of aluminum alloy: approximately 640°C (1,184°F)

  Possible heating temperature

  Extrusion molding material (6000 series) : 110°C (230°F)

  Press molding material (5000 series) : 350°C (662°F)

- During pulling work, pulling fully with large force causes weld to peel (spot weld peeling or cracks are generated in fillet weld). Pull out gradually.
- Aluminum alloy has high thermal conductivity. When heating, remove interior equipment and other related parts extensively.

PLASTIC REPAIR

DISTINGUISHING PLASTIC MATERIAL

DISTINGUISHING PLASTIC MATERIAL : Precautions for Plastics

INFOID:0000000012189016

Plastic materials can be distinguished by the product name embossed on the back of the part. When repairing plastic parts, the repair method will vary with the material used.
Refer to the Body Repair Manual section of each model's Service Manual for information on plastic materials used like below example.
Large plastic parts have material codes embossed on the back. Refer to BRM-49, "TYPES OF PLASTIC : Classification of Plastic".

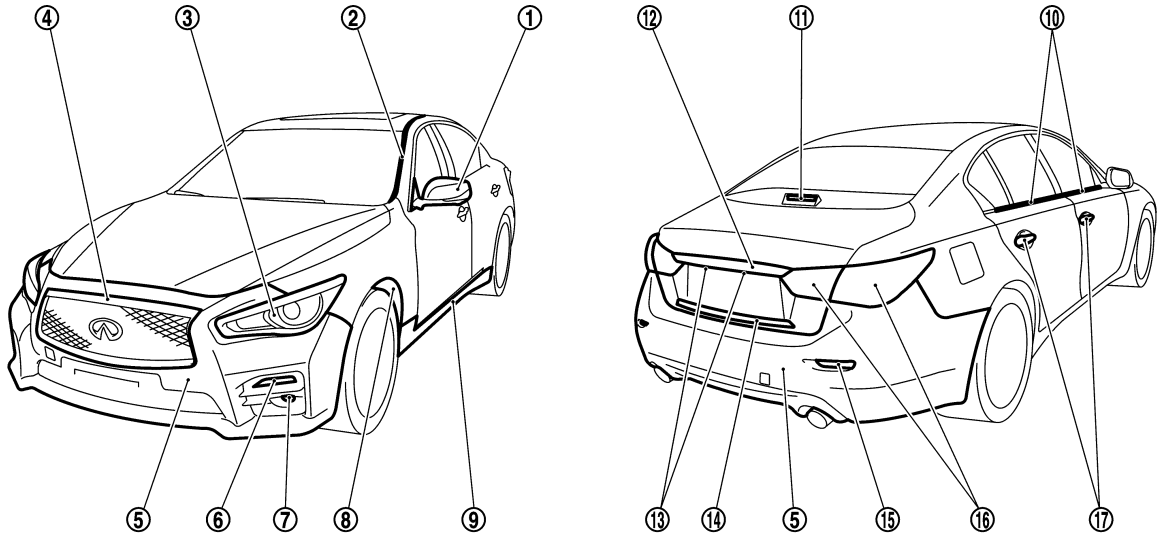
Abbre-viation	Material name	Heat resisting temperature °C (°F)	Resistance to gasoline and solvents	Other cautions
PE	Polyethylene	60 (140)	Gasoline and most solvents are harmless if applied for a very short time (wipe out quickly).	Flammable
ABS	Acrylonitrile Butadiene Styrene	80 (176)	Avoid gasoline and solvents.	—
AES	Acrylonitrile Ethylene Styrene	80 (176)	↑	—
EPM/ EPDM	Ethylene Propylene (Diene) co-polymer	80 (176)	Gasoline and most solvents are harmless if applied for a very short time (wipe out quickly).	Flammable
PS	Polystyrene	80 (176)	Avoid solvents.	Flammable
PVC	Poly Vinyl Chloride	80 (176)	Gasoline and most solvents are harmless if applied for a very short time (wipe out quickly).	Poisonous gas is emitted when burned.
TPO	Thermoplastic Olefine	80 (176)	↑	Flammable
AAS	Acrylonitrile Acrylic Styrene	85 (185)	Avoid gasoline and solvents.	—
PMMA	Poly Methyl Methacrylate	85 (185)	↑	—
EVAC	Ethylene Vinyl Acetate	90 (194)	↑	—
PP	Polypropylene	90 (194)	Gasoline and most solvents are harmless if applied for a very short time (wipe out quickly).	Flammable, avoid battery acid.
PUR	Polyurethane	90 (194)	Avoid gasoline and solvents.	—
UP	Unsaturated Polyester	90 (194)	↑	Flammable
ASA	Acrylonitrile Styrene Acrylate	100 (212)	↑	Flammable
PPE	Poly Phenylene Ether	110 (230)	↑	—
TPU	Thermoplastic Urethane	110 (230)	↑	—
PBT+ PC	Poly Butylene Terephthalate + Polycarbonate	120 (248)	↑	Flammable
PC	Polycarbonate	120 (248)	↑	—
POM	Poly Oxymethylene	120 (248)	↑	Avoid battery acid.
PA	Polyamide	140 (284)	↑	Avoid immersing in water.
PBT	Poly Butylene Terephthalate	140 (284)	↑	—
PAR	Polyarylate	180 (356)	↑	—
PET	Polyethylene terephthalate	180 (356)	↑	—
PEI	Polyetherimide	200 (392)	↑	—

CAUTION:

- **When repairing and painting a portion of the body adjacent to plastic parts, consider their characteristics (influence of heat and solvent) and remove them if necessary or take suitable measures to protect them.**
- **Plastic parts should be repaired and painted using methods suiting the materials' characteristics.**

DISTINGUISHING PLASTIC MATERIAL : Location of Plastic Parts (Example)

INFOID:0000000012189015



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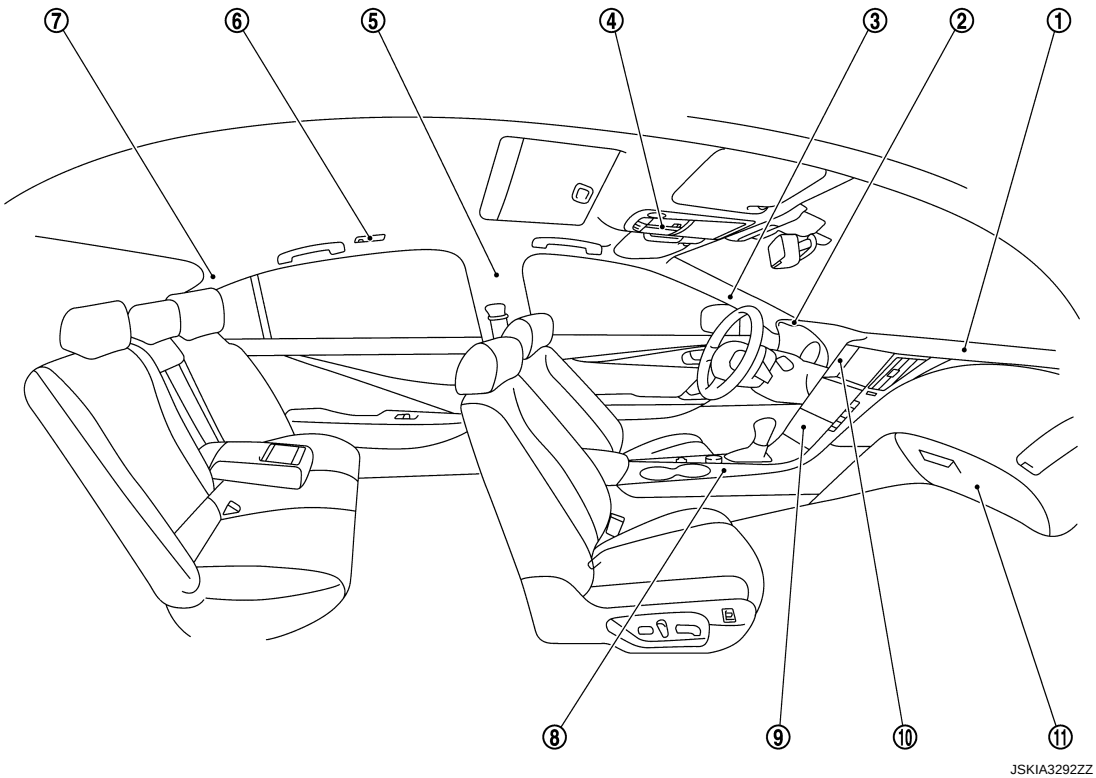
Component				Material
①	Door mirror	With camera	Cover	ABS
			Base	PA
			Housing	ABS
			finisher	ABS
		Without camera	Housing	ASA
			finisher	ASA
	Side turn signal lamp		Lens	PMMA
			Housing	ABS
②	Side roof molding			PVC + Stainless
	Lower side molding			ASA
③	Front combination lamp		Lens	PC
			Housing	PP
④	Front grille			ABS
⑤	Bumper fascia			PP + EPM
⑥	Front turn signal lamp		Lens	PC
			Housing	PC
⑦	Front fog lamp		Lens	PC
			Housing	PBT + ASA + Glass fiber

Component			Material
⑧	Front fender protector		PP
⑨	Sill cover		PP + EPM
⑩	Door outside molding		PVC + Stainless
⑪	High mount stop lamp	Lens	PC
		Housing	PC + ABS
⑫	Trunk lid finisher	Outer	ABS
		Inner	ASA
⑬	License plate lamp	Lens	PC
		Housing	PC
⑭	Trunk lid molding		ABS
⑮	Reflex reflector	Lens	PMMA
		Housing	ABS
⑯	Rear combination lamp	Lens	PMMA
		Housing	ABS + ASA
⑰	Door outside handle	Grip body	PC + PET
		Grip finisher	ABS



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Component			Material
①	Instrument panel	Skin	TPU
		Pad	PUR
		Core	PP + EPDM
②	Cluster lid A		PP
③	Front pillar garnish	Base	PP
		Skin	PET
④	Map lamp	Switch finisher	PP
		Console	PP
	Lid box assembly		PC + ABS
⑤	Center pillar garnish	Base	PP
		Skin	PET
⑥	Personal lamp	Lens	PC
		Housing	PP
⑦	Rear pillar finisher	Base	PP
		Skin	PET

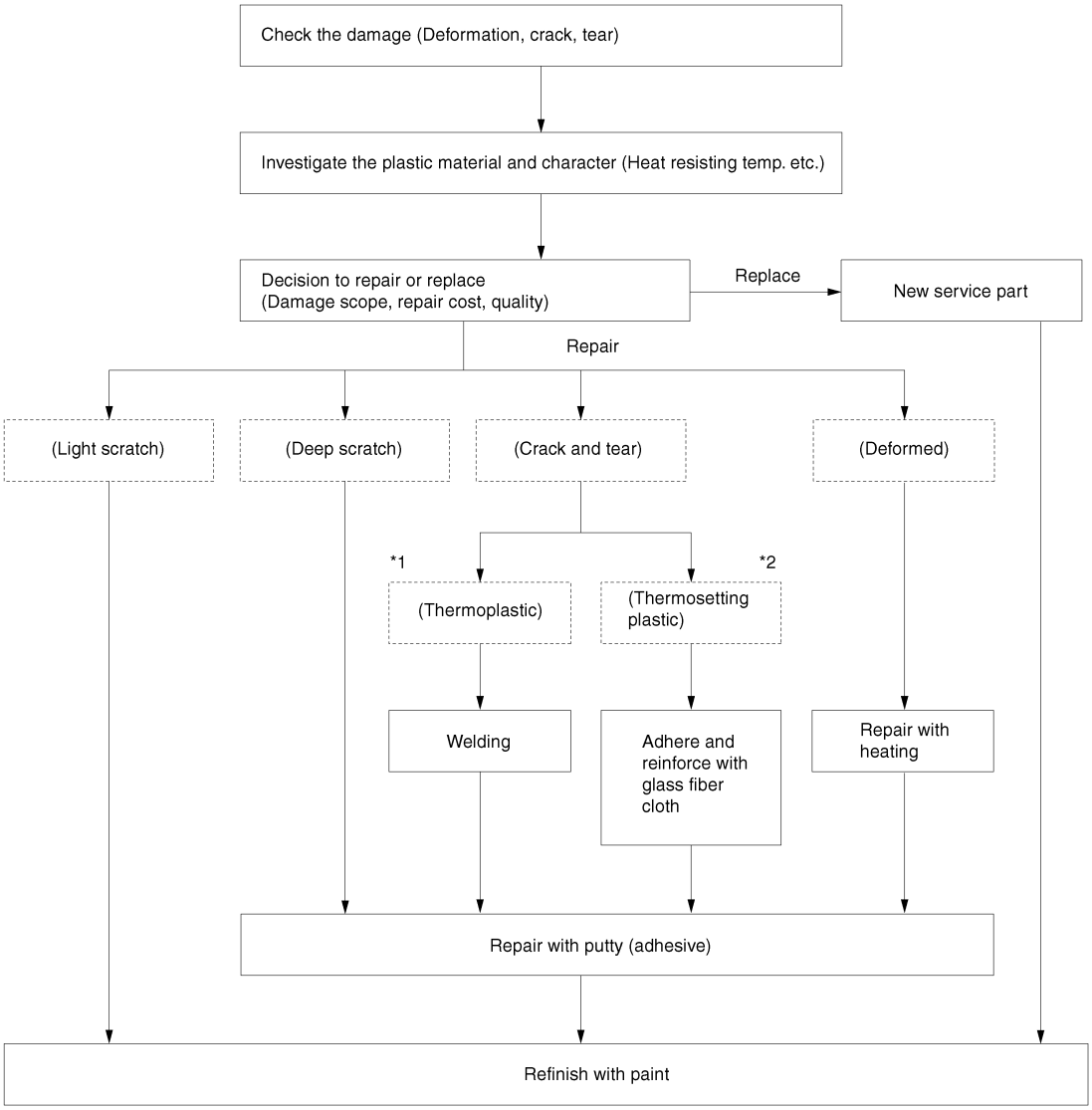
Component				Material
⑧	Center console	Body		PP
		Console box		ABS
		Console lid	Insert lid	PC + ABS
			Inner lid	PP
		Instrument side panel		PP + EPDM
		Console finisher		PC + ABS
		Upper rear console	Aluminum	PC + ABS
			Wood	PC + Glass fiber
⑨	Console finisher			ABS
⑩	Instrument finisher C		Aluminum	PC + ABS
			Wood	PC + Glass fiber
	Side ventilator grille			PC + ABS
⑪	Glove box		Skin	PVC
			Pad	PUR
			Core	ABS

REPAIR PROCEDURE OF PLASTIC MATERIAL

REPAIR PROCEDURE OF PLASTIC MATERIAL : Repair Procedure of Plastic Material

INFOID:0000000012106694

Plastic parts are repaired as follows.



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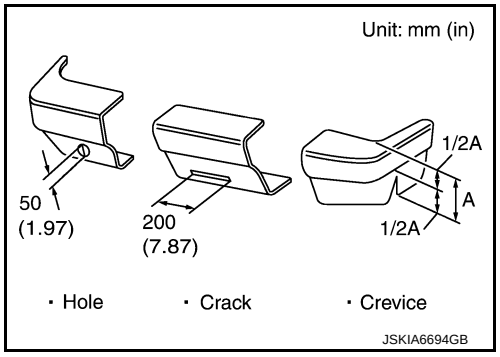
*1: PP, PE, PVC, ABS, PC, PA, TPU, PPO, POM, etc.
*2: FRP and PUR (contain glass fiber)

The maximum extents repairable with flexible parts repair material for bumper are as follows:

Hole : 50 mm (1.97 in) in diameter
Crack : 200 mm (7.87 in) in length
Crevice : Less than 1/2 of total width



JSKIA6694GB

New parts replacement cost and repair cost must be compared, and the result checked with the customer to determine which method will be used.

REPAIR METHOD

REPAIR METHOD : Repair Method

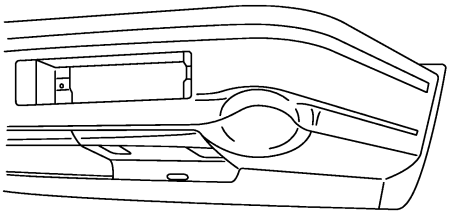
INFOID:0000000012138206

Plastic material repairs can be divided into four general categories: heating repair, welding repair, adhesive repair and laminating repair. According to the damage condition, a combination of one or more of these methods are used.

REPAIR METHOD : Heating Repair

INFOID:0000000012123750

Infrared lamp, jet heater, or dry oven are used to heat deformed plastic parts to their deformation temperature. At this temperature, the part becomes soft and the deformed area can easily be repaired. In some cases, partial deformation cannot be repaired.



Condition of damage

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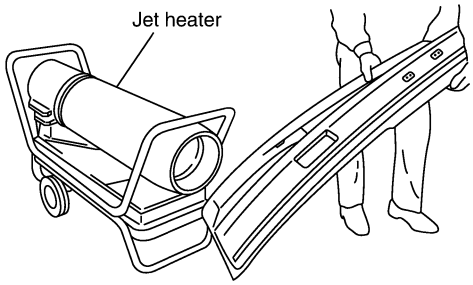


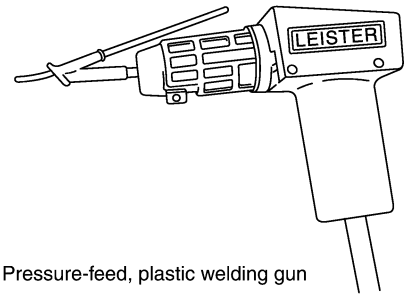
Heating repair by jet heater

JSKIA6696GB

REPAIR METHOD : Welding Repair

INFOID:0000000012123749

- If the damage is a crack or tear, use the plastic welding tool. In this method, the welding rod is welded into the damaged area.
- The welding repair method can be applied to thermoplastic materials but not to thermosetting plastics.
- The welding rod must be the same material as the damaged part. It can be purchased on the market.
  Some damaged areas may be unrepairable and must be scrapped. In this case, a portion of the scrapped part may be used as a welding rod.
  To repair urethane parts, it is recommended to obtain commercially available welding rods.
- Welding rods available on the market are for hard-type PP, urethane, PC, ABS, PE and PVC.



Pressure-feed, plastic welding gun

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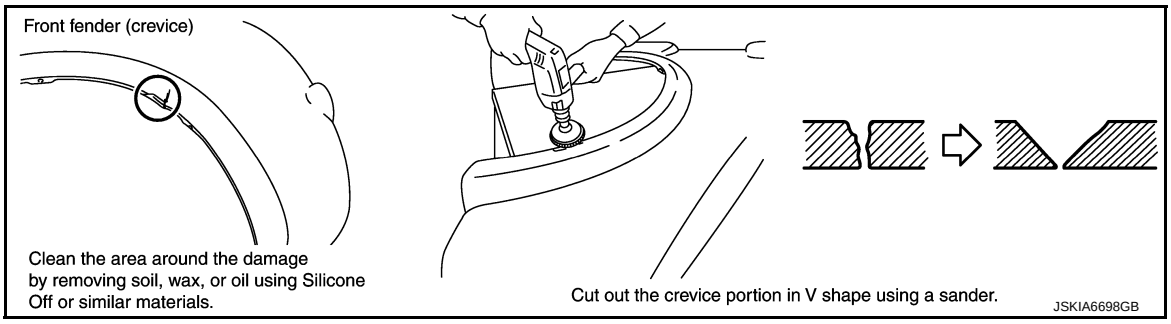
REPAIR METHOD : Adhesive Repair

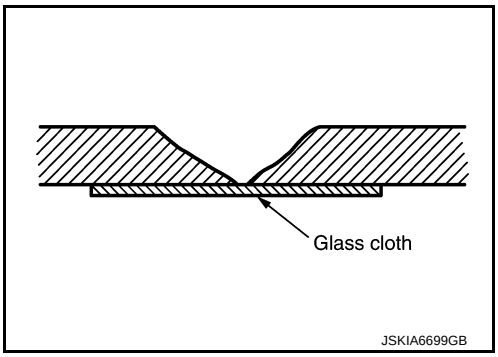
INFOID:0000000012123748

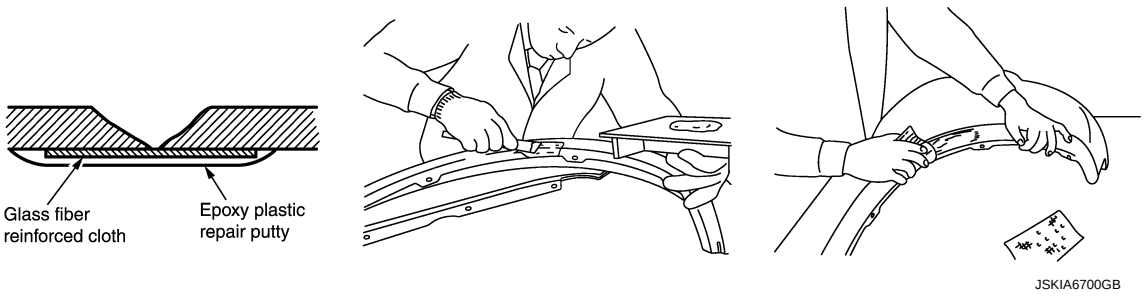
If the damaged part is a large cavity or is badly scraped, the adhesive repair method is used. The repair is accomplished by mixing two liquid type adhesives and forming a putty. Cracked and torn FRP and glass fiber urethane cannot be repaired by this method. A glass fiber reinforced cloth and an epoxy type adhesive are applied from the back side to reinforce the damaged area. When PP material is adhered, PP primer for adhesion should be applied on the adhesion surface.

FLEX PANEL REPAIR BY USING PLASTIC REPAIR PUTTY



Sand the top surface and the back surface of and around the crevice using #180 sandpaper. Place a glass fiber reinforced cloth soaked with the instant adhesives (3M™ 8007 or the equivalent) onto the back of the crevice so that it covers the crevice and its adjacent area. (Glass fiber reinforced cloth must be measured and cut beforehand.)
*: Primer needs to be applied for PP materials.





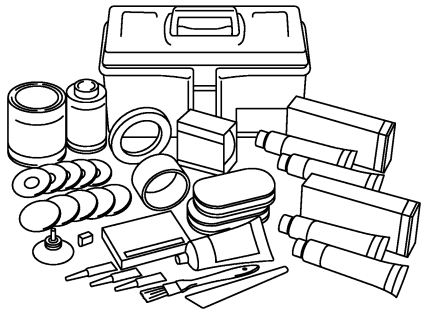
Apply epoxy plastic repair putty (3M™ 5887 or the equivalent) to cover the fixed glass fiber reinforced cloth and its surrounding areas using a spatula after making sure that the glass fiber reinforced cloth has dried. *: Primer needs to be applied for PP materials.	Apply epoxy plastic repair putty to the panel crevice surface using a spatula.	Place #120 sandpaper onto the pad for sanding after making sure that the epoxy plastic repair putty has dried. Then, finish sanding using #180 and #320 sandpaper.

REPAIR METHOD : Repair Tools

INFOID:0000000012123745

The main repair tools used for heating repair are infrared stand, jet heater, and welding equipment exclusively developed for plastics. Repair kits that contain repair materials are also available on the market. The main repair tools are listed below.

Repair Tool	Product name	Applicable plastic	Remarks
Resin parts repair tools	3M™ Structure plastic adhesive 8005 or equivalent	Urethane, PP, PC, ABS, FRP	Adhesive repairs are possible.
Epoxy resin repair product	3M™ Automix™ plastic repair putty 5887	↑	↑
	3M™ epoxy adhesive 8106		
	3M™ plastic parts putty 8108		
	3M™ instant adhesive 8007		
Welding equipment	Lyster Type Plastic Processing-Welder	Thermoplastic resin	Welding
Infrared stand	—	Urethane, thermoplastics	Heating repair
Jet heater	—	Urethane, thermoplastics	↑
Soldering gun	—	Temporary mending of thermo-plastics	Welding



Resin parts repair tools JSKIA6892GB

REPAIR METHOD : Repair Working Order

INFOID:0000000012106695

This flowchart shows the main steps for repair according to the condition of the portion to be repaired. For details, refer to the Technical Bulletin of Plastic Bumper Repair.
A: Application PUR bumper
B: Application PP bumper
A_1, B_1: Cracks or holes in bumper foundation
A_2, B_2: Scratches on bumper surface
A_3, B_3: Service parts (Black foundation)

◯: Repaired practice △: If necessary

No.	Operation procedures	PUR (A)			PP (B)		
		A_1	A_2	A_3	B_1	B_2	B_3
1	Degreasing	◯	◯	◯	◯	◯	◯
2	Sanding (I) (disc paper #50)	◯	◯	—	◯	◯	—
3	Applying auto-body repair tape (to back portion)	△	—	—	△	—	—
4	Temporary fastening	—	—	—	△* (For cracks)	—	—
5	Welding (For large crack or hole)	—	—	—	△*	—	—
6	Sanding (II) (disc paper #80)	—	—	—	△*	—	—
7	Applying primer	—	—	—	◯	◯	—
8	Drying	—	—	—	◯	◯	—
9	Applying flexible parts repair material	◯	◯	—	◯	◯	—
10	Drying	◯	◯	—	◯	◯	—
11	Sanding (III) (disc paper #120)	◯	◯	—	◯	◯	—
12	Sanding (IV) (disc paper #180, 240)	◯	◯	◯	◯	◯	◯
13	Cleaning (I)	◯	◯	◯	◯	◯	◯
14	Plastic primer coating	△	△	△	◯	◯	◯
15	Drying	△	△	△	◯	◯	◯
16	Applying primer surfacer	◯	◯	◯	◯	◯	◯
17	Drying	◯	◯	◯	◯	◯	◯
18	Sanding (V) (sandpaper #320, #400, #600)	△	△	△	△	△	△
19	Cleaning (II)	△	△	△	△	△	△
20	Applying finishing coats	◯	◯	◯	◯	◯	◯
21	Drying	◯	◯	◯	◯	◯	◯

*: These are used for hard-type PP.

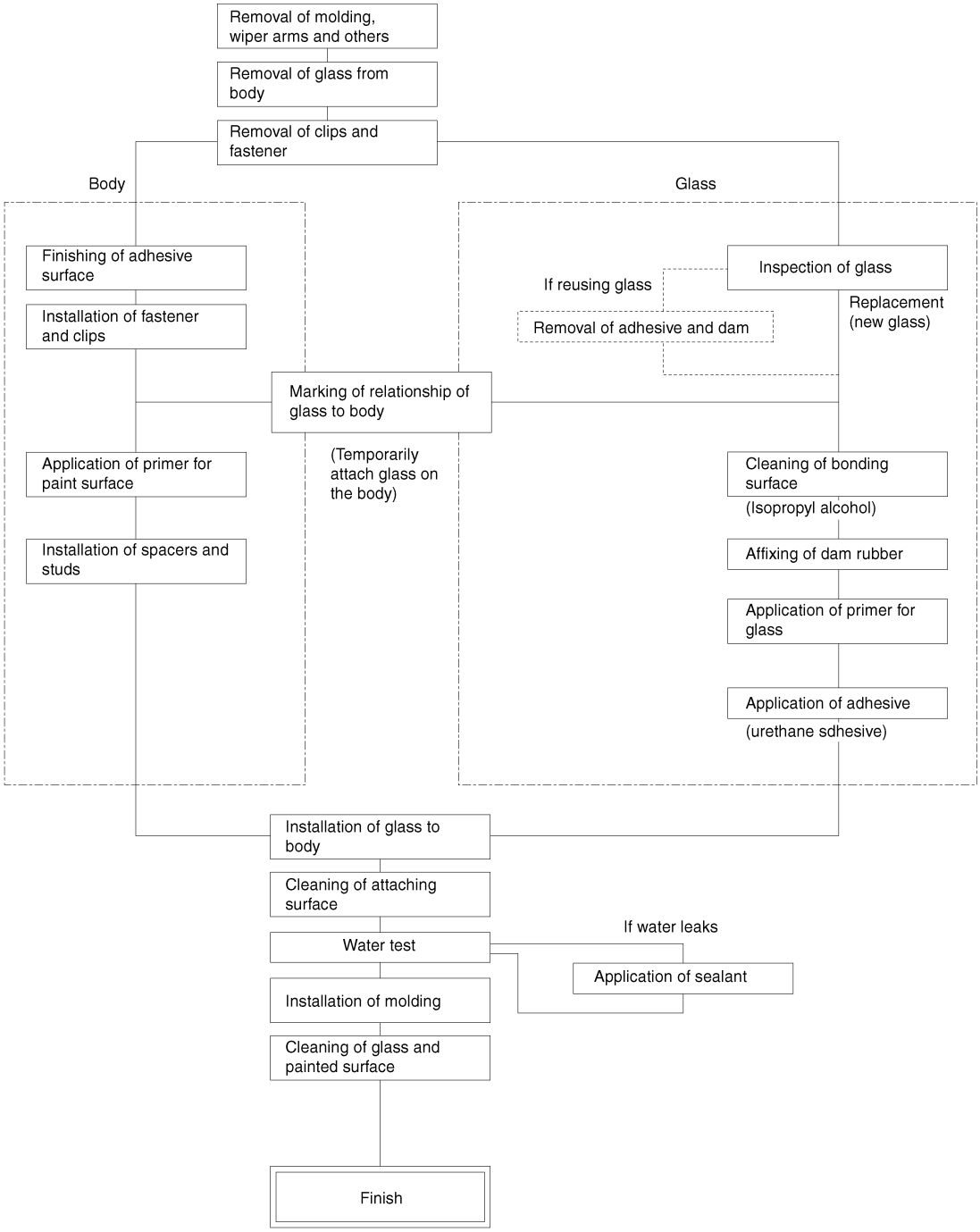
GLASS STATIONARY

REPLACEMENT PROCEDURE OF WINDSHIELD AND REAR WINDOW

REPLACEMENT PROCEDURE OF WINDSHIELD AND REAR WINDOW : Replacement Procedure of Windshield and Rear Window

INFOID:0000000012106699

The windshield glass and rear window glass of most of NISSAN's vehicles have been installed with urethane adhesive sealant.
This section shows removal and installation of the glass that is bonded with urethane adhesive sealant.



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REMOVAL OF GLASS

REMOVAL OF GLASS : Removal of Related Parts

INFOID:0000000012123759

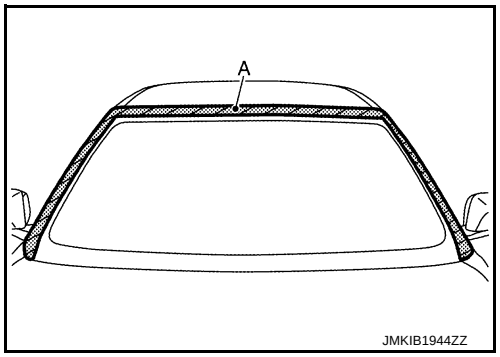
Remove moldings, wiper arms, garnishes, etc. that may be scratched. Parts to be removed may vary slightly for different makes of cars. Refer to each model's Service Manual when removing the moldings.

REMOVAL OF GLASS : Cutting of Urethane Adhesive Sealant

INFOID:0000000012106700

(1) PIANO WIRE METHOD

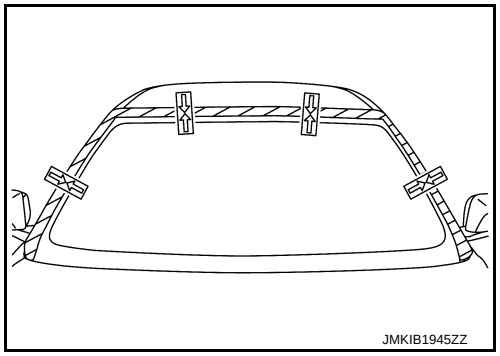
1. Apply protective tape (A) on body panel around windshield glass to protect painted surface from damage.



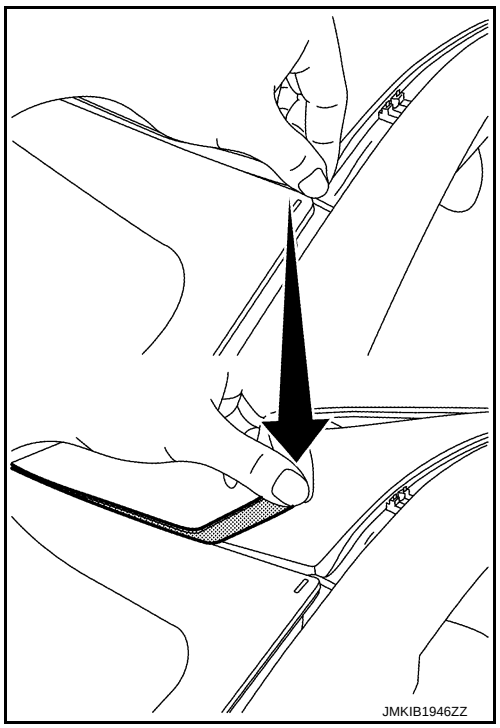
2. Follow the below depend on the case.

a. In case glass is reusable:
Paint matching marks on the windshield glass and body panel, positioning during installation can be easily performed.

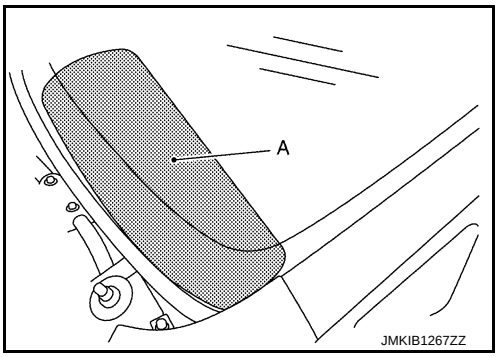
b. In case glass is not reusable:
Skip this process.



3. Remove windshield glass upper molding.
CAUTION:
Remove windshield glass upper molding left on vehicle using a pliers etc..



4. Apply protective standish cover (A) on instrument panel to protect it from damage.

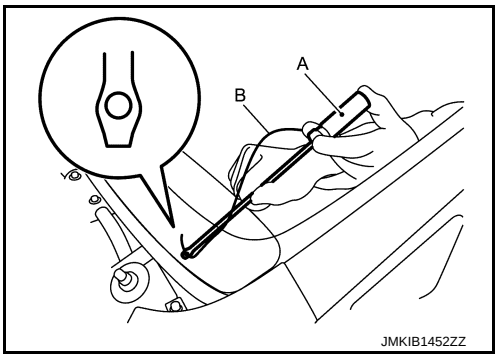


5. Remove the adhesive using a piano wire.

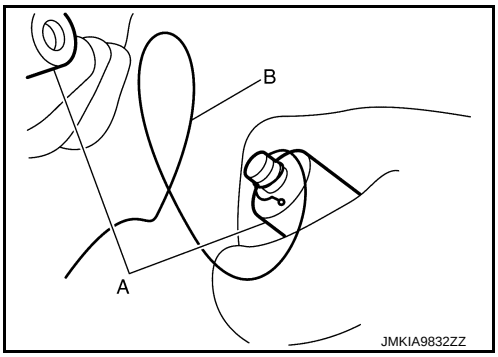
a. Pass the piano wire (B) from passenger room to bonded area of glass using a wire pierce (A).

CAUTION:

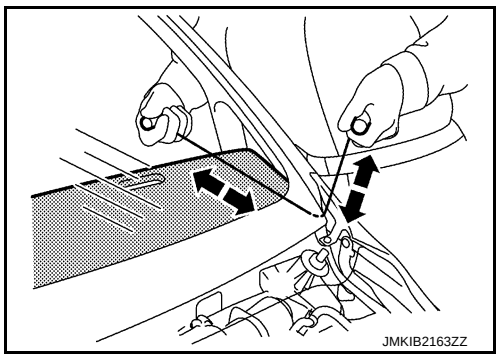
- **Never press piano wire excessively against edge of glass.**
- **For corner area, never insert piano wire into the mating surfaces of glass.**
- **Never damage harness around glass.**



b. Tie both ends of the piano wire (B) to the wire grip (A), etc..



c. With 2 persons, one holding the piano wire inside the vehicle along with the glass and the other holding it outside the vehicle along with the gap between the body and glass, pull one grip to cut off the adhesive.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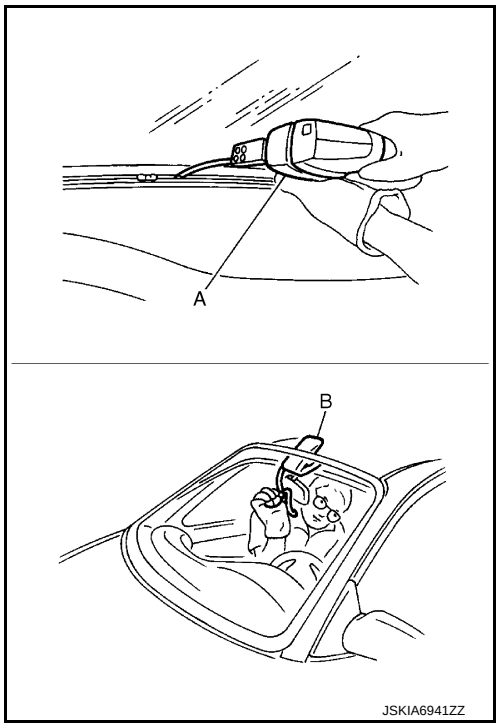
NOTE:
Power cutting tool (A) and an inflatable pump bag (B) can also be used.



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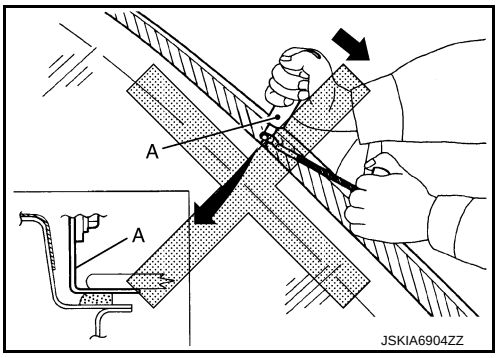
6. Follow the below depend on the case.

a. In case glass is reusable:

CAUTION:

- **Never use a windshield cutter (A) if the windshield is reused. (If may scratch the glass surface.)**
- **Never damage the windshield glass and body panel.**

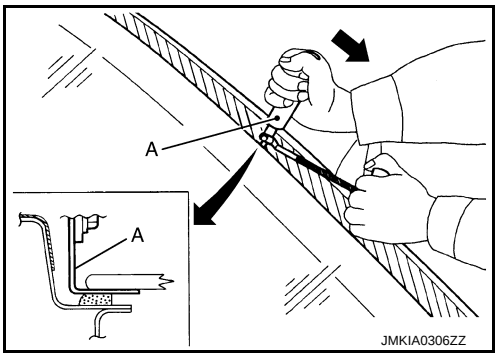


b. In case glass is not reusable:

Using a windshield cutter (A) into the bonded area. Remove the adhesive by pulling the knife, keeping the tip parallel to the edge of glass.

NOTE:

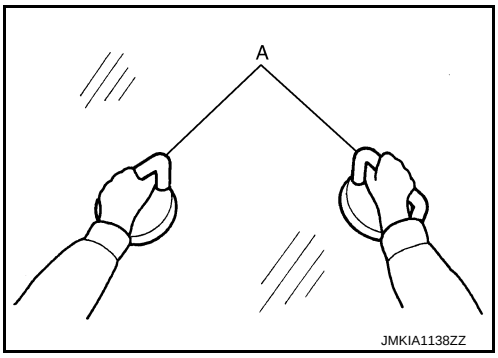
Apply soapy water around the bonded area on the body for smooth movement of windshield cutter.



7. Use suction lifter (A) or rubber suction cups, etc. to remove windshield glass from the vehicle.

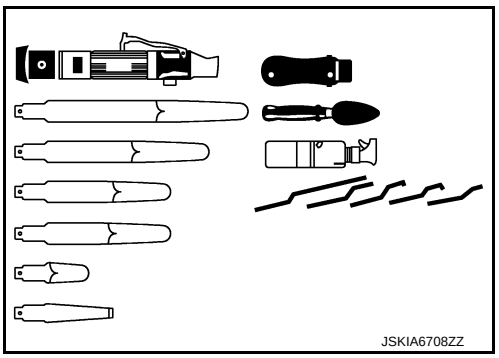
CAUTION:

2 workers are required for removal in order to prevent damage.



(2) AIR KNIFE METHOD

- An air knife is used to cut glued windshield sealant.
- The windshield sealant is cut while the blade cuts at high frequency by air pressure.
- It is composed of five blades of different sizes.
- It allows access to areas without damaging exterior painting and moldings.
- Working inside the vehicle, just one operation is required.
- Working hours can be reduced.

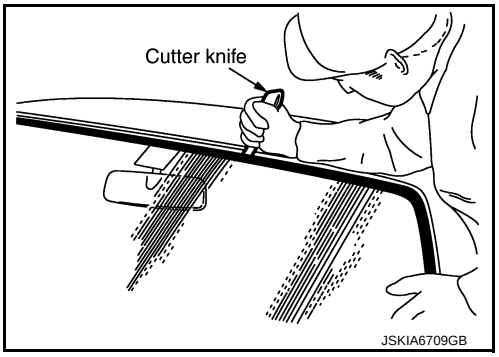


(3) USE OF A CUTTER KNIFE

A cutter knife may be used to cut around the edge prior to using the windshield knife.

NOTE:

Be careful not to scratch the panel.

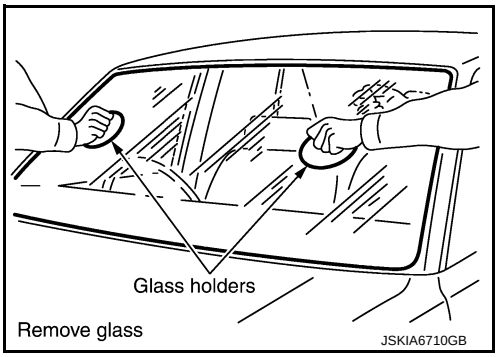


REMOVAL OF GLASS : Removal, Inspection and Cleaning of Glass

INFOID:0000000012123758

(1) WHEN GRASS IS NOT BROKEN

- From the outside, using glass holders, remove the glass from the forward position.
- Scrape off old adhesive.
- Use alcohol or similar cleaning solvent to clean the glass.
- Inspect the glass thoroughly for scratches and dirt.
- Remove dam rubber.



(2) WHEN GLASS IS BROKEN

- While cutting the sealant with the knife, remove pieces of broken glass.
- Small pieces should be completely removed using a vacuum cleaner.

NOTE:

- Prior to the sealant cutting process, the instrument panel must be covered with a protective covering so as to prevent pieces of broken glass from falling into the defroster duct.
- At the time when the glass was broken, some pieces may have entered the defroster duct and heater. Carefully inspect and remove them, if found.
- When removing glass, do not hold only one side. Use glass holders and apply an even force to remove the glass.

REMOVAL OF GLASS : Glass Storage

INFOID:0000000012123757

The glass has a curved shape. When storing, place the glass on top of a cloth or a pad that has a similar curvature.

NOTE:

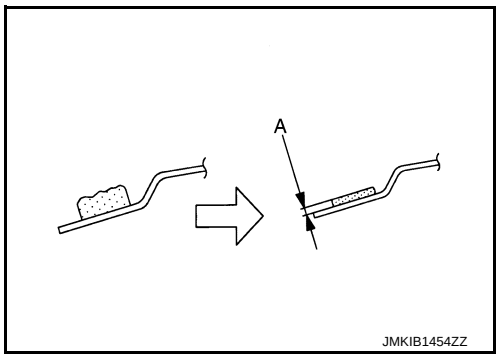
Do not store the glass leaning on its corners.

INSTALLATION OF GLASS

INSTALLATION OF GLASS : Installation

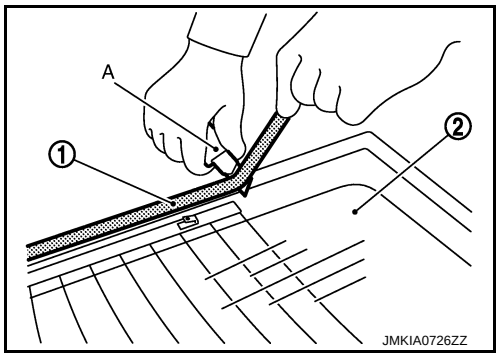
INFOID:0000000012123762

1. Remove remaining adhesive and sealant using a scraper on the body side to approximately a depth that is 2 mm (0.079 in) thickness (A) so that entire contour becomes smooth.
CAUTION:
If the bonded area on the body is scratched, repair it using a 2 liquid type urethane paint. Never use lacquer type paint.



2. Follow the below depend on the case.

a. In case glass is reusable:
Remove remaining adhesive ① and sealant using a cutter knife (A) smooth out windshield glass surface ②.



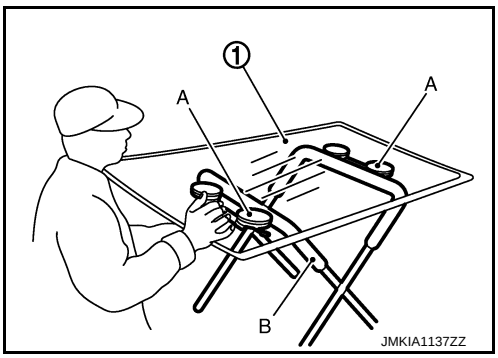
b. In case glass is not reusable:
Skip this process.

3. Follow the below depend on the case.

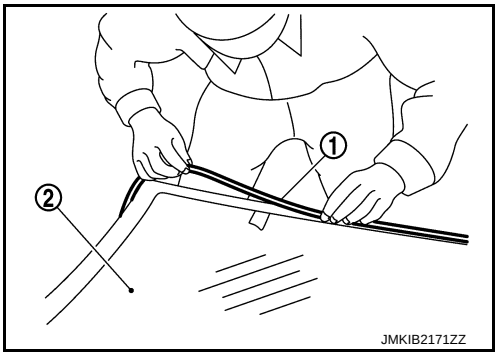
a. In case glass is reusable:
Remove all windshield glass spacer.

b. In case glass is not reusable:
Mount the glass onto the vehicle and point matching marks on the body and glass when installing new glass. Then remove the glass again.

4. Use suction lifter (A) or rubber suction cups to set glass ① on glass stand (B).

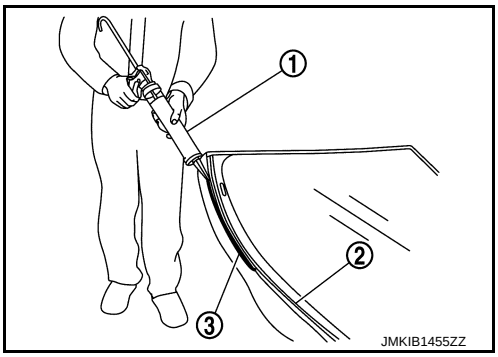


5. Clean the bonded area on glass and body side using a white gasoline or degreasing agent.
6. Install new windshield insulator and new windshield spacers to windshield glass.
7. When installing glass ②, apply the dam sealant rubber ① from the edge of the glass so as to hide the black print.
   CAUTION:
   Start to apply the dam sealant rubber at the outline mark of black print. Apply it so as to only place it without pulling. Stop applying at another outline mark of black print.

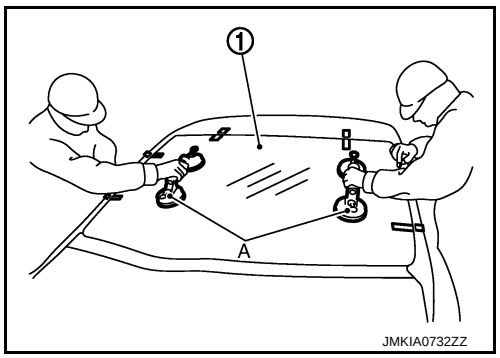


8. Apply primer for glass along the entire circumference of glass.
   Use the sealing kit for glass application and the special holder for cartridge or similar tools.
   CAUTION:
   There are 2 types of primer. Never confuse the application methods.
   - **Primer for painted surfaces**
   - **Primer for glass**
   - **Apply primer for glass and adhesive by following the black print marks on windshield glass**

   NOTE:
   The essential function of primers is to strengthen adhesion between the glass and the painted surface.
9. Apply primer for the painted surface to the body side bonding surface.
   CAUTION:
   - **If the body side bonding surface is repaired with 2 liquid type urethane paint, always apply the primer after drying the paint.**
   - **If primer for painted surfaces adheres to a painted surface other than the bonding area, or if it overflows, quickly remove it with white gasoline or degreasing agent.**
   - **Always use a Standish cover (stainless plate) to prevent primer for painted surfaces from adhering to the instrument panel assembly.**
10. Use sealant gun ①, affix the dam sealant rubber ② and apply adhesive ③ along the edge of the glass within the time period indicated in the primer's instruction after applying primer.
    NOTE:
    - Open adhesive by cutting off the nozzle tip and set it in a sealant gun.
    - Regarding the range of adhesive, refer to the Service Manual on each model.

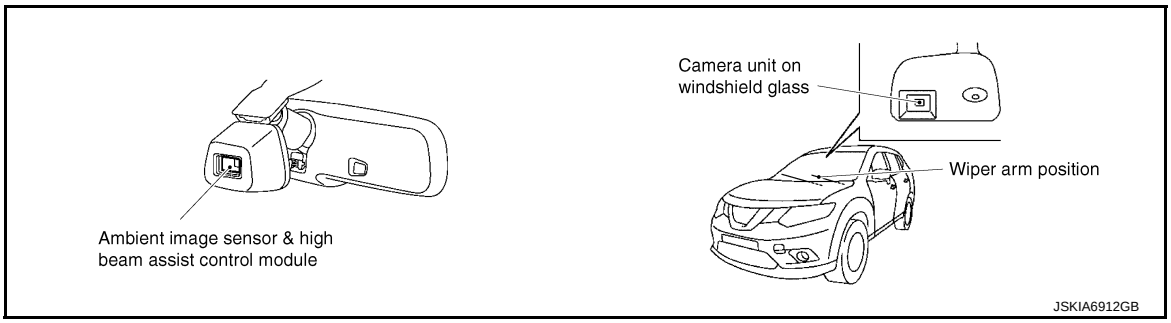


11. Use suction lifter (A) or rubber suction cups that are installed in advance, align the matching marks between the holder and roof panel hole and between the body and windshield glass ① to install them on the vehicle.
CAUTION:
2 workers are required when installing the windshield glass.



12. Press entire surface of glass lightly to fit it completely.
13. Correct any adhesive overflow or shortage using a spatula to make the surface smooth.
14. Install new windshield glass upper molding.
CAUTION:
- **Always install the windshield glass upper molding before the adhesive hardens.**
- **After installing glass, keep the front door glass open until the adhesive is completely cured.**
- **Never drive the vehicle before the adhesive is completely cured.**

NOTE:
Lightly affix the center of molding. Affix the whole length while checking the length on the left and right.
15. Remove protective tape.
16. Install the removed parts.
CAUTION:
- **Adjust the camera unit on the windshield glass, if equipped.**
- **Adjust the front wiper arms stop position.**
- **Be sure to perform "WRITE CONFIGURATION" when replacing inside mirror assembly (high beam assist control module), if equipped. Or not doing so, high beam assist control function does not operate normally.**
- **Check the mating area with surrounding parts. Adjust if necessary.**

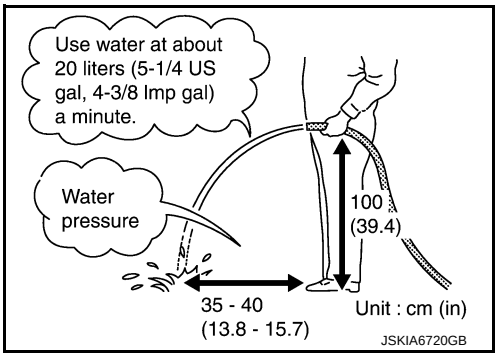


INSTALLATION OF GLASS : Inspection for Water Leakage

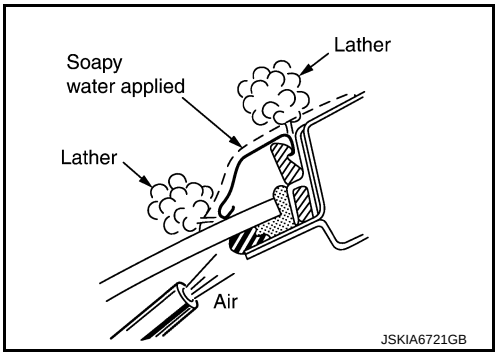
INFOID:0000000012106696

(1) PERFORM A WATER LEAKAGE TEST

- Pour water on the vehicle, and check the passenger compartment and trunk for water leakage after the hardening time has elapsed.
- Use water at a rate of 20 liters (5-1/4 US gal, 4-3/8 Imp gal) a minute. The water pressure must be at such a level that when sprayed from the waist, water falls to a place 35 cm - 40 cm (13.8 in - 15.7 in) away. [The hose should be an ordinary garden hose of approximately 15 mm (0.59 in) in diameter.]

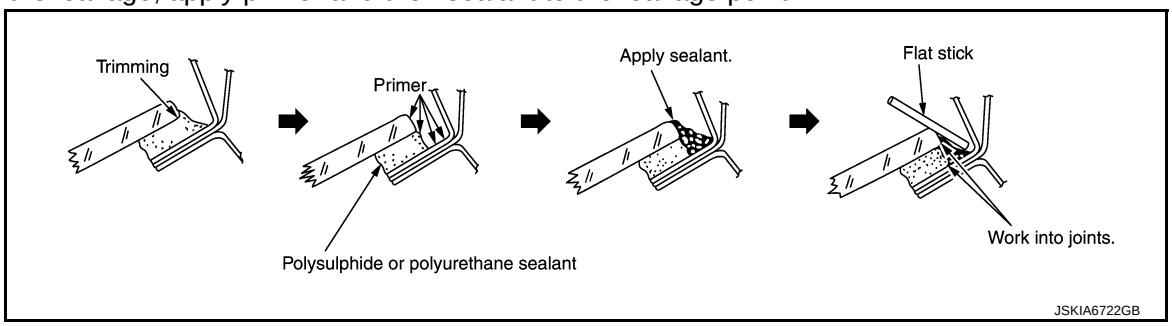


- The hose should be used as it is, or press the end of it lightly according to the condition of the panel joint. Water should be sprayed for more than 10 minutes from a distance of 3 cm - 30 cm (1.18 in - 11.81 in).
- The water leakage inspection should be made from the lower to the upper body.
- **CAUTION:**
  Wait at least 2 hours after installing windshield glass because the adhesive must be cured before performing the leakage test.
- For water leakage around the front and rear windows, an air checking method is available, as shown in the figure.



(2) SEAL ANY WATER LEAKS

Leakage can be repaired without removing and reinstalling glass.
If water is leaking between caulking material and body or between glass and caulking material, determine the extent of the leakage by applying water while pushing glass outward.
To stop the leakage, apply primer and then sealant to the leakage point.



REPLACEMENT OF MOLDED TYPE REAR WINDOW

REPLACEMENT OF MOLDED TYPE REAR WINDOW : Replacement of Molded Type Rear Window

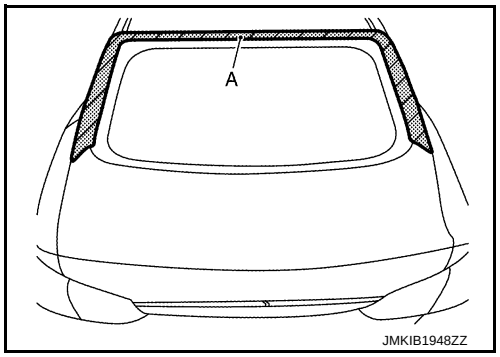
INFOID:0000000012138239

There are some models which have the molded type rear window.
The molded type rear window is normally preassembled with a single piece of molding. For service, glass is available separate from the molding.

REPLACEMENT OF MOLDED TYPE REAR WINDOW : Removal

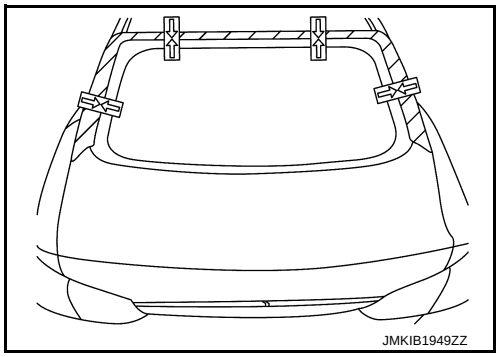
INFOID:0000000012123763

1. Apply protective tape (A) on body panel around rear window glass to protect painted surface from damage.



2. Follow the below depend on the case.

a. In case glass is reusable:
Paint matching marks on the rear window glass and body panel, positioning during installation can be easily performed.

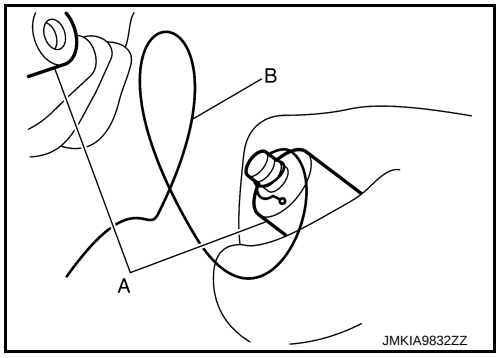


b. In case glass is not reusable:
Skip this process.

3. Remove the adhesive using a piano wire.

a. Pass the piano wire from passenger room to bonded area of glass using a wire pierce.
CAUTION:
- **Never press piano wire excessively against edge of rear window glass.**
- **For corner area, never insert piano wire into the mating surfaces of rear window glass.**
- **Never damage harness around rear window glass.**

b. Tie both ends of the piano wire (B) to wire grip (A), etc..



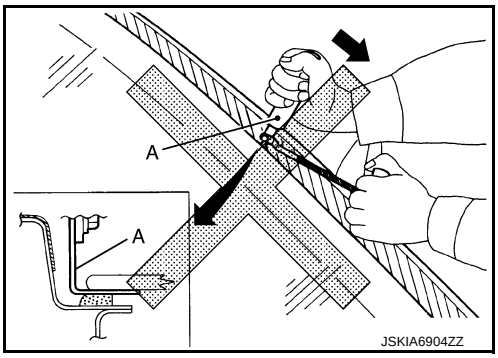
4. Follow the below depend on the case.

a. In case glass is reusable:
With 2 persons, one holding the piano wire inside the vehicle along with the glass and the other holding it outside the vehicle along with the gap between the body and glass, pull one grip to cut off the adhesive.

CAUTION:

- **Never use a windshield cutter (A) if the rear window is reused. (It may scratch the glass surface.)**
- **Never damage the rear window and body panel.**

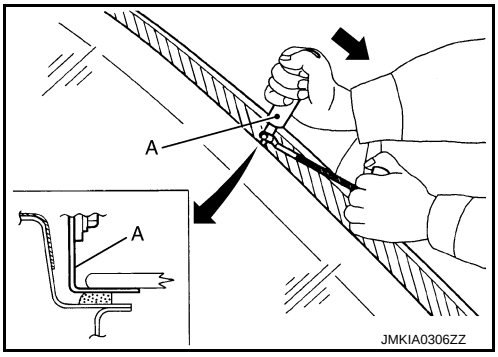
NOTE:
Power cutting tool and an inflatable pump bag can also be used.



b. In case glass is not reusable:
Using a windshield cutter (A) into the bonded area. Remove the adhesive by pulling the knife, keeping the tip parallel to the edge of glass.

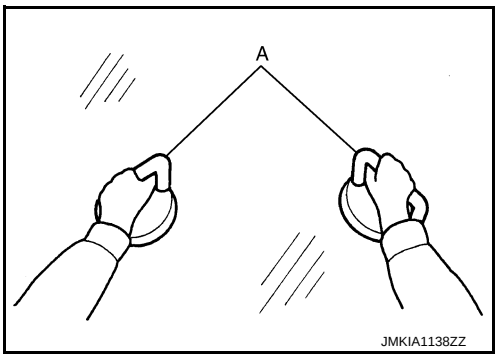
NOTE:

- Apply soapy water around the bonded area on the body for smooth movement of windshield cutter.
- Power cutting tool and an inflatable pump bag can also be used.



5. Use suction lifter (A) or rubber suction cups, etc. to remove rear window glass from the vehicle.

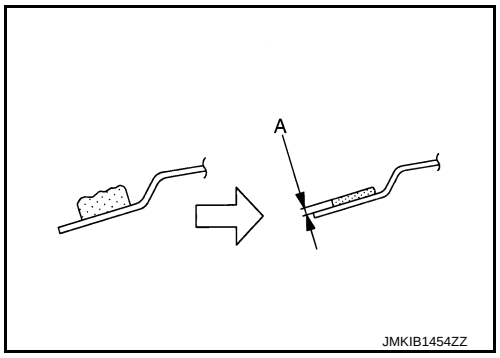
CAUTION:
2 workers are required for removal in order to prevent damage.



REPLACEMENT OF MOLDED TYPE REAR WINDOW : Installation

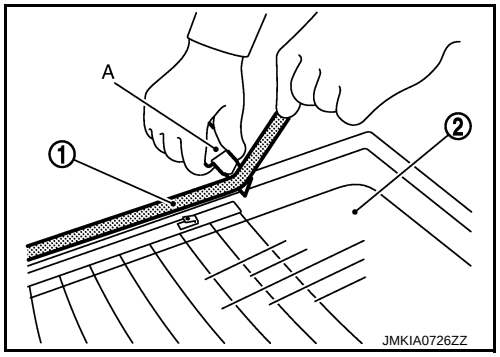
INFOID:0000000012106697

1. Remove remaining adhesive and sealant using a scraper on the body side to approximately a depth that is 2 mm (0.079 in) thickness (A) so that entire contour becomes smooth.
CAUTION:
If the bonded area on the body is scratched, repair it using a 2 liquid type urethane paint. Never use lacquer type paint.



2. Follow the below depend on the case.

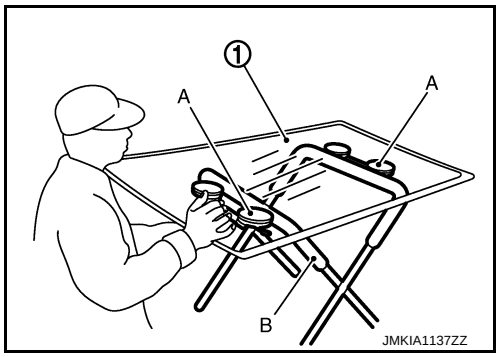
a. In case glass is reusable:
Remove remaining adhesive ① and sealant using a cutter (A) smooth out rear window glass surface ②.



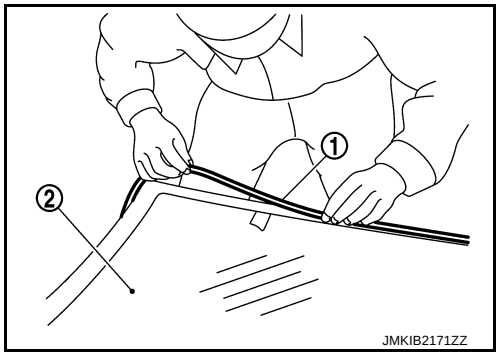
b. In case glass is not reusable:
Skip this process.

3. Mount rear window glass onto the vehicle and paint matching marks on body panel and rear window glass when installing new rear window glass. Then remove rear window glass again.

4. Use suction lifter (A) or rubber suction cups to set rear window glass ① on glass stand (B).



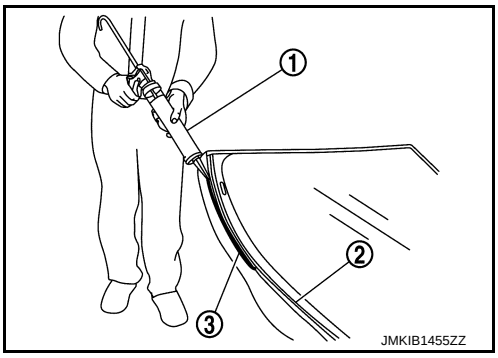
5. Clean the bonded area on rear window glass and body panel using a white gasoline or degreasing agent.
6. Install new rear window spacers to new rear window glass.
7. When installing new rear window glass ②, apply the dam sealant rubber ① from the edge of the rear window glass so as to hide the black print.
CAUTION:
Start to apply the dam sealant rubber at the outline mark of black print. Apply it so as to only place it without pulling. Stop applying at another outline mark of black print.



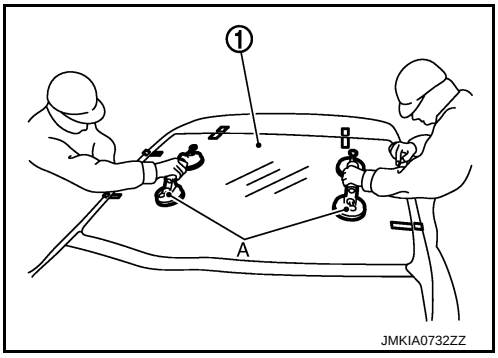
8. Apply primer for glass along the entire circumference of rear window glass.
   Use the sealing kit for glass application and the special holder for cartridge or similar tools.
   CAUTION:
   There are 2 types of primer. Never confuse the application methods.
   - **Primer for painted surfaces**
   - **Primer for glass**
   - **Apply primer for rear window glass and adhesive by following the black print marks on rear window glass.**

   NOTE:
   The essential function of primers is to strengthen adhesion between rear window glass and painted surface.
9. Apply primer for the painted surface to the body side bonding surface.
   CAUTION:
   - **If the body side bonding surface is repaired with 2 liquid type urethane paint, always apply the primer after drying the paint.**
   - **If primer for painted surfaces adheres to a painted surface other than the bonding area, or if it overflows, quickly remove it with white gasoline or degreasing agent.**

10. Use sealant gun ①, affix the dam sealant rubber ② and apply adhesive ③ along the edge of rear window glass within the time period indicated in the primer's instruction after applying primer.
    NOTE:
    - Open adhesive by cutting off the nozzle tip and set it in a sealant gun.
    - Regarding the range of adhesive, refer to the Service Manual on each model.



11. Use suction lifter (A) or rubber suction cups that are installed in advance, align the matching marks between the holder and roof panel hole and between the body panel and rear window glass ① to install them on the vehicle.
    CAUTION:
    2 workers are required when installing rear window glass.



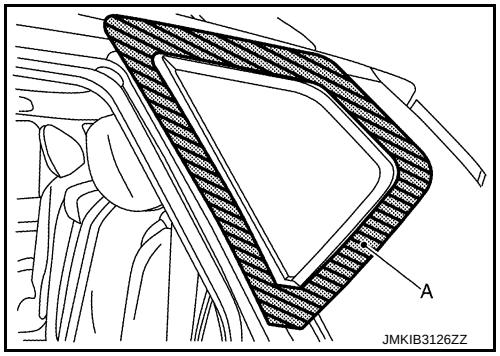
12. Press entire surface of glass lightly to fit it completely.
13. Correct any adhesive overflow or shortage using a spatula to make the surface smooth.
14. Remove protective tape.
15. Install the removed parts.
    CAUTION:
    Check the mating area with surrounding parts. Adjust if necessary.

REPLACEMENT OF MOLDED TYPE SIDE WINDOW

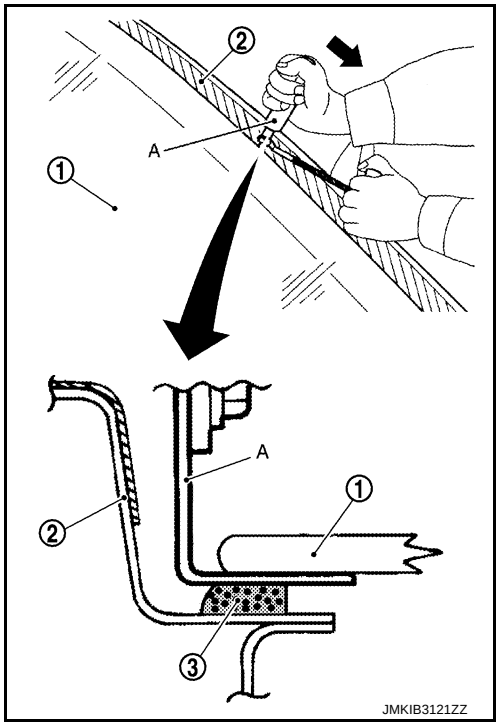
REPLACEMENT OF MOLDED TYPE SIDE WINDOW : Removal

INFOID:0000000012195232

1. Apply protective tape (A) on body side outer panel around side window glass to protect painted surface from damage.



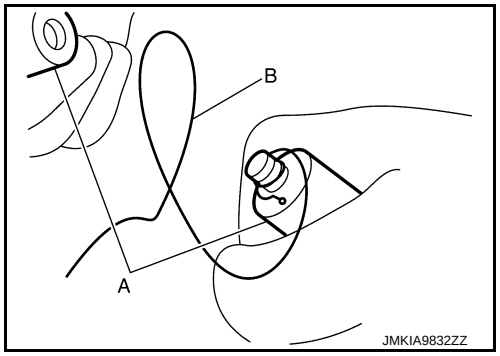
2. Insert a windshield cutter (A) between side window glass ① and body side outer panel ②. Remove adhesive ③ by pulling the windshield cutter, keeping the tip parallel to the edge of side window glass.
CAUTION:
Use piano wire to cut sealant if its difficult to use windshield cutter.



3. Remove the adhesive using a piano wire.

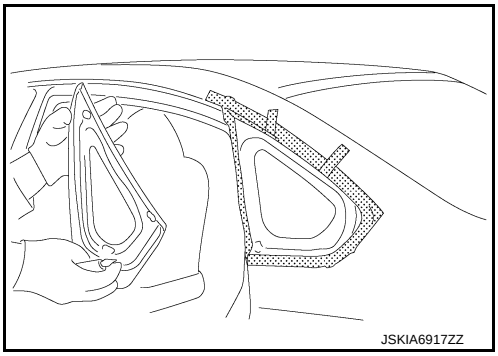
a. Pass the piano wire from passenger room to bonded area of side window glass using a wire pierce.
CAUTION:
Never damage surrounding parts.

b. Tie both ends of the piano wire (B) to wire grip (A), etc..



c. Remove adhesive by using piano wire alongside of side window glass and body side outer panel.
CAUTION:
Remove adhesive, 2 workers are required by all means.
NOTE:
Power cutting tool and an inflatable pump bag can also be used.

4. Remove side window glass.



REPLACEMENT OF MOLDED TYPE SIDE WINDOW : Installation

INFOID:0000000012195231

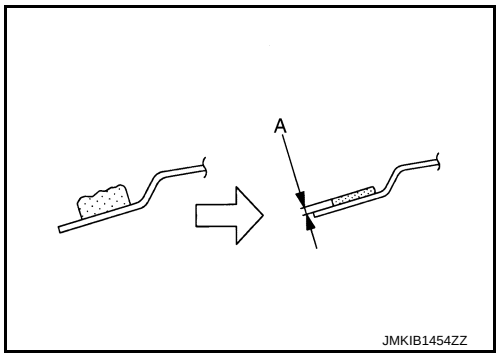
CAUTION:

- **Whether window glass is reusable or not differs according to the model. For details, refer to the Service Manual for each model.**
- **Never damage body side outer panel.**

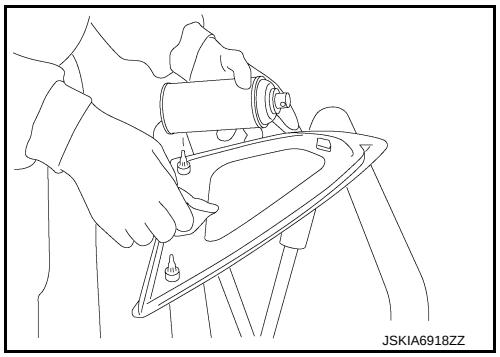
1. Use a cutter knife or scraper, and leave the of adhesive on the body side approximately 2 mm (0.079 in) (A) to make adhesive surface smooth.

   CAUTION:

   If the bonded area on the body is scratched, repair it using a 2 liquid types urethane paint. Never use lacquer type paint.



2. Clean the bonded area on side window glass and body side outer panel using a white gasoline or degreasing agent.



3. Apply glass primer along the entire circumference of side window glass.

   CAUTION:

   - **There are 2 types of primer. Never confuse the application methods.**
   - **Painted surfaces primer**
   - **Glass primer**
   - **Use the sealing kit for glass application and the special holder for cartridge or similar tools.**
   - **Dry glass primer according to the specification of adhesive kit.**

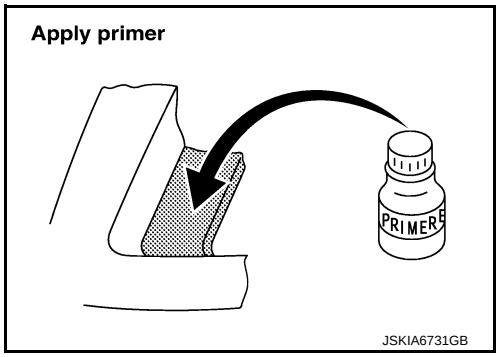
   NOTE:

   The essential function of primers is to strengthen adhesion between the glass and the painted surface.

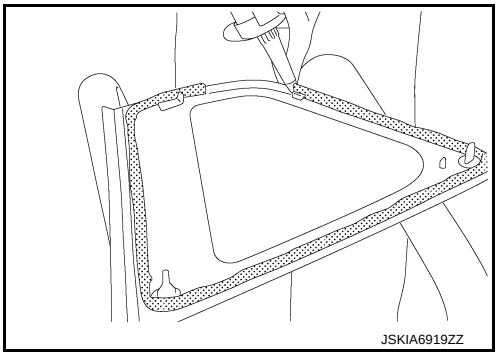
4. Apply painted surface primer to the body side bonding surface.

   CAUTION:

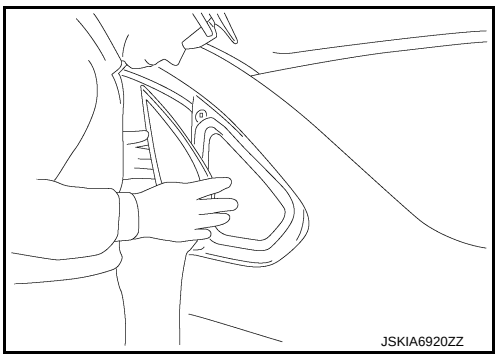
   - **If the body side bonding surface is repaired with 2 liquid types urethane paint, always apply the primer after drying the paint.**
   - **If painted surfaces primer adheres to a painted surface other than the bonding area, or if it overflows, quickly remove it with white gasoline or degreasing agent.**
   - **Dry painted surface primer according to the specification of adhesive kit.**



5. Apply adhesive to entire circumference of side window glass by using a sealant gun.
   NOTE:
   Open adhesive by cutting off the nozzle tip and set it in a sealant gun.


JSKIA6919ZZ

6. Press entire surface of side window glass lightly to fit it completely.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7. Correct any adhesive overflow or shortage using a spatula to make the surface smooth.
   CAUTION:
   - **After installing side window glass, keep the all door glass open until the adhesive is completely cured.**
   - **Never drive the vehicle before the adhesive is completely cured.**
8. Remove protective tape.
9. Install removed parts.
   CAUTION:
   Check the mating area with surrounding parts. Adjust if necessary.

REPLACEMENT OF MOLDED TYPE SIDE WINDOW : Inspection

INFOID:0000000012196098

WATER LEAKAGE INSPECTION

CAUTION:
- **Dry adhesive according to the specification of adhesive kit, do the leaking check when adhesive is stiffen.**
- **If leakage was found, start over from the beginning as side window glass removal, install and leaking check.**

WINDSHIELD GLASS REPAIR

WINDSHIELD GLASS REPAIR : Windshield Glass Repair

INFOID:0000000012123766

In windshield glass repair work, the windshield glass damaged by flying stones or other causes while driving is temporarily repaired using a windshield glass repair kit. It takes 25 minutes to repair for ordinary damage.
Laminated safety glass is used for automobiles that have a triple-layer construction, in which the transparent interlayer is sandwiched between outer layers.
“Damage” on the glass can be defined as follows. Impact causes the outermost layer of the glass to crack, which generates an air gap inside the glass. Consequentially, diffusion of light occurs, and driver's view is obstructed.
The aim of windshield glass repair work is to secure visibility and to minimize damage by injecting ultraviolet curing resin into the damaged area and curing the resin.

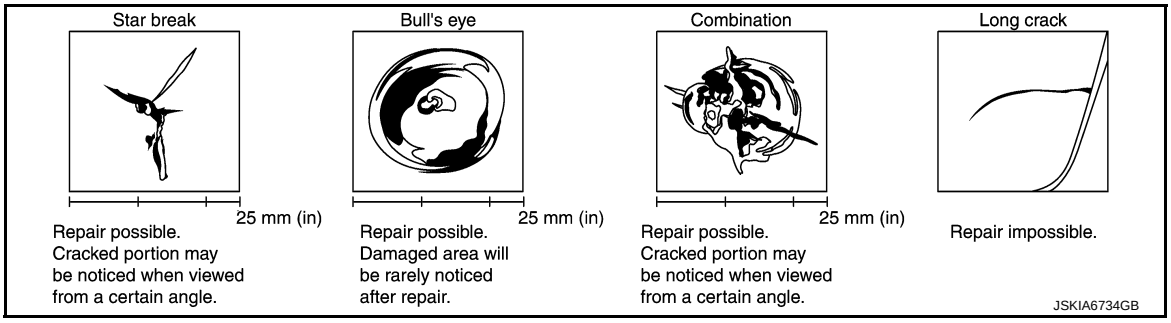
WINDSHIELD GLASS REPAIR : Range of Repairable Damage

INFOID:0000000012123765

Damage must be at least 5 cm (1.97 in) inward from the windshield glass edges. The diameter of the damaged area must be 25 mm (0.98 in) or less.

WINDSHIELD GLASS REPAIR : Type of Repairable Damage

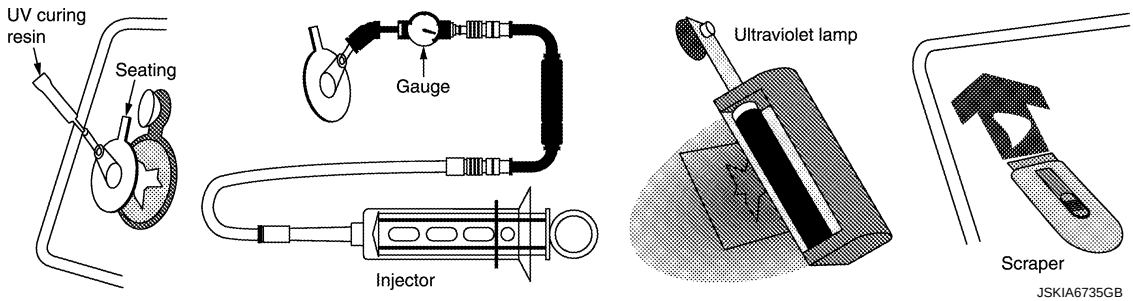
INFOID:0000000012123764



WINDSHIELD GLASS REPAIR : Windshield Glass Repair Method

INFOID:0000000012106698

Outline of windshield glass repair by using by windshield glass repair kit



Preparation	Intake/pressurization	Ultraviolet irradiation work	Finish
• Remove unnecessary pieces of glass from the damaged area using a glass picker or drill. • Degrease, apply the base seat onto the damage, and then inject the resin.	• Bleed air from the damaged area using an injector. • Apply pressure to penetrate the resin thoroughly inside the damaged area using an injector.	• First, position an ultraviolet lamp so that it is aimed at the damaged area. • Then, turn on the lamp and cure the resin.	Scrape excess resin using a scraper or similar tool, and then polish the glass with a brightening agent.

AIR BAG SYSTEM
PRECAUTIONS

PRECAUTIONS : Precautions

INFOID:0000000012123780

When removing or installing SRS (Supplemental Restraint System), closely observe the related precautions outlined in SR and SRC sections of the Service Manual.

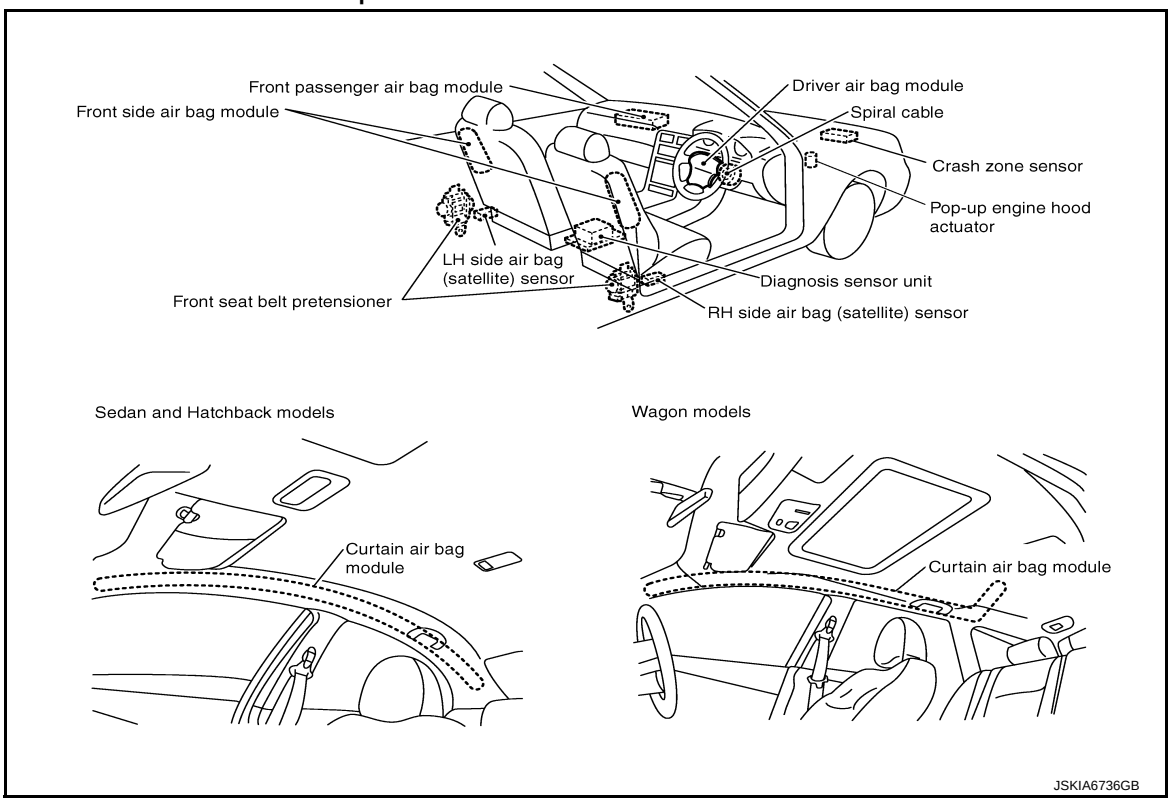
PRECAUTIONS : Supplemental Restraint System (SRS) "AIR BAG" and "Seat Belt Pretensioner" Service

INFOID:0000000012123772

- Do not use electrical test equipment to check SRS circuits unless instructed to in the Service Manual.
- Before servicing the SRS, turn ignition switch OFF, disconnect both battery cables and wait at least 3 minutes.
  For approximately 3 minutes after the cables are removed, it is still possible for the air bag and seat belt pretensioner to deploy. Therefore, do not work on any SRS connectors or wires until at least 3 minutes have passed.
- Diagnosis sensor unit must always be installed with their arrow marks "⇐" pointing towards the front of the vehicle for proper operation. Also check diagnosis sensor unit for cracks, deformities or rust before installation and replace as required.
- The spiral cable must be aligned with the neutral position since its rotations are limited. Do not turn steering wheel and column after removal of steering gear.
- Handle air bag module carefully. Always place driver and front passenger air bag modules with the pad side facing upward and seat mounted front side air bag module standing with the stud bolt side facing down.
- Conduct self-diagnosis to check entire SRS for proper function after replacing any components.
- After air bag inflates, the front instrument panel assembly should be replaced if damaged.
- Always replace instrument panel pad following front passenger air bag deployment.

PRECAUTIONS : SRS Component Parts Location

INFOID:0000000012123771



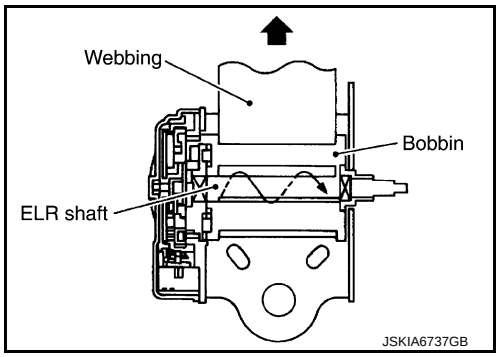
WARNING:

The CAUTION LABELS are important when servicing air bags in the field. If they are dirty or damaged, replace them with new ones.

PRECAUTIONS : Front Seat Belt Pretensioner with Load Limiter

INFOID:0000000012106701

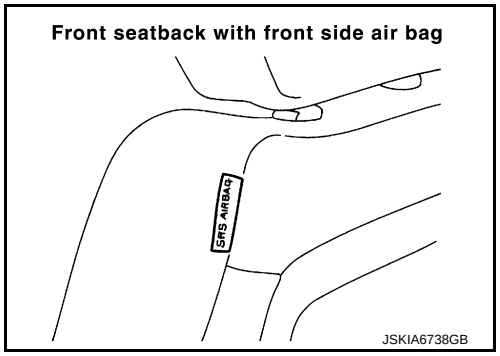
The seat belt pretensioner system with load limiter is installed for both the driver's seat and the front passenger's seat. It operates simultaneously with the SRS air bag system in the event of a frontal collision with an impact exceeding a specified level.
When the frontal collision with an impact exceeding a specified level occurs, seat belt slack resulting from clothing or other factors is immediately taken up by the pretensioner. Vehicle passengers are securely restrained.
When passengers in a vehicle are thrown forward in a collision and the restraining force of the seat belt exceeds a specified level, the load limiter permits the specified extension of the seat belt by the twisting of the ELR shaft, and a relaxation of the chest-area seat belt web tension while maintaining force.



PRECAUTIONS : Front Side Air Bag

INFOID:0000000012123770

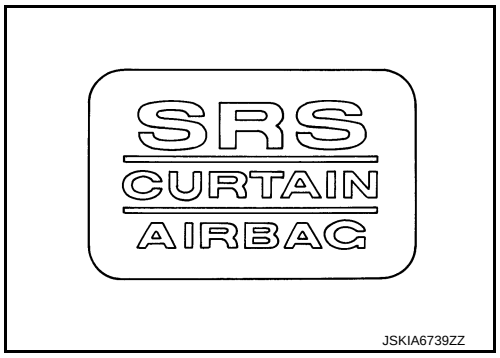
Front side air bags are installed in some NISSAN vehicles.
The front seatbacks with built-in type side air bag have the labels as shown.



PRECAUTIONS : Side Curtain Air Bag

INFOID:0000000012123769

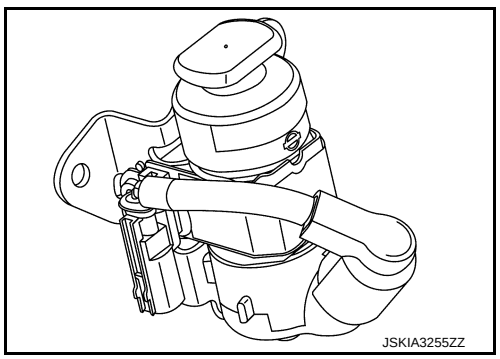
The side curtain air bags have the labels as shown.



PRECAUTIONS : Pop-up Engine Hood

INFOID:0000000012193969

Pop-up engine hood is installed in some NISSAN vehicles. The pop-up engine hood actuator is installed under the hood.

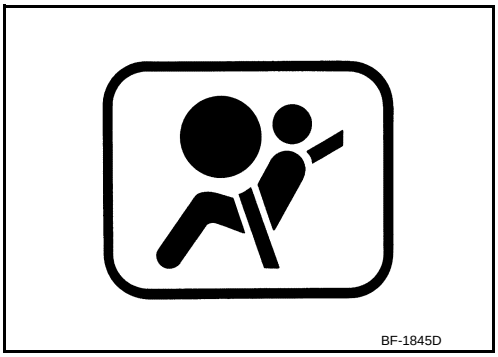


PRECAUTIONS : Maintenance Items

INFOID:0000000012123768

CHECK “AIR BAG” WARNING LAMP

When the ignition key is in the “ON” or “START” position, the “AIR BAG” warning lamp will illuminate for approximately 7 seconds and then turn off. This means that the system is operational.


BF-1845D

SCRAPPING THE AIR BAG AND PRETENSIONER

SCRAPPING THE AIR BAG AND PRETENSIONER : Precaution for Disposal

INFOID:0000000012123776

Before disposing of air bag module and seat belt pretensioner, or vehicles equipped with such systems, deploy the systems. If such systems have already been deployed due to an accident, dispose of them as indicated in the Service Manual for each model.

TROUBLE DIAGNOSES

TROUBLE DIAGNOSES : Self-diagnosis Function

INFOID:0000000012123779

- The SRS self-diagnostic results can be read with air bag warning lamp and/or CONSULT.
- The user mode is exclusively prepared for the customer (driver). This mode warns the driver of a system malfunction through the operation of the air bag warning lamp.
- The diagnosis mode allows the technician to locate and inspect the malfunctioning part.
- For details, refer to SRC section of the Service Manual.

TROUBLE DIAGNOSES : Collision Diagnosis

INFOID:0000000012106703

When the SRS components and the related parts check, refer to the description of the COLLISION DIAGNOSIS on the Service Manual for each model.

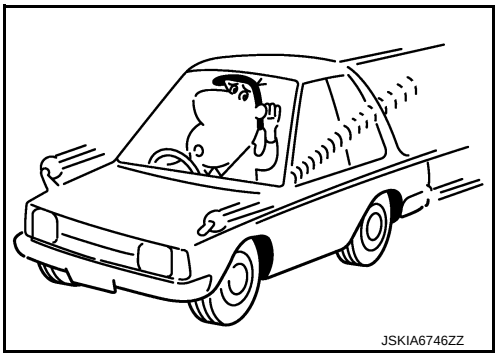
WIND NOISE

POSSIBLE CAUSES

POSSIBLE CAUSES : Possible Causes

INFOID:0000000012123783

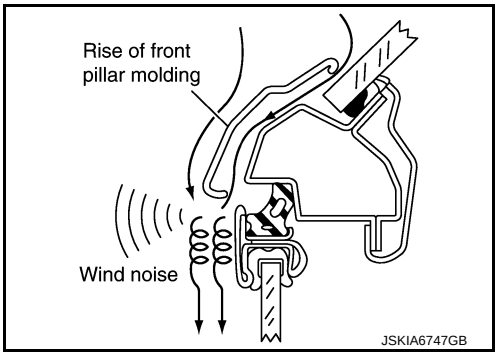
Wind noise and air leakage noise are high frequency noises heard while driving. They are heard mainly from around the door when the window is closed.



POSSIBLE CAUSES : Air or Wind Noise Generated

INFOID:0000000012106704

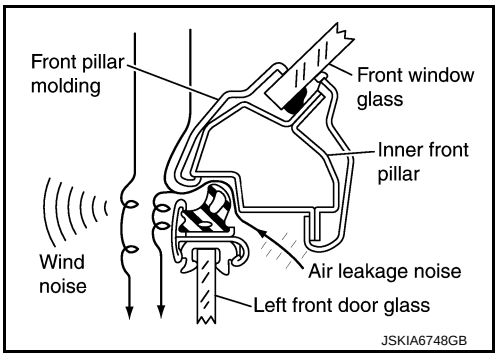
When the wind hits a projection, an eddy or swirl is produced behind the object creating a noise (the principle of flute and bugle sounds). The parts having projections include drip molding, pillar molding, waist molding, hood, wiper, outside mirrors and antenna. The parts having unevenness include pillar molding and front door glass.



POSSIBLE CAUSES : Air Leakage Noise

INFOID:0000000012123782

This is noise produced by air leakage from the passenger compartment which is not tightly closed (e.g., weatherstrip improperly installed).
Parts often causing (1) and (2) are the regions around the front pillar, door sash and door glass.

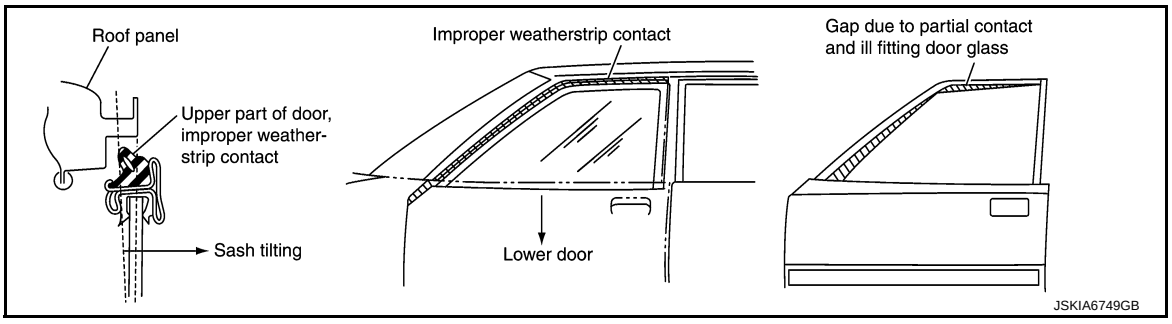


CHECKING AND REPAIR

CHECKING AND REPAIR : Checking and Repair

INFOID:0000000012106705

Parts	Check standard	Corrective action
Weatherstrip	Imperfect adhesion to contact surface and improper contact of lip due to separation, breakage, crush and hardening	Repair or replace weatherstrip
Door sash and related parts	• Improper weatherstrip contact due to a bent door sash • Gap caused by improperly installed corner piece • Gap caused by badly finished corner sash • Separation and breakage of the rubber on the door glass run	• Repair • Install properly • Repair with body sealer and masking tape • Repair
Door assembly	Improper weatherstrip contact due to improper fitting door	Correct door fit
Door glass	Gap caused due to ill fitting door glass	Align door glass
Body	Improper body finishing on contact surface for door weatherstrip (uneven panel joint, sealer installed improperly, and spot welding splash)	Repair contact surface
Drip molding	Rise and separation of molding	Repair or replace
Front pillar	Rise and separation of molding	Repair or replace
Waist molding	Door glass gap due to rise of molding and deformation of rubber seal	Repair

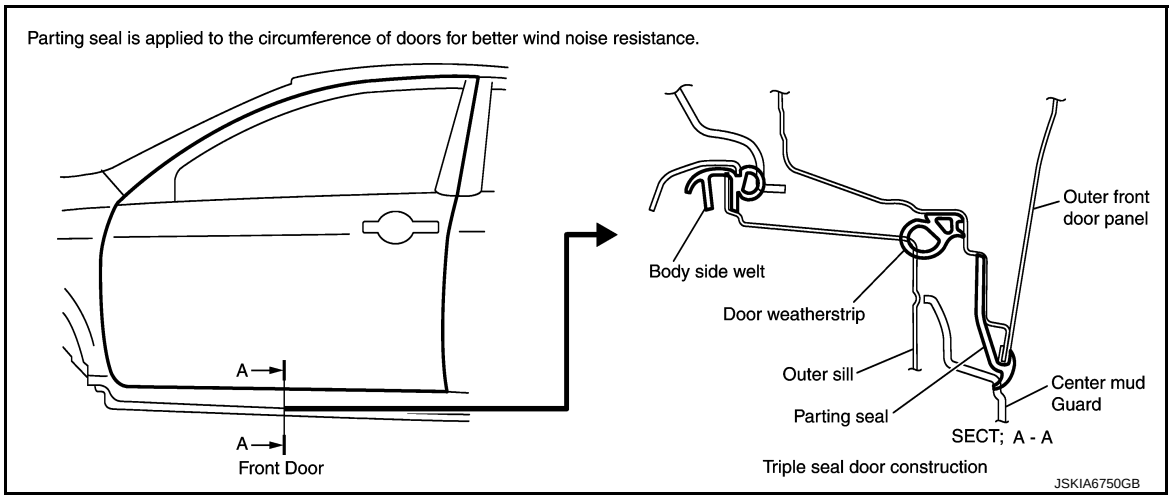


PREVENTIVE CONSTRUCTION AGAINST WIND NOISE

PREVENTIVE CONSTRUCTION AGAINST WIND NOISE : Preventive Construction against Wind Noise

INFOID:0000000012106706

Doors have a triple seal construction that consists of door weatherstrip, body side welt and parting seal. Because of this, anti-noise performance and door closing sound have been improved, and a secure feel when the door is closed has been enhanced.



PAINT
SCRATCH SHIELD

SCRATCH SHIELD : Scratch Shield

INFOID:0000000012242092

Scratch shield is a clear coat that is more scratch resistant compared with conventional clear coats, helping a vehicle maintain its new look for a longer period of time. The paint also repairs fine scratches, restoring a vehicle's surface close to its original state.

NOTE:
ASAP (Anti Scratch Advanced Paint) and scratch shield are the same paint.

SCRATCH SHIELD : Types of Clear Coat and Their Characteristics (Existing Model)

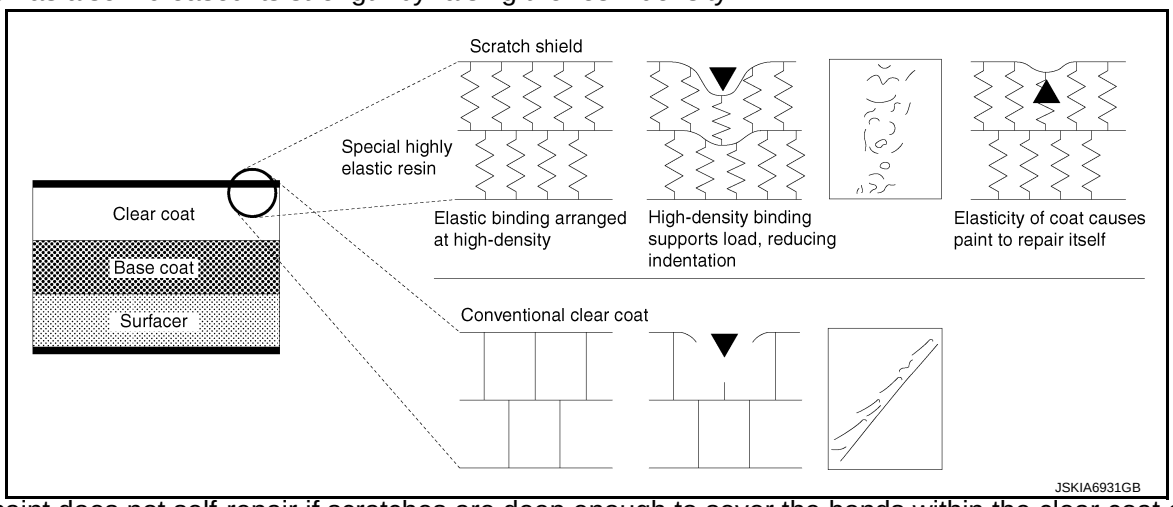
INFOID:0000000012242091

	Conventional clear	Hard clear	Scratch shield
Merit	Inexpensively priced	Hard to scratch	• Hard to scratch • Scratches from car washing and the like can repair themselves
Demerit	Easily damaged from car washing	Relatively expensive price	• Expensive price • Difficult to polish

SCRATCH SHIELD : Principle

INFOID:0000000012242090

A special highly elastic resin has been combined with a conventional clear coat to increase the paint's flexibility. This has also increased its strength by raising the resin density.

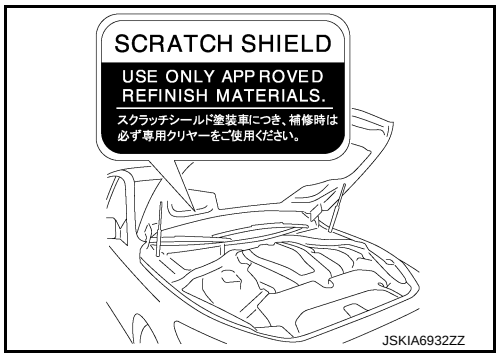


- The paint does not self-repair if scratches are deep enough to sever the bonds within the clear coat or if the clear coat has been peeled off.
- The amount or time required for self-repair depends on the surrounding temperature and the depth of the scratch. In some case, restoration may take up 1 week.

SCRATCH SHIELD : Precautions for Repair Coating

INFOID:0000000012106707

- A caution label is attached on the backside of the hood for models to which scratch shield is applied. Be sure to check the caution label when performing paint repair work.
- Before repairing scratch shield paint vehicles, contact the paint manufacturer.
  NOTE:
  In some cases, the name ASAP (Anti Scratch Advanced Paint) is used in paint procedures issued by paint manufacturers.



MATTE COLOR

MATTE COLOR : Matte Color

INFOID:0000000012242095

Matte color is a less glossy paint that can be made by applying a clear coat mixed with a matting agent on the color base.

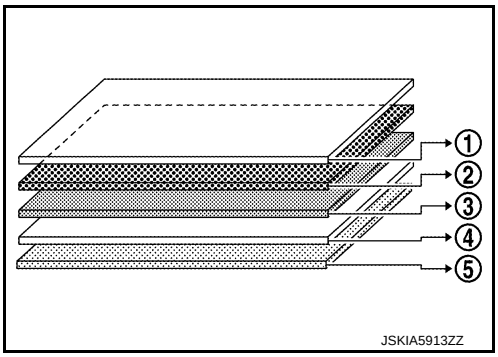
MATTE COLOR : Coating Film Structure

INFOID:0000000012242094

Matte color is applied to the R35 models as a dark matte gray (KBL) and composed of color base (KAD). The matte clear coat is then applied to it.

MULTILAYER COATING OF KBL COLOR (EXAMPLE: FOR R35 MODELS)

① Matte clear coat
② Color base coat (KAD)
③ Primer coat
④ Electrodeposition coat
⑤ Steel panel



MATTE COLOR : Notes for Handling

INFOID:0000000012242093

If your vehicle is equipped with matte paint, special care is necessary to clean your vehicle to maintain the appearance of the matte paint.

CAUTION:

Failure to follow the proper matte paint care instructions can permanently affect the appearance of the paint. Improper care can result in shiny spots, rub marks or other damage. This damage can only be repaired at a body shop trained in matte paint repair. Damage resulting from improper matte paint care is not covered under NISSAN's new vehicle limited warranty.

- **Do not use an automatic car wash.**
- **Do not rub the paint.**
- **Only use cleaners and soaps that are specifically formulated for matte paint.**
- **Do not use terry cloth towels to wash or dry the vehicle.**
- **Do not rub repeatedly with any cleaning material to minimize the risk of burnishing a shiny spot.**
- **Hand wash with a wet microfiber cloth, dry with clean damp chamois, and use light pressure with a microfiber towel. Minimize the pressure you use.**
- **Test all cleaning products on a hidden part of the vehicle (such as under the rocker sills) to make certain they do not affect the appearance of the matte paint.**
- **Pre-rinse the vehicle before washing to remove coarse dirt that can scratch the paint.**
- **Do not wash using a pressure washer.**
- **Spot treat heavy dirt accumulation with a cleaner made for matte paint.**
- **Do not use solvent based tar and bug remover products to clean the vehicle.**
- **Do not use waxes and sealers, even those specifically formulated for matte paint. These products may affect the appearance (add shine) of the matte paint.**

MATTE COLOR : Precautions for Repair Coating

INFOID:0000000012106708

Matte color repair paint requires a very high level of painting technique since partial touch-up paint and polishing work is not possible. Before performing repair painting, consult with the manufacturer of the repair paint to be used, and always perform trial painting several times before starting work.

ULTIMATE METAL SILVER

ULTIMATE METAL SILVER : Ultimate Metal Silver

INFOID:0000000012242098

Ultimate metal silver (KAB) is adopted for the R35 models as a special paint color. The clear coat consists of a conventional clear and hard clear paint and is resistant against chipping.

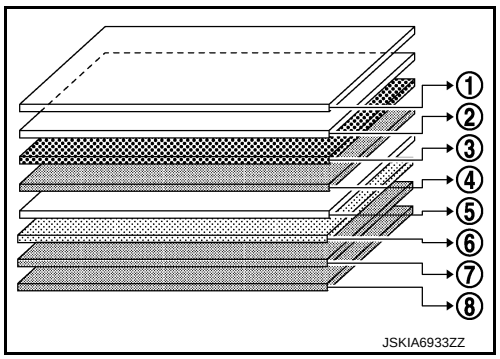
ULTIMATE METAL SILVER : Coating Film Structure

INFOID:0000000012242096

The top coat is a 4-coat finish that is composed of a base coat (K23), clear coat 1, plating silver and clear coat (clear coat 2 + hard clear). The plating silver is composed of evenly piled nano particles that creates a metallic surface appearance.

MULTILAYER COATING OF KAB COLOR (EXAMPLE: FOR R35 MODELS)

① Hard clear coat
② Clear coat 2
③ Plating silver
④ Clear coat 1
⑤ Color base coat (K23)
⑥ Surfacer
⑦ Electrodeposition coat
⑧ Steel panel



ULTIMATE METAL SILVER : Precautions for Repair Coating

INFOID:0000000012106709

Ultimate metal silver (KAB) requires a very high level of painting technique. Before performing repair painting, consult with the manufacturer of the repair paint to be used, and always perform trial painting several times before starting work.

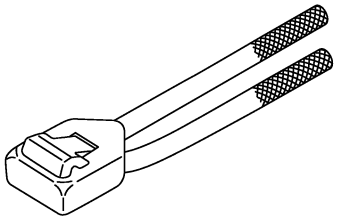
TOOLS AND EQUIPMENT

Hand Tools

INFOID:0000000012106718

This section briefly deals with the types, applications, features and examples of use of the equipment and tools necessary for car-body repair work. For information regarding hammers, dollies, spoons, etc., refer to BRM-59, "SHEET METAL WORK TOOLS : Sheet Metal Work Tools".

Tool name	Hemming tool		
Application	Used when hemming outer door panels, etc.	Features	• Faster hemming work than by hammering • Smoother finish than by hammering



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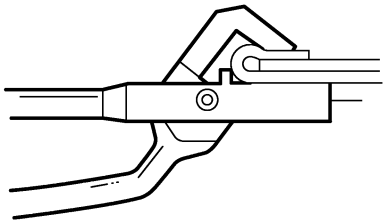
Example:



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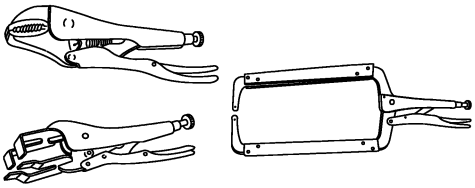
Tool name	Vise clamp		
Application	Attached to panel to clamp portion to be welded	Features	Easy to adjust opening dimensions and clamping force



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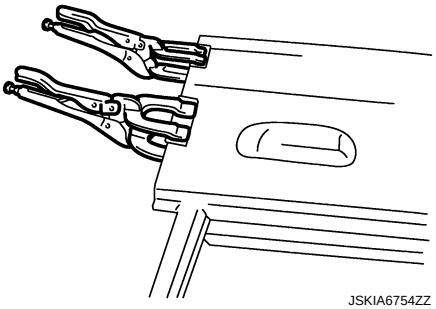
Example:



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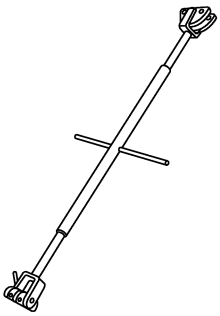
Tool name	Support rod		
Application	Grips or supports front pillars, etc. when cutting/ joining work is required	Features	Adjustable length for easy panel alignment



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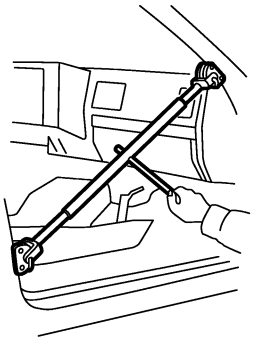
Example:



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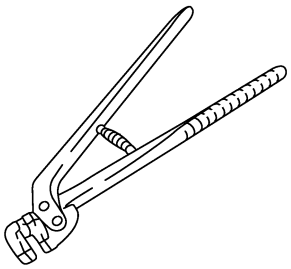
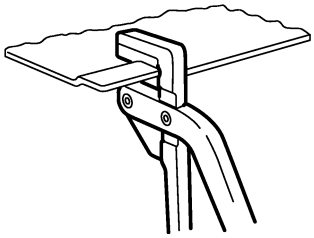
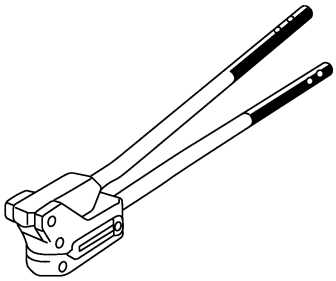
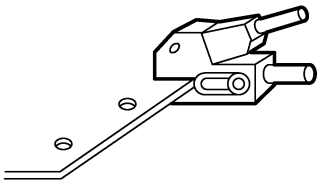
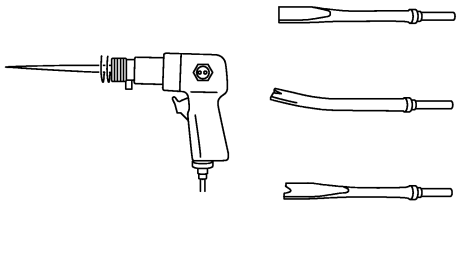
Tool name	Flange tool		
Application	Used for flange work for overlapping portions of panels	Features	For easy flange work
 JSKIA6757ZZ		Example:  JSKIA6758ZZ	
Tool name	Puncher		
Application	Used to punch holes for plug welds in panels	Features	• Easy to handle and short work time • No burrs remain around holes
 JSKIA6759ZZ		Example:  JSKIA6760ZZ	

Air Tools

INFOID:0000000012106719

Tool name	Air chisel		
Application	Used to cut off panels and to separate panels and spot welds	Features	• Compact and lightweight • A variety of jobs can be done with a suitable chisel • Ideal for cutting off panels in any shape (straight/curved cutting) • No dirt or dust is produced during working • Considerable vibration and noise



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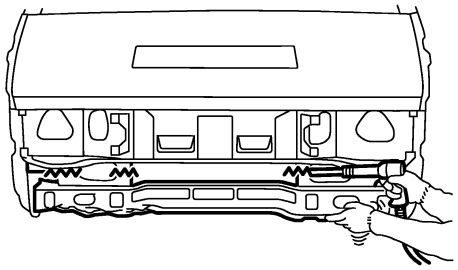
Example:



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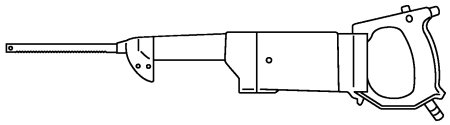
Tool name	Air saw		
Application	Used to cut off single panels, overlapped panels, etc.	Features	• Short panel cutting time • Considerable noise is produced • Suitable for cutting any shape (straight/curved lines)



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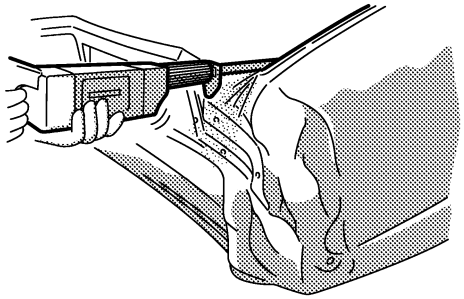
Example:



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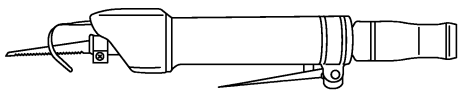
Tool name	Mini air saw		
Application	Used to cut off complex panel structure	Features	• Suitable for sharply curved line cutting as compared with air saws • Greater vibration than air saws



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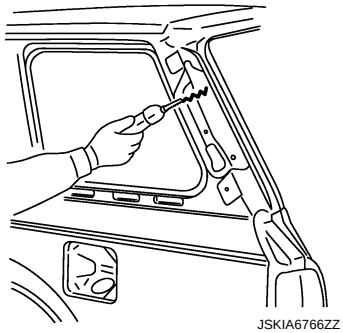
Example:



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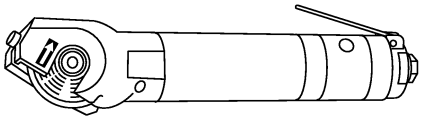
Tool name	Diamond cutter		
Application	Used to cut outer panel	Features	• Short cutting end • Suitable for cutting panels whose clearance with reinforcements is small (e.g. rear fender)



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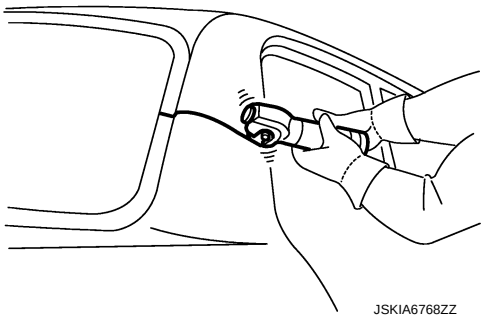
Example:



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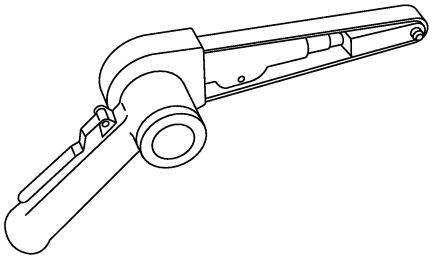
Tool name	Belt sander		
Application	Used to remove paint and finish welded surfaces	Features	• Ideal for use in closed or deep portions where disc sander cannot be used • Compact and lightweight • Adjustable handle angle as desired



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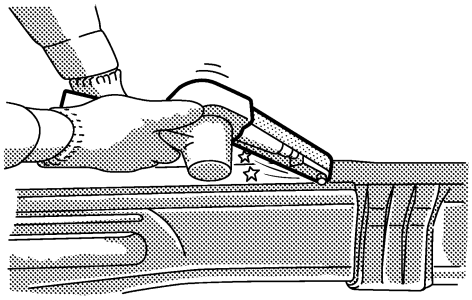
Example:



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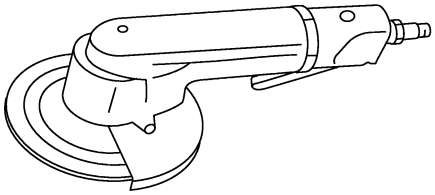
Tool name	Air grinder		
Application	Used for grinding welded surfaces	Features	Lightweight and high working efficiency



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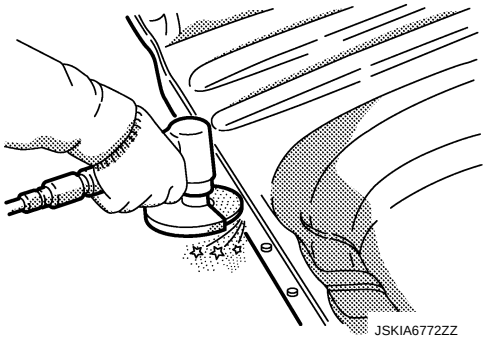
Example:



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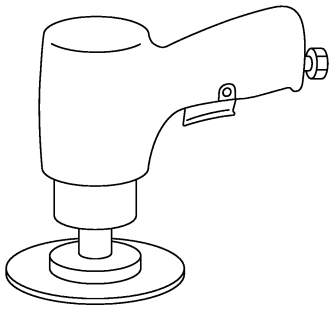
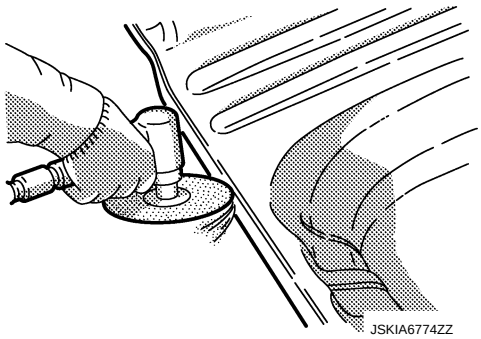
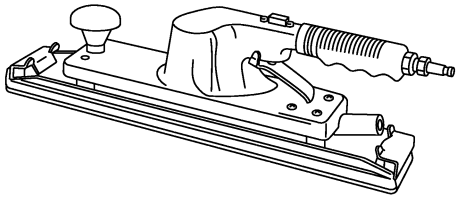
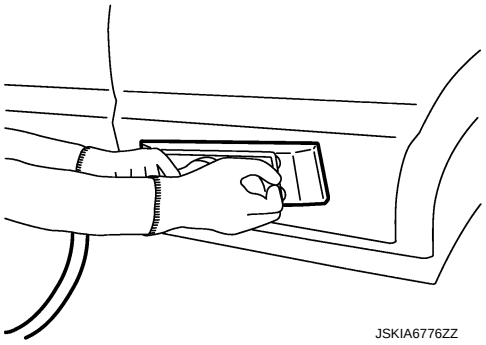
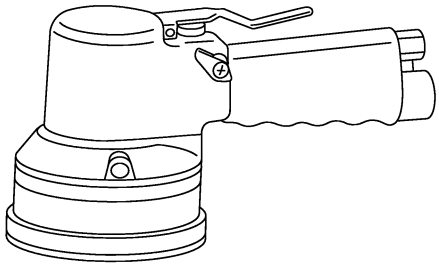
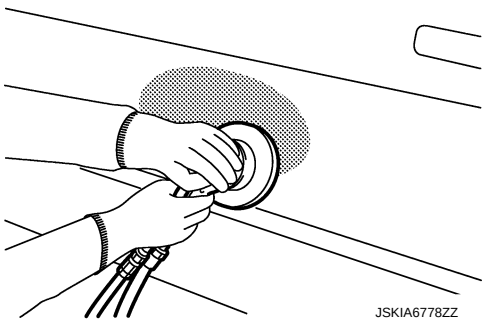
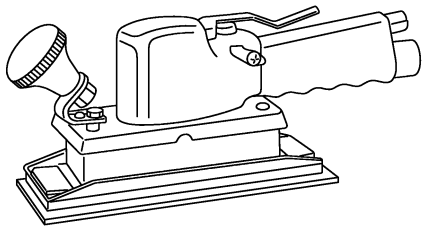
Tool name	Air disc sander		
Application	Used to remove paint film and rust from welded portions	Features	• Small and lightweight • High working efficiency • Less heat transmission to panels than air grinder
 JSKIA6773ZZ		Example:  JSKIA6774ZZ	
Tool name	Straight sander		
Application	Used for rough sanding of body filler	Features	• Ideal for sanding large areas • Sanding in reciprocating motion along filler surface
 JSKIA6775ZZ		Example:  JSKIA6776ZZ	
Tool name	Dual-action sander		
Application	Used for rough sanding of body filler or for feather-edging after application of filler	Features	• Sanding with dual rotary action along filler surface • Dual rotary action assures fewer traces of sandpaper
 JSKIA6777ZZ		Example:  JSKIA6778ZZ	

Tool name	Orbital sander		
Application	Used for rough sanding of body filler or for feather-edging finish after application of filler	Features	• Sanding in orbital motion along filler surface which contacts panel • Wider contact area than that of dual-action sander provides smoother finish

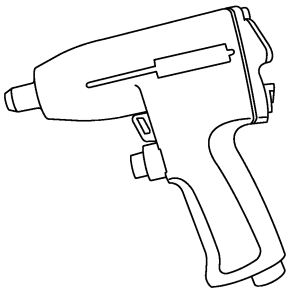


JSKIA6779ZZ

Example:

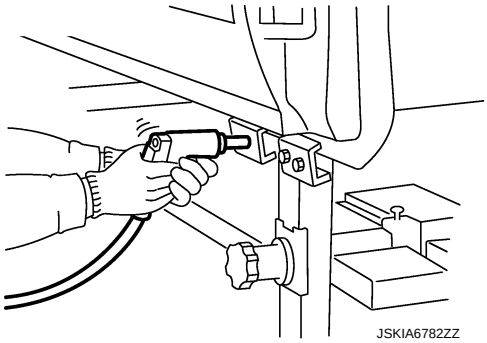
JSKIA6780ZZ

Tool name	Impact wrench		
Application	Used to remove/install clamps when securing car body to body straightening equipment with bolts and nuts	Features	• High tightening torque • Short work time



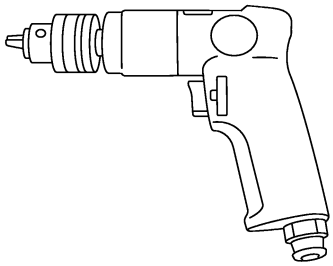
JSKIA6781ZZ

Example:



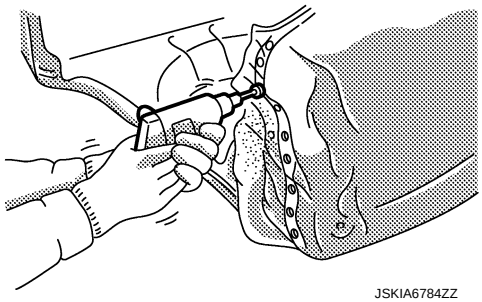
JSKIA6782ZZ

Tool name	Air drill		
Application	Used in combination with spot cutter to separate spot welded panels	Features	• Smaller and lighter than electric drill • Greater working efficiency

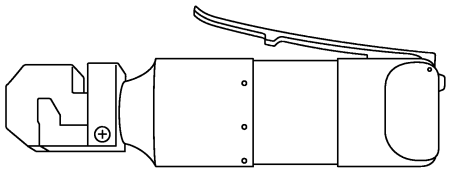
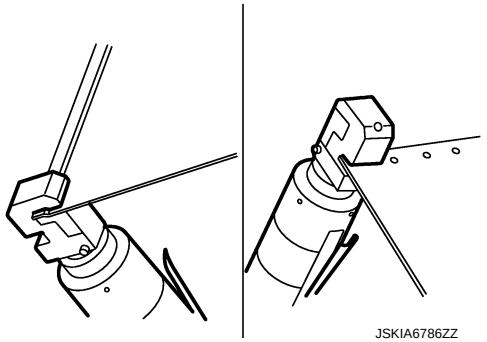
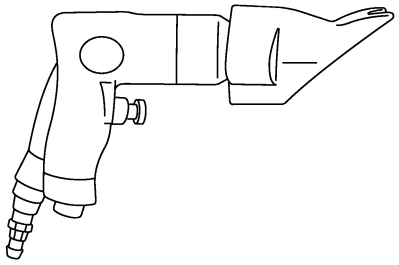
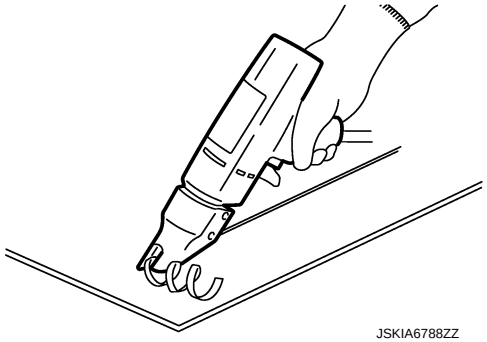
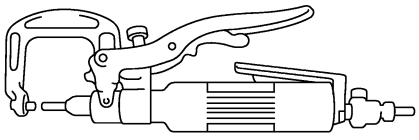
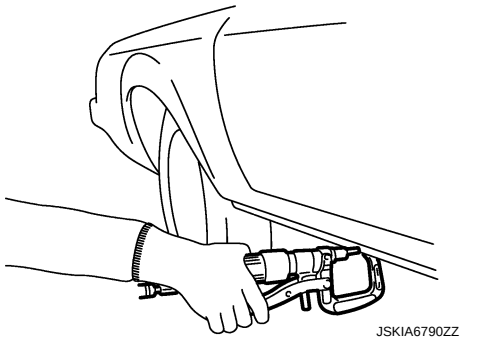


JSKIA6783ZZ

Example:

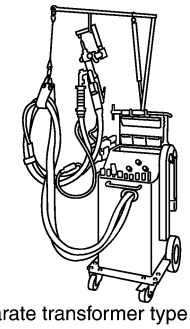
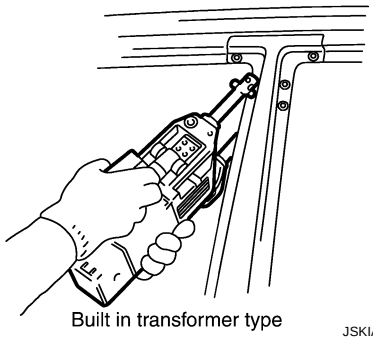
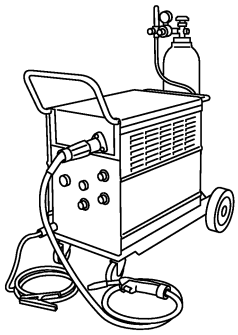
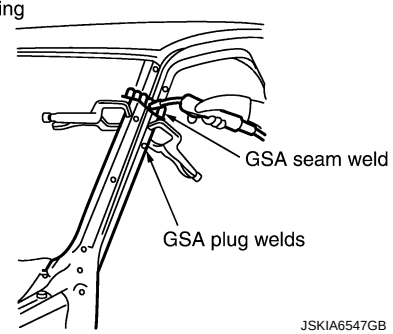


JSKIA6784ZZ

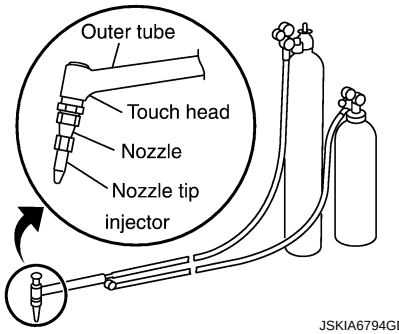
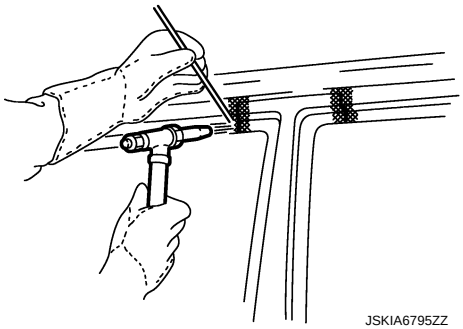
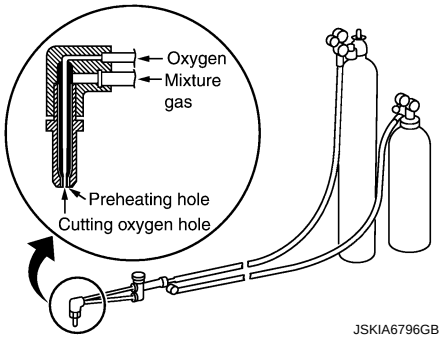
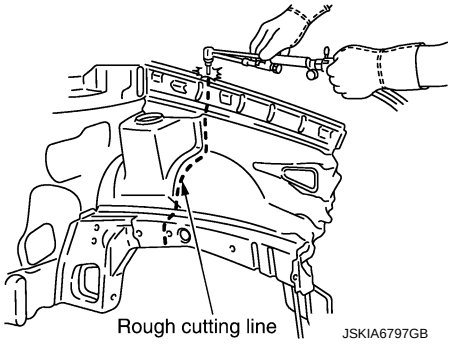
Tool name	Air flanging and punching tool		
Application	Used to form flange at overlapping portions of panels and to punch holes for plug welding on panels	Features	• Greater working efficiency because of two functions (flange formation and hole making) in single tool • Shorter work time than hand tools
 JSKIA6785ZZ		Example:  JSKIA6786ZZ	
Tool name	Air shear		
Application	Used to roughly cut panels	Features	• No chips are produced • Suitable for cutting any shape (straight/curved lines)
 JSKIA6787ZZ		Example:  JSKIA6788ZZ	
Tool name	Spot catcher		
Application	Used to separate spot welds on panels	Features	• Greater work efficiency since welded portion is held by attachment • Spot cutter can be held securely at welded portion
 JSKIA6789ZZ		Example:  JSKIA6790ZZ	

Welders

INFOID:0000000012106720

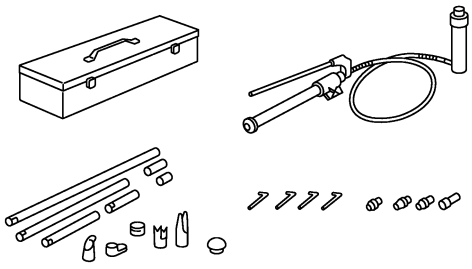
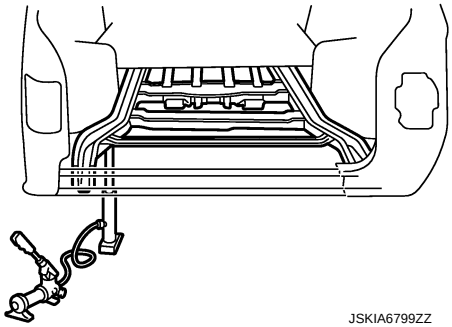
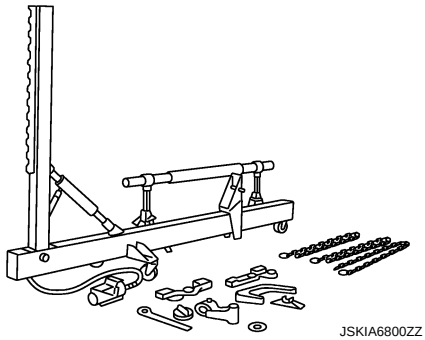
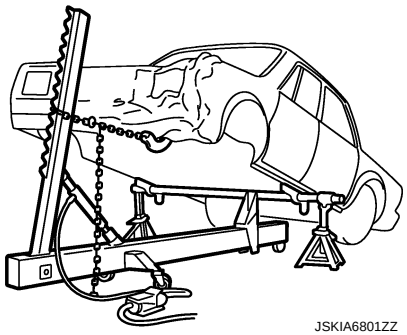
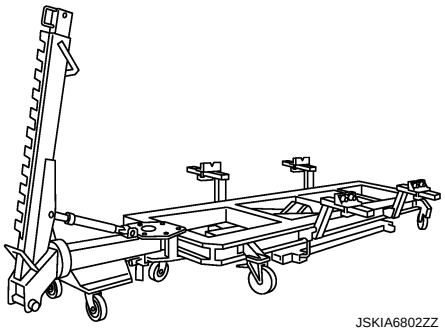
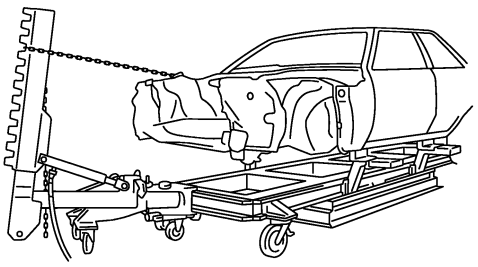
Tool name	Spot welder		
Application	Used to weld panels	Features	• Fast welding time and minimum thermal transmission to panels • Increased efficiency assured and work skill not required
 Separate transformer type JSKIA6791GB		Example:  Built in transformer type JSKIA6792GB	
Tool name	G.S.A. welders (MIG/MAG welders)		
Application	Used to weld panels, etc.	Features	• Less thermal transmission to panels than gas welders • Greater efficiency since G.S.A welder can be used with one hand
 JSKIA6793ZZ		Example: ▪ Welding  JSKIA6547GB	

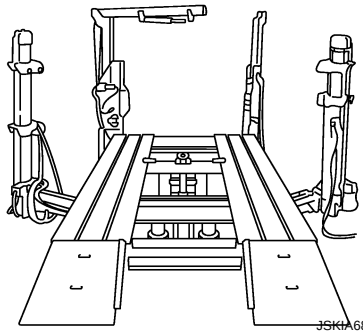
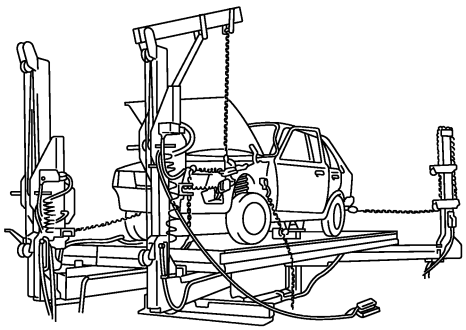
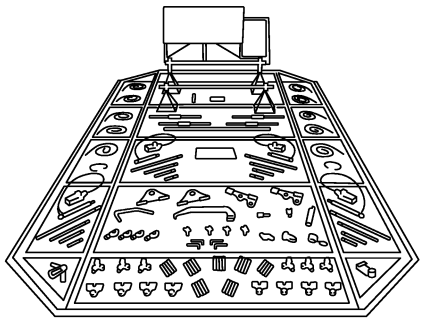
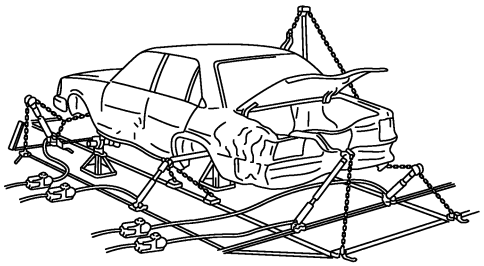
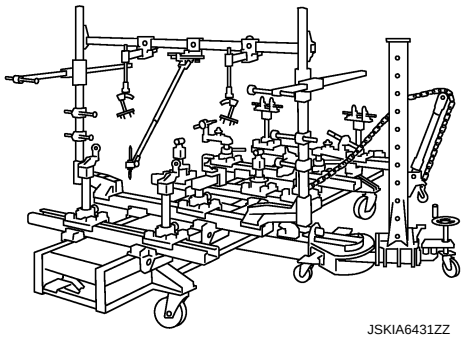
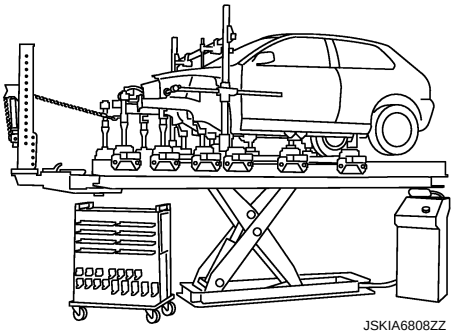
Gas welders are widely used for brazing or cutting panels. However, a torch must be selected to suit the type of work being done. Torches are summarized below:

Tool name	Gas welder torch		
Application	Used to shrink panels and braze panel joints	Example:	
 JSKIA6794GB		 JSKIA6795ZZ	
Tool name	Gas cutter torch		
Application	Used to roughly cut panels and remove paint and undercoat from panels	Features	Short panel cutting time
 JSKIA6796GB		Example:  JSKIA6797GB	

Body Straightening Equipment

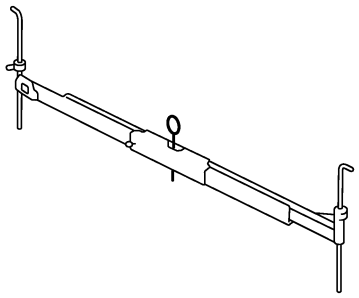
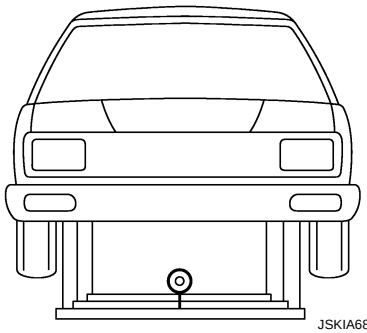
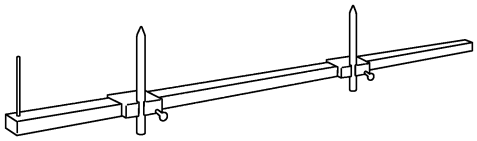
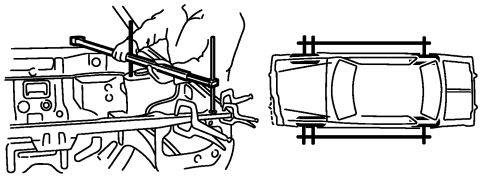
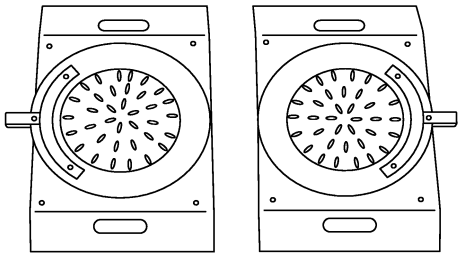
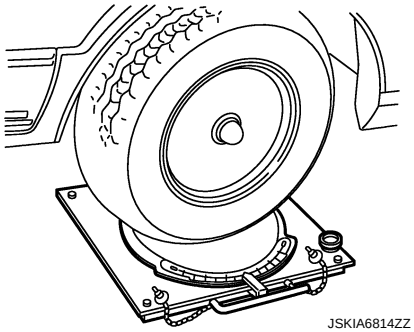
INFOID:0000000012106721

Tool name	Hydraulic porto power		
Application	Used to correct deformed panels by pulling or pushing	Features	Used with many attachments to provide a wide variety of panel correcting jobs
 JSKIA6798ZZ		Example:  JSKIA6799ZZ	
Tool name	Portable straightening equipment		
Application	Used to straighten damaged body	Features	• Easy to move from place to place and easy to set up correctly • Ideal for body alignment if damage to panel is minor
 JSKIA6800ZZ		Example:  JSKIA6801ZZ	
Tool name	Bench type straightening equipment (Movable)		
Application	Used to straighten damaged body	Features	• Easy to move from place to place • Easy to change pulling direction
 JSKIA6802ZZ		Example:  JSKIA6803ZZ	

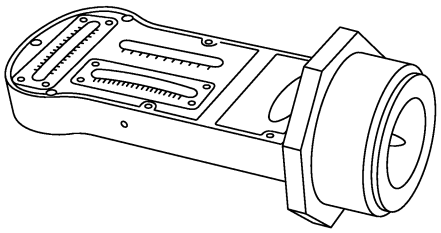
Tool name	Stationary rack type straightening equipment		
Application	Used to straighten damaged body	Features	• Easy to measure or secure lower part of body because car is held horizontally in a high position • Greater working area is required as compared with other body straightening equipment
 JSKIA6804ZZ		Example:  JSKIA6805ZZ	
Tool name	Base frame type straightening equipment		
Application	Used to straighten damaged body	Features	• Simultaneous pulling or pushing in many directions • Small and lightweight attachments for easy use
 JSKIA6806ZZ		Example:  JSKIA6807ZZ	
Tool name	Universal jig bench type straightening equipment		
Application	Used to straighten damaged body	Features	• Uses a universal jig bracket on which the jig can move multi-directionally and is fastened with screws or pins • Need to adjust the jig for various vehicle models
 JSKIA6431ZZ		Example:  JSKIA6808ZZ	

Measuring Equipment

INFOID:0000000012106722

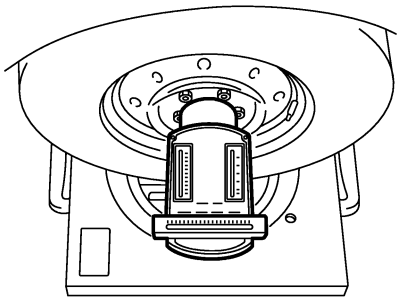
Tool name	Centering gauge		
Application	Used to measure twist, and left/right and fore/aft bends in the body	Features	Easy to confirm body deformation (at a glance)
 JSKIA6809ZZ		Example:  JSKIA6810ZZ	
Tool name	Tram tracking gauge		
Application	Used to measure various portions of body	Features	• Expandable-shrinkable measuring element assures a wide variety of body measurements • Capable of measuring wheelbase
 JSKIA6811ZZ		Example:  JSKIA6812ZZ	
Tool name	Turning radius gauge		
Application	Used to measure steering angle of front wheels	Features	Easy to carry for use anywhere
 JSKIA6813ZZ		Example:  JSKIA6814ZZ	

Tool name	Camber/caster/kingpin gauge		
Application	Used to measure camber, caster and kingpin angle (front wheel alignment)	Features	Used in conjunction with turning radius gauge



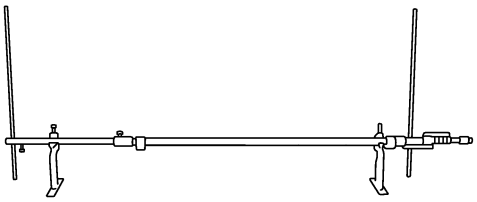
JSKIA6815ZZ

Example:



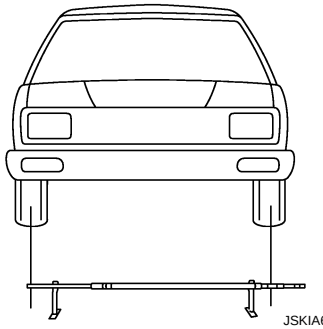
JSKIA6816ZZ

Tool name	Toe-in gauge		
Application	Used to measure toe-in (wheel alignment)	Features	Easy to handle and easy to use anywhere



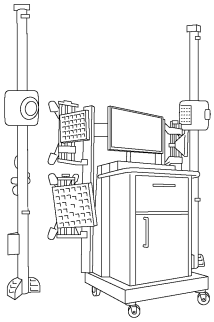
JSKIA6817ZZ

Example:



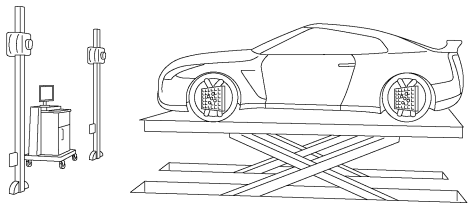
JSKIA6818ZZ

Tool name	4 wheel alignment tester		
Application	• Used to measure 4 wheel alignment • Wheel alignment for the following is possible: toe, camber, caster, kingpin angle, thrust angle, wheel set back, toe out on turn (T.O.O.T.), maximum steering wheel turning angle, side offset, axle offset, difference between left and right wheelbase, and difference between front and rear treads	Features	• Measurement item can be displayed in color graphics Models without cables to connect between sensor and main body are also available • Data can be managed with computers • Model that can display each wheel alignment adjustment location is also available



JSKIA6901ZZ

Example:

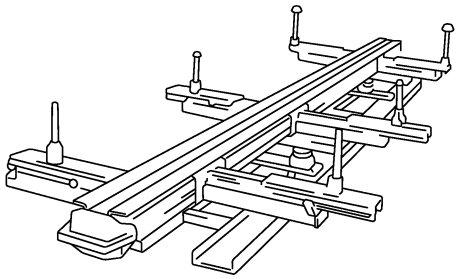
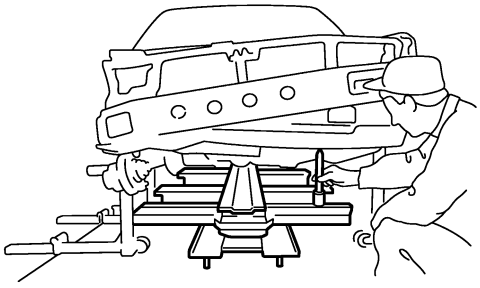
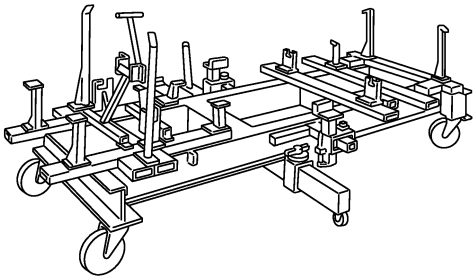
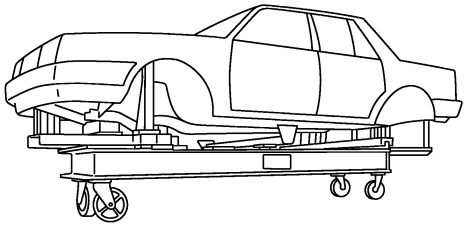


JSKIA6902ZZ

Three-dimensional Measuring Equipment

INFOID:0000000012106723

The three-dimensional measuring equipment registers measuring points on the body in terms of height, width and length.
The following types of this equipment are used.

Tool name	Mechanical type universal measuring equipment		
Application	Used to measure body dimensions during body repair work	Features	• Used with various attachments to measure without removing parts • Capable of automatically staying parallel to the base the body
 JSKIA6821ZZ		Example:  JSKIA6822ZZ	
Tool name	Dedicated type measuring equipment (Dedicated jig bench type body straightening equipment)		
Application	Used to align body during body repair work	Features	• Designed for use on specific car model, requiring no measurements during work • This is one of the dedicated jig type body straightening equipment functions
 JSKIA6823ZZ		Example:  JSKIA6824ZZ	

Quick Repair Tools

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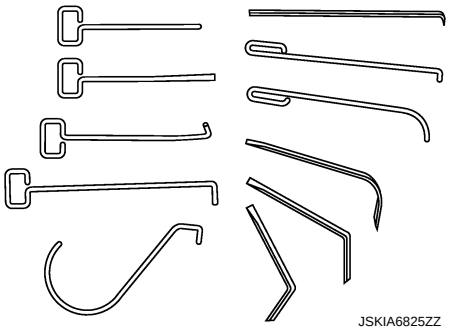
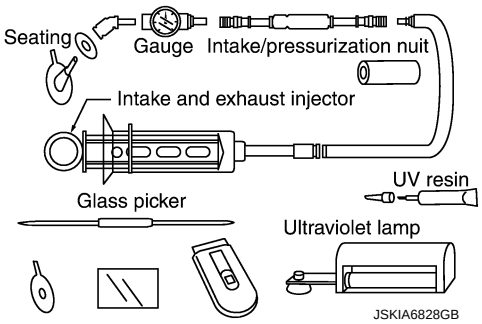
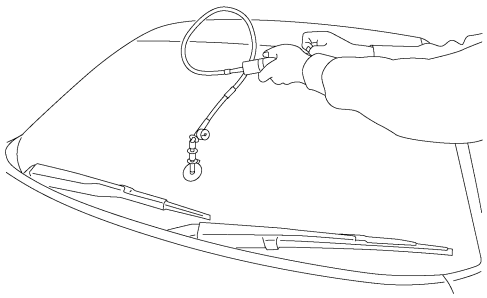
Tool name	Dent repair tools		
Application	Used to perform sheet metal work on dents without damaging the coated surface	Features	• Colored sheet metal work is performed • A different tool is used according to the location
 JSKIA6825ZZ		Example:  JSKIA6346ZZ	
Tool name	Wind shield glass repair kit		
Application	Used to repair windshield glass damage	Features	• Visibility can be secured, and damage range minimized • Repair is quick and simple • Repair time is approx. 25 minutes
 JSKIA6828GB		Example:  JSKIA6903ZZ	