

Automotive Body Repair and Paint Work Level-IV

Based on October, 2023, Curriculum Version-II



**Module Title: - Aligning/Replacing Damage Chassis,
Structure and Body Shell**

Module code: EIS BRP4 M06 1023

Nominal duration: 100 Hours

Prepared by Ministry of Labor and Skills

October, 2023

ACKNOWLEDGMENT

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronyms

SST----- Special Service Tolls
 DC ----- Direct Current
 OME ----- Original Equipment Manufacture
 RO----- Repair Order
 GSA----- Gas Shielded Arc welding

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Introduction to the Module

This module covers the competence required to carry out structural repairs using straightening and realigning, welded panel replacement and body panel manual measuring procedures. The module includes identification and confirmation of work requirement, preparation for work, application of structural straightening and realigning and welded panel replacement procedures and techniques, inspection and measuring of outcomes and completion of work finalization processes, including clean-up and documentation. This module identifies the competence required to carry out vehicle measurement and to repair the identified body misalignment. It required to locate, identify and repair high strength steel (HSS), including advanced and ultra-high strength steel components in motor vehicles.

This module covers the units:

- chassis and body shell alignment
- Structural Straightening and Realigning Procedures
- Body Panel Measuring Procedures
- Welded Panel Replacement Procedures
- Cleanup Work Area and Maintain Equipment

Learning Objective of the Module

- Perform Structural Straightening and Realigning Procedures
- Cleanup Work Area and Maintain Equipment
- Apply Body Panel Measuring Procedures
- Perform Welded Panel Replacement Procedures

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Chassis and Body Shell Alignment

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Purpose of aligning chassis and body shell
- Identifying tools, equipment and materials

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Understand the Purpose of aligning chassis and body shell
- Apply Identify tools, equipment and materials

1.1 Purpose of aligning chassis and body shell

Aligning the chassis and body shell of a vehicle is an important step in the manufacturing process. Proper alignment ensures that the vehicle's suspension system works as intended, which can improve handling, ride comfort, and safety. It also helps to prevent uneven tire wear and prolongs the life of the tires. In addition, proper alignment can help to reduce fuel consumption and emissions by minimizing rolling resistance

1.2 Identifying Tools, Equipment and Materials

Body Straightening Equipment's

- 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, height to be adjusted according to the worker's position

How to Select Body Straightening Equipment

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

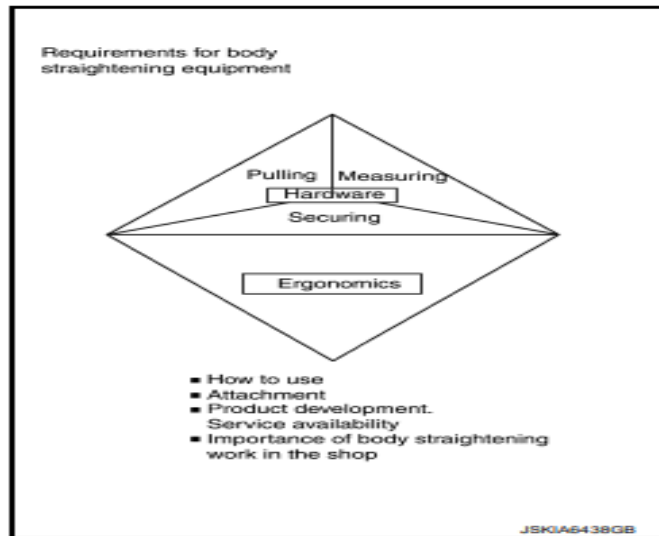


Figure1.1 Requirements for Body Straightening Equipment

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 Clamps

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

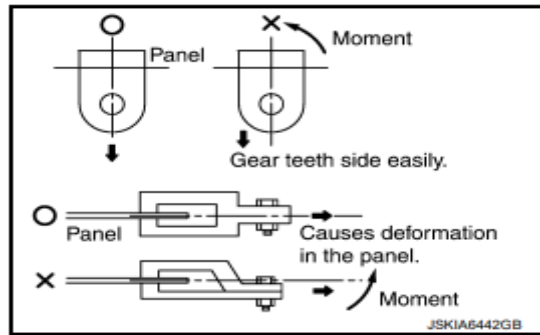


Figure1. 2 the direction of the chain's pulling force

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

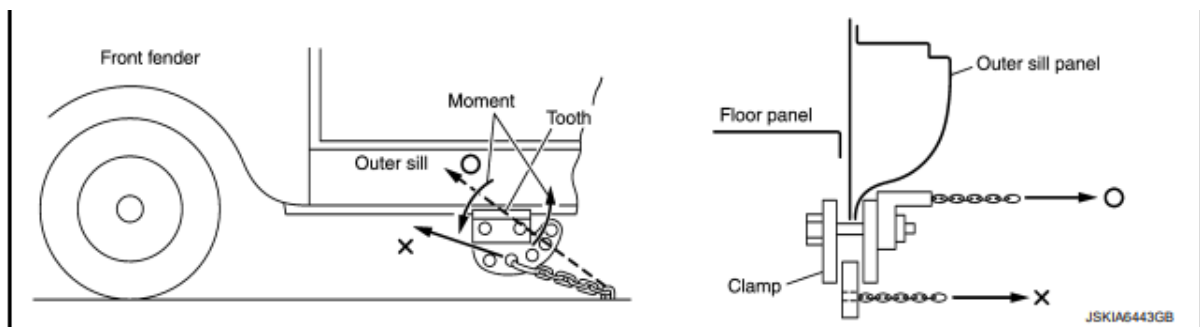


Figure1.3 The direction of the chain's pulling force

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

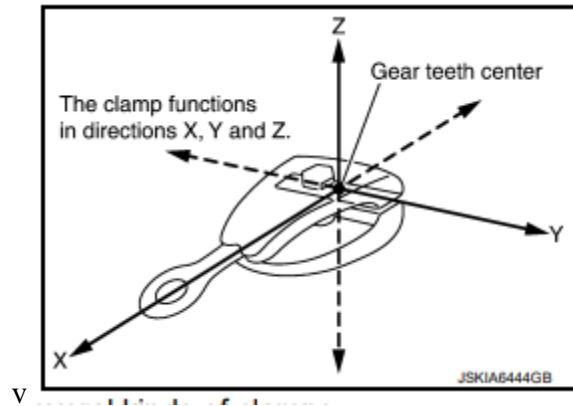


Figure1. 4 Clamp the direction

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

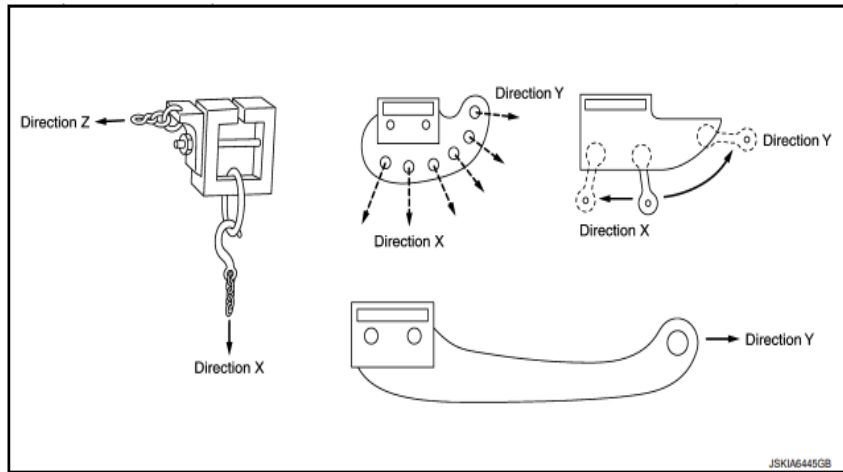


Figure 1.5 Kinds of Clamps.

Body Straightening Equipment Hooks and Other Tools

(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.

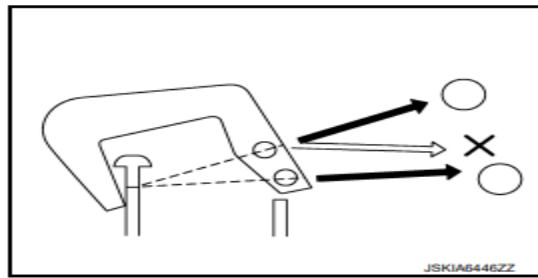


Figure1.6 hooks

- 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

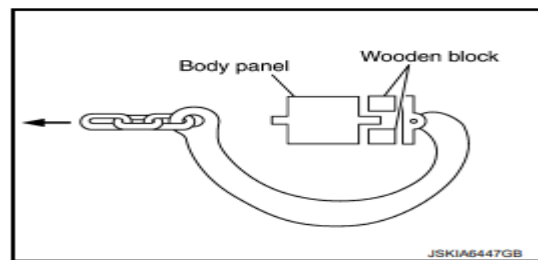


Figure1.7 hooks

(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.

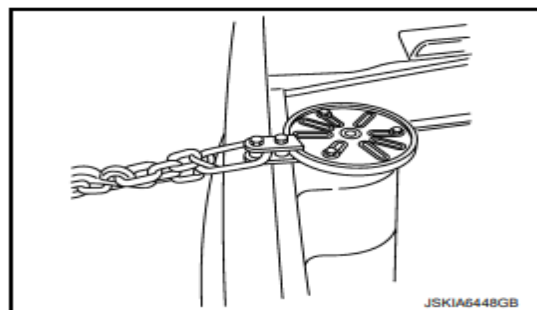


Figure1.8 specific-use pulling tool

Body Straightening Equipment High Intensity Cabin Structure

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

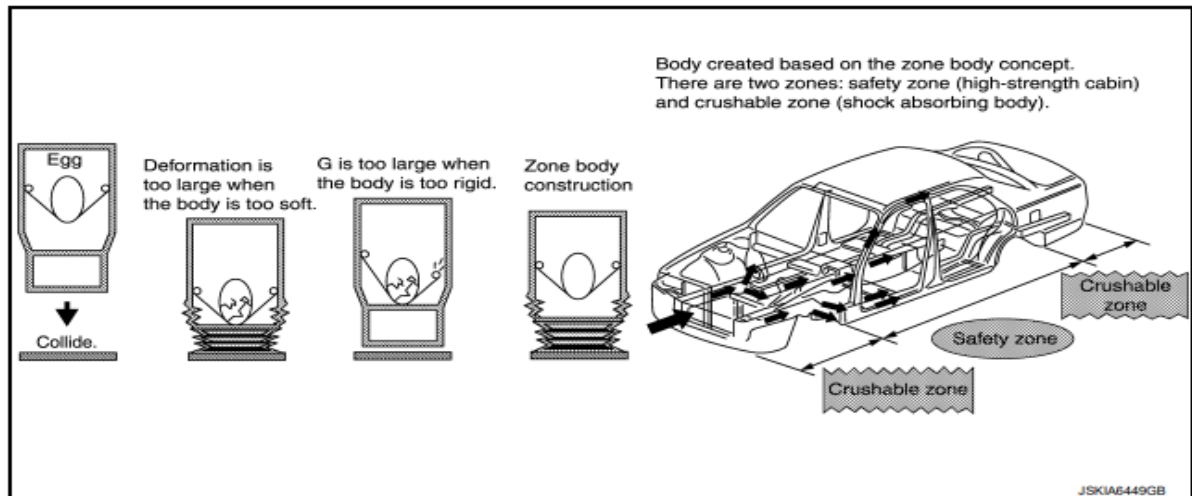


Figure1. 9 high intensity cabin structure

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.)

1) High Intensity Cabin Structure (Side Impact)

- To improve the lateral strength of the occupant compartment, lateral strength such as cross members, 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.

Self-Check-1

Directions: Answer all the questions listed below.

Part I: Choose the correct answer from the given alternatives

1. proper alignment can help to reduce
 - A. fuel consumption
 - B. emissions
 - C. minimizing rolling resistance
 - D. all
2. Which can improve handling, ride comfort, and safety?
 - A. fuel
 - B. alignment
 - C. wrenches
 - D. all

Part II fill in the blank space

1. _____ Unlike clamps which grab an object, hooks are curved tools that pull on the body?
2. _____ are special jigs which are used to repair a specific part of the vehicle?
3. _____ Equipment has three equally important functions: pulling, securing and measuring?

Part III. Give Short Answer

1. Write basic tools for Chassis and Body Shell Alignment?
2. Write equipment for Chassis and Body Shell Alignment?

Unit Two: Body Panel Measuring

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Collision Repair Measurements
- Completing workplace/equipment documentation

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Collision Repair Measurements
- Apply Completing workplace/equipment documentation

2.1 Collision Repair Measurements system

Basic Dimensions

a) There are two types of dimensions in the diagram.

(1) (Three-dimensional distance)

- Straight-line distance between the centers of two measuring points

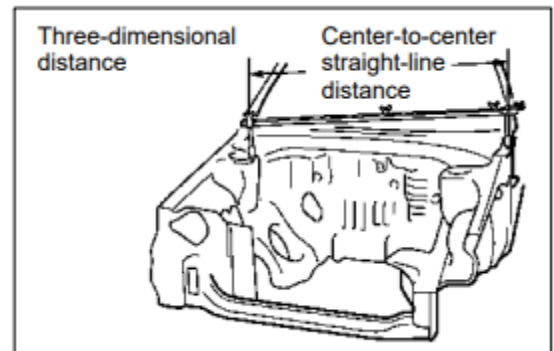


Figure2. 1Three-Dimensional Distance

(2) (Two-dimensional distance)

- Horizontal distance in forward/rearward between the centers of two measuring points.
 - The height from an imaginary standard line.
- b) In cases in which only one dimension is given, left and right are symmetrical.

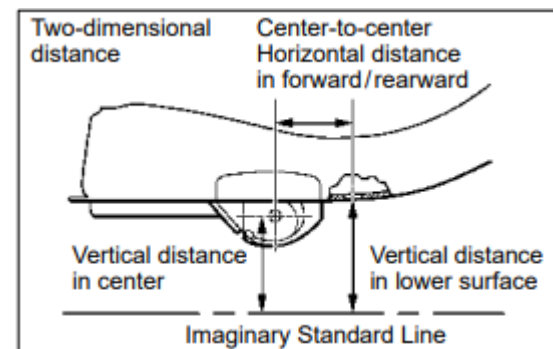


Figure 2. 2two-Dimensional Distance

- c) The dimensions in the following drawing indicate actual distance. Therefore, please use the dimensions as a reference.
- d) The line that connects the places listed below is the imaginary standard line when measuring the height. (The dimensions are printed in the text)

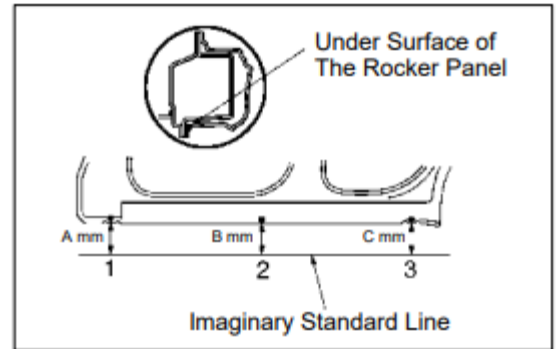


Figure 2.3 imaginary Standard Line

Measuring Methodologies for Vehicle Repair

There are two ways you can measure a damaged vehicle in order to understand where you need to make repairs: single-point measuring and multipoint measuring.

Single-Point Measuring

As the name implies, single-point takes one measurement at a time. You measure one point on the damaged vehicle and record it. Then you measure the next point and record it. Then you measure the next point and record it. Then you measure the next point and record it. Then you well, you get the picture. Just like reading that paragraph, single-point measuring is slow. And tedious. And Monotonous. This minimizes your shop's productivity. It's also inaccurate in many cases, which can lead to less-than-perfect repairs—and that leaves your shop liable for any issues in subsequent collisions.

Multipoint Measuring

Far more accurate and faster than single-point measuring, a multipoint measuring system is able to take numerous measurements simultaneously. At Chief, we call this Live Mapping.™ Live Mapping is the most efficient way to blueprint necessary repairs before you begin the repair process itself. Once you begin your pulls, Live Mapping measures those repairs as you make them, meaning you don't need to stop and re-measure after every pull. Not only that, it tells you when a repair is complete so that you can stop pulling at precisely the right time.

Your Three Options for Modern Measuring Equipment

When you're in the market for new measuring equipment, you're going to face a choice between three different options: point systems, ultrasound systems and laser systems. Each of these systems are advanced, compared to methodology from just a decade or two in the past. And each has a unique way of measuring a vehicle that needs repairs. Depending on your

current measuring your shop’s productivity and profitability with an upgrade.

system, you could easily improve

Point Systems

The days of relying on measuring tapes in a repair shop are long gone. That said, point systems use the same principles while updating the technology. Instead of one tech holding the tape measure while another tech takes the measurement, point systems use a combination of a computerized base and arm. The base is typically bolted to the floor under a rack to ensure it remains stationary. The tech then uses a robotic arm to point to a location on the vehicle. Through a signal, the arm transmits the location back to the base. The distance between the two is calculated and a measurement is made. This process is repeated at various points around the vehicle. Those measurements are then compared to OEM measurements in a database. When there are discrepancies between the vehicle on the rack and the OEM specs, it shows where a pull needs to be made.

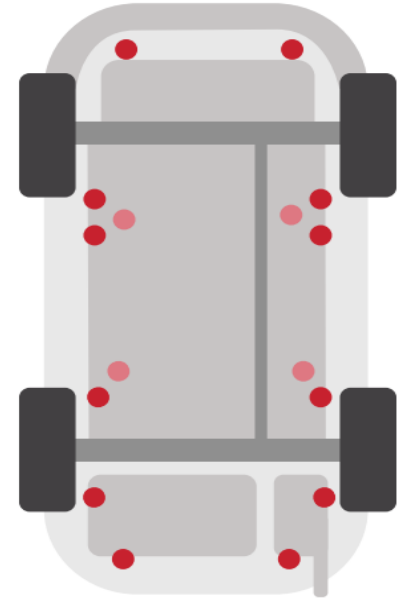


Figure2. 4Point system

Ultrasound Systems

Much like point systems, ultrasound systems use a base that acts as a centralized hub for taking measurements. That’s where the similarities end. Instead of holding an arm and touching different parts of the car, the tech hangs “probes” at predetermined, specific points around the vehicle. Those probes then emit ultrasonic signals back to the hub, which is equipped with high-frequency microphones that then measure the distance between the hub and the probes. The measurements are then compared to OEM measurements in a database, allowing the tech to understand where a pull needs to be made. Without needing to take measurements with a pointer, the tech is free to focus on the repairs instead of gathering data.

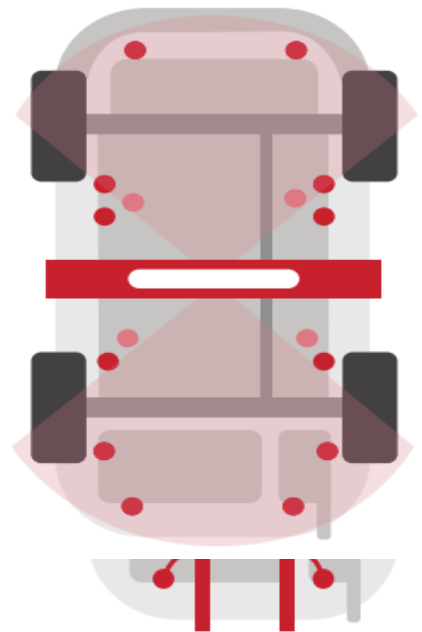


Figure2.5 Ultrasound system

Laser Systems

Just as with ultrasound systems, laser systems require a tech to hang “targets” from the vehicle. Instead of the dozen or so probes on ultrasound systems, some laser systems allow up to 45 targets for much more accurate measurements. Once the targets are in place, a mounted laser unit fires a laser (or two) that spins in a full 360-degree circle. As the lasers oscillate, they make contact with targets and measure the distance between. Those measurements are collected in a computer unit, which compares them to OEM specs in a database. This comparison shows all of the places a vehicle needs repairs, as well as the precise distances a pull needs to be made. Some laser units, like the new Galileo™ scanner from Chief, are completely portable and work with equipment throughout your shop—not just on your frame racks. This keeps your frame rack free for repairs, while letting you take Measurements for the next round of repairs in another bay. With these portable units, you can increase your productivity and your profitability by maximizing the number of possible repairs moving through your shop.

Chief: Laser-focused on improving your productivity and profitability

When it comes to measurement systems for repair shops, many people look at Chief as the gold standard.

2.2 Completing workplace/equipment documentation

Report writing

As technicians you may be called on to produce a report for a customer. If you are involved in research of some kind, it is important to be able to present results in a professional way. The following sections describe the main headings that a report will often need to contain together with an example report based on the performance testing of a vehicle alternator.

Laying out results in a standard format is the best way to ensure all the important and required aspects of the test have been covered. Keep in mind that the report should convey clearly to another person what has been done. Further, a ‘qualified’ person should be able to extract enough information to be able to repeat the test – and check your findings. Use clear simple language remembering that in some cases the intended audience may not be as technically competent as you are.

Main headings of a report

The following suggestions for the headings of a professional report will cover most requirements but can, of course, be added to or subtracted from if necessary. After each heading, I have included brief notes on what should be included.

A. Contents: - If the report is more than about five pages, a list of contents with page numbers will help the reader find his or her way through it.

B. Introduction:- explain the purpose of what has been done and set the general scene.

C. Test criteria: - define the limits within which the test was carried out. For example, temperature range or speed settings.

D. Facilities/Resources: - State or describe what equipment was used.

E. Test procedures: - explain here exactly what was done to gain the results. In this part of the report, it is very important not to leave out any details.

F. Measured results: - Present the results in a way that is easy to interpret. A simple table of figures may be appropriate. If the trend of the results or a comparison is important, a graph may be better. Pictures of results or oscilloscope waveforms may be needed. If necessary a very complex table of results from which you draw out a few key figures could be presented as an appendix. You should also note the accuracy of any figures presented ($\pm 0.5\%$ for example).

G. Analysis of results: - this is the part where you should make comment on the results obtained. For example, if, say, a fuel consumption test was carried out on two vehicles, a graph comparing one result to the other may be appropriate. Comments should be added if necessary, such as any anomaly that could have affected the results (change of wind direction for example).

H. Conclusions/Comments/Observations:- Note here any further tests that may be necessary. Conclude that device X does perform better than device Y – if it did. If appropriate, add observations such as how device Y performed better under the set conditions, but under other circumstances the results could have been different. Comment on the method used if necessary.

Check list for car



Vehicle REPORT CARD

as recommended by Ford Motor Company

SCHEDULED MAINTENANCE ITEMS*			
DATE	SERVICED	DATE	SERVICED
<input type="checkbox"/> Report Card Inspection	<input type="checkbox"/>	<input type="checkbox"/> Engine Air Filter	<input type="checkbox"/>
<input type="checkbox"/> Oil & Filter Change	<input checked="" type="checkbox"/>	<input type="checkbox"/> Engine Coolant	<input type="checkbox"/>
<input type="checkbox"/> Tyre Rotation	<input checked="" type="checkbox"/>	<input type="checkbox"/> Brake Fluid	<input type="checkbox"/>
<input type="checkbox"/> Fuel Filter	<input type="checkbox"/>	<input type="checkbox"/> Cabin Air Filter	<input checked="" type="checkbox"/>
<input type="checkbox"/> ___ Mile Scheduled Maintenance	<input type="checkbox"/>	<input type="checkbox"/> Spark Plugs	<input checked="" type="checkbox"/>

Name: _____
Date: _____
Registration: _____
Mile: _____

*This is only a partial list of vehicle maintenance items and is NOT all-inclusive. Please consult your Owner's Manual for vehicle-specific maintenance requirements.

ECOBOOST May contribute to vehicle efficiency and promote a greener environment.

Checked and OK at this time May require future attention Requires immediate attention

INTERIOR	SERVICED
<input checked="" type="checkbox"/> A/C Blows Cold	<input type="checkbox"/>
<input checked="" type="checkbox"/> Interior Lights	<input type="checkbox"/>
<input checked="" type="checkbox"/> Clutch Operation (if equipped)	<input type="checkbox"/>

LIGHTS / WINDSHIELD	SERVICED
<input checked="" type="checkbox"/> Operation of horn, exterior lamps, turn signals, hazard and brake lamps	<input type="checkbox"/>
<input checked="" type="checkbox"/> Windshield for cracks, chips and pitting	<input type="checkbox"/>

WIPER BLADES	SERVICED
<input type="checkbox"/> Wipe Test Performed	<input type="checkbox"/>
<input checked="" type="checkbox"/> Wiper Blades	<input type="checkbox"/>

FLUID LEVELS	SERVICED
<input checked="" type="checkbox"/> Brake Reservoir	<input type="checkbox"/>
<input checked="" type="checkbox"/> Clutch Reservoir	<input type="checkbox"/>
<input checked="" type="checkbox"/> Differential/Transfer Case	<input type="checkbox"/>
<input checked="" type="checkbox"/> Windew Washer	<input type="checkbox"/>
<input checked="" type="checkbox"/> Field Leaks	<input type="checkbox"/>
<input checked="" type="checkbox"/> Transmission	<input type="checkbox"/>
<input checked="" type="checkbox"/> Coolant Protection Concentrate Reservoir	<input type="checkbox"/>
<input checked="" type="checkbox"/> Power Steering	<input type="checkbox"/>

BELTS / HOSES / MOUNTS	SERVICED
<input checked="" type="checkbox"/> HVAC system and hoses/lines for leaks and/or damage	<input type="checkbox"/>
<input checked="" type="checkbox"/> Engine cooling system, radiator, hoses and clamps	<input type="checkbox"/>
<input checked="" type="checkbox"/> Accessory drive belt(s)	<input type="checkbox"/>

TYRE / BRAKE WEAR		
TYRE TREAD		
BRAKE LINING		
Over 5mm (Disc) or Over 2mm (Drum)	3mm to 4mm	Less than 3mm
Less than 3mm (Disc) or Less than 1mm (Drum)		

TYRE WEAR INDICATES	SERVICED
<input type="checkbox"/> Alignment check needed	<input type="checkbox"/>
<input type="checkbox"/> Wheel balance needed	<input type="checkbox"/>

Brake re-assembly not taken this service visit

Additional Items Found: _____

LEFT FRONT	SERVICED	RIGHT FRONT	SERVICED
<input checked="" type="checkbox"/> Tyre Tread Depth ____ mm Tyre Age ____	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tyre Tread Depth ____ mm Tyre Age ____	<input type="checkbox"/>
<input checked="" type="checkbox"/> Tyre Wear Pattern/Damage	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tyre Wear Pattern/Damage	<input type="checkbox"/>
<input checked="" type="checkbox"/> Tyre Pressure – set to factory-recommended PSI	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tyre Pressure – set to factory-recommended PSI	<input type="checkbox"/>
<input checked="" type="checkbox"/> Brake Pad/Shoe Thickness ____ mm	<input type="checkbox"/>	<input checked="" type="checkbox"/> Brake Pad/Shoe Thickness ____ mm	<input type="checkbox"/>
<input checked="" type="checkbox"/> Rotor Thickness: ____ mm	<input type="checkbox"/>	<input checked="" type="checkbox"/> Rotor Thickness: ____ mm	<input type="checkbox"/>

LEFT REAR	SERVICED	RIGHT REAR	SERVICED
<input checked="" type="checkbox"/> Tyre Tread Depth ____ mm Tyre Age ____	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tyre Tread Depth ____ mm Tyre Age ____	<input type="checkbox"/>
<input checked="" type="checkbox"/> Tyre Wear Pattern/Damage	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tyre Wear Pattern/Damage	<input type="checkbox"/>
<input checked="" type="checkbox"/> Tyre Pressure – set to factory-recommended PSI	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tyre Pressure – set to factory-recommended PSI	<input type="checkbox"/>
<input checked="" type="checkbox"/> Brake Pad/Shoe Thickness ____ mm	<input type="checkbox"/>	<input checked="" type="checkbox"/> Brake Pad/Shoe Thickness ____ mm	<input type="checkbox"/>
<input checked="" type="checkbox"/> Rotor Thickness: ____ mm	<input type="checkbox"/>	<input checked="" type="checkbox"/> Rotor Thickness: ____ mm	<input type="checkbox"/>

SPARE TYRE	SERVICED
<input checked="" type="checkbox"/> Tyre Pressure – set to factory-recommended PSI	<input type="checkbox"/>

Advise or: _____
Tech: _____
Customer Signature: _____

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Instructions for Completing the Vehicle Report Card

To Ensure That Customers Receive Accurate Maintenance Information In Their Follow Up Communications, The Condition Of The Vehicle As It Left The Dealership Should Be Reflected On The Vehicle Report Card And Coded On The Repair Order

The Importance of Green, Yellow and Red Condition Codes

All multi-point inspection systems/components need to have their initial condition identified at that time of inspection and updated after all service work is performed, including additional service requests sold and completed during the service visit. Repair Orders (ROs) should be coded to indicate the vehicle’s condition as it left the dealership using the instructions detailed below

Genuine Direct utilizes green, yellow and red condition codes for brakes, tyres and batteries – the primary customer “defection commodities” from dealerships to the aftermarket.

During the inspection, if it’s determined a system/component requires immediate (red) or future (yellow) attention; a line should be added to RO to reflect this condition cod (e.g. YBK) all conduction recorded on the RO will print on the customer invoice.

Important Note: Record the lowest value assigned for any measurement/condition. For example, if two brake measurements were green and two were yellow, record the lowest value overall – yellow: YBK.

The following codes should be entered on the RO as a labor operation when the RO is closed:

- 99P (or Q99P) to indicate the full vehicle inspection was completed per the Vehicle Report Card
- The appropriate code for each un serviced red or yellow condition
- The appropriate code for each green brake, tyre and battery condition

Items in the Report Card Systems/Components section that are not entered as red or yellow are assumed to be green and not in need of repair/replacement.

Dealership personnel responsible for entering the condition codes when ROs are closed should refer to the key provided on the Dealer copy of the Vehicle Report Card.

What if a Component Is Repaired/ Replaced?

When the inspection indicates a red or yellow condition, it needs to be recorded on the Vehicle Report Card. The Service Advisor should connect the customer to review the finding and obtain the customer approval to produce with the repair/replacement.

Assuming the dealership is granted permission to complete the repair/replacement, the Service Advisor should update the Vehicle Report card by checking the “serviced” check box indicate that work was performed during the visit, thereby reflecting a green condition code when the vehicle left the dealership. Note: Green brake, tyre and battery codes are to be entered on the RO in order for this information to appear on GENUINE Direct mailers

- Report Only Post-Service Work Condition Codes On Repair Orders - Do Not Simply Record the Initial Inspection Results. The Condition Of The Vehicle As It Left The Dealership Should Be Reflected On The Vehicle Report Card And Coded On The Repair Order.

Self-Check-2

Directions: Answer all the questions listed below

Part I:- Choose the appropriate answer from the given alternatives

1. _____ways can measure a damaged vehicle in order to understand where you need to make repairs
 - A. single-point measuring
 - B. multipoint measuring
 - C. A and B
 - D. None of the above
2. _____ takes one measurement at a time?
 - A. single-point measuring
 - B. multipoint measuring
 - C. A and B
 - D. None of the above

Part II: Match Each Words of Definitions

Column A

1. Contents:
2. Introduction:
3. Test criteria:
4. Facilities/Resources
5. Test procedures
6. Measured results
7. Analysis of results

Column B

- A. Present the results in a way that is easy to interpret
- B. list of contents with page numbers will help the reader find his or her way through it
- C. explain here exactly what was done to gain the results
- D. define the limits within which the test was carried out
- E. State or describe what equipment was used
- F. explain the purpose of what has been done and set the general scene
- G. Is the part where you should make comment on the results obtained

Part II:- Give Short Answer

1. Write Modern Measuring Equipment for damaged vehicle?

Unit THREE: Structural Straightening and Realignment

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- straightening and realigning methods
- Visual, mechanical and physical examination
- Types of Frame Deformation
- Straightening and realigning structural damage
- hydraulic reforming, Heating,

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- perform straightening and realigning methods
- Perform Visual, mechanical and physical examination
- Identify Types of Frame Deformation
- Perform Straightening and realigning structural damage
- Use hydraulic reforming, Heating,

3.1 Straightening and Realignment Methods

- 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

- 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.

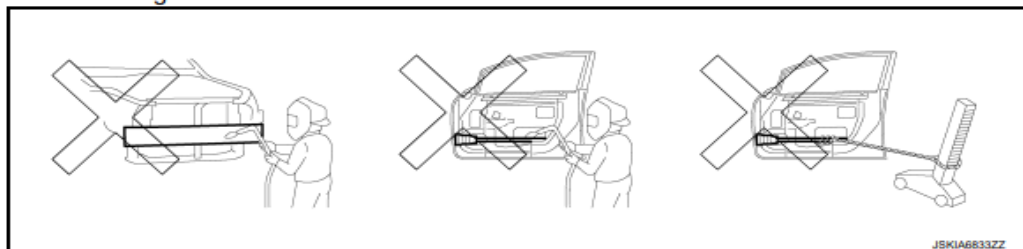


Figure3.1 Door Side Impact

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.

3.1.1 Visual, mechanical and physical examination

Inspecting Body Damage Diagnosis:

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 correct

Damage Diagnosis Determining Various Conditions of the Collision

- 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

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

Example

- Cracked or stressed paint
- Cracked or broken glass

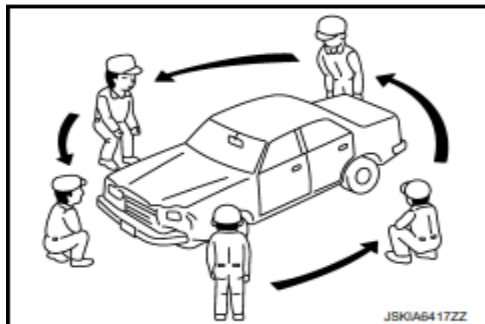


Figure3. 2 Observation of Overall Vehicle

(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.

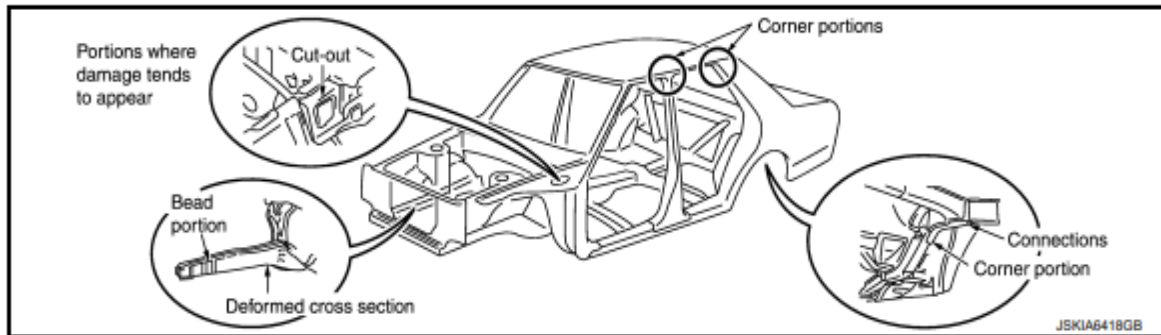


figure3. 3 Detailed Observation of Overall Vehicle

(3) Observation Of Fitting

Examine the fit of various portions without lifting them. Estimate the damage in the pillar and hinge portions.

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

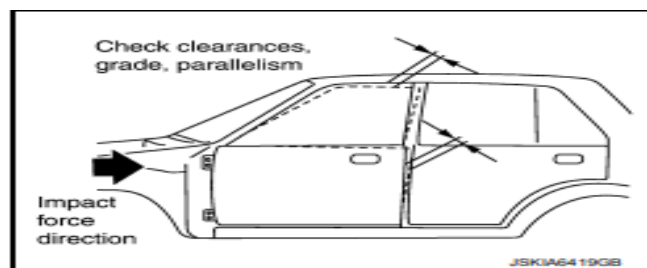


figure3. 4 Observation of Fitting

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

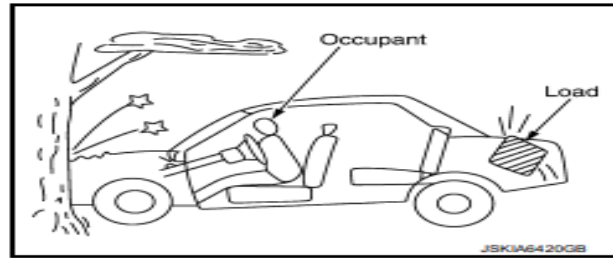


figure3. 5 Checking For Mechanical Damage

(4) **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 mounted points.

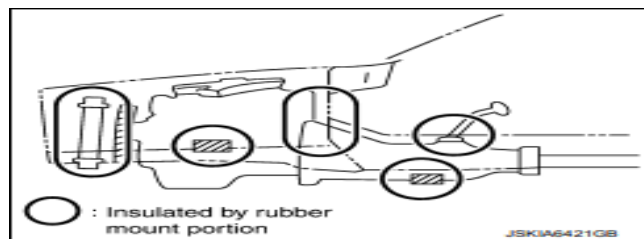


figure3. 6 damage by inertia

3.1.2 Types of Frame Deformation

Twist

Twist The horizontal bar is tilted on both ends

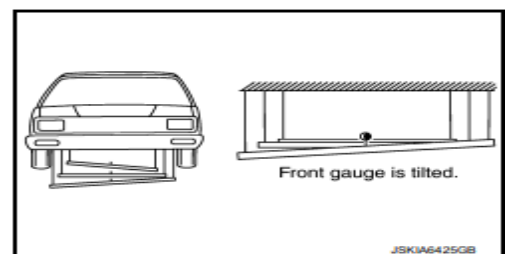


Figure3. 7 twist

Sag

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

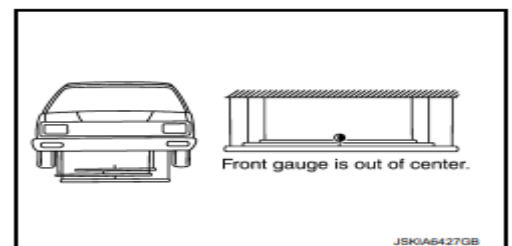


figure3. 8 sag

Side-sway

The horizontal bars are correctly aligned, but the center target is displaced

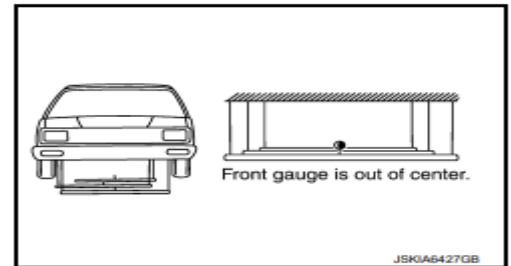


figure3. 9 Side-sway

Analyzing Damage

Analyzing damage is done before Unibody/frame straightening by inspecting direct and indirect damage. Look for direct damage to frame rails and indirect damage to large surface area panels, such as the roof and quarter panels. Check for improper panel gaps and alignment. Look for cracked sealer or undercoating, bulges, buckles, and other signs of major damage. Finding uneven gaps or spaces between panels can give you helpful information on how to pull out the damage. For example, if the front of a quarter panels is pushed into the back door at the bottom, you would know that lower rear structure pulling is needed. Regarding vehicle dimensions, there are three types or directions of Unibody/frame damage:

1. **Length damage** normally results from a front or rear hit that pushes body panels toward the center of the vehicle. The length measurement will usually be shorter than specifications. However, it is sometimes possible for the length to be stretched longer than normal.
2. **Width damage results** when parts are pushed to the center by a side or angled impact. The width measurement will usually be shorter than factory dimensions.
3. **Height damage** results from impact damage that forces parts or panels up or down. A rollover accident will normally crush the roof down and cause the height dimension to be too short. If a frame rail or another panel is pushed up or down, the height dimensions will not be within factory specifications.

3.2 Straightening and realigning structural damage

3.2.1 Starting Structural Repairs

Generally, you start by removing large, external, bolt-on parts that are badly damaged. For example, if the front end was hit hard, you might remove the hood first. This would give you more room to access rear fender bolts. It would also allow more light into the front for finding and removing hidden bolts. Use this kind of logic to efficiently remove parts.

If in doubt about how to remove a part, refer to the vehicles service manual or computer-based service information. Factory or aftermarket service information explains and illustrates how parts are serviced. Such information provides step-by-step instructions for the specific make and model vehicle. It gives bolt locations, torque values, removal sequences, and other important information. To give you an idea of the types of things to consider when starting a repair, refer to **Figure 3.10** Panel replacements is often the only permanent remedy for corrosion damage. For instance, a rusted-out rocker panel and cab corner on a truck would be repaired by cutting away the rusty metal and welding new partial panels in place.

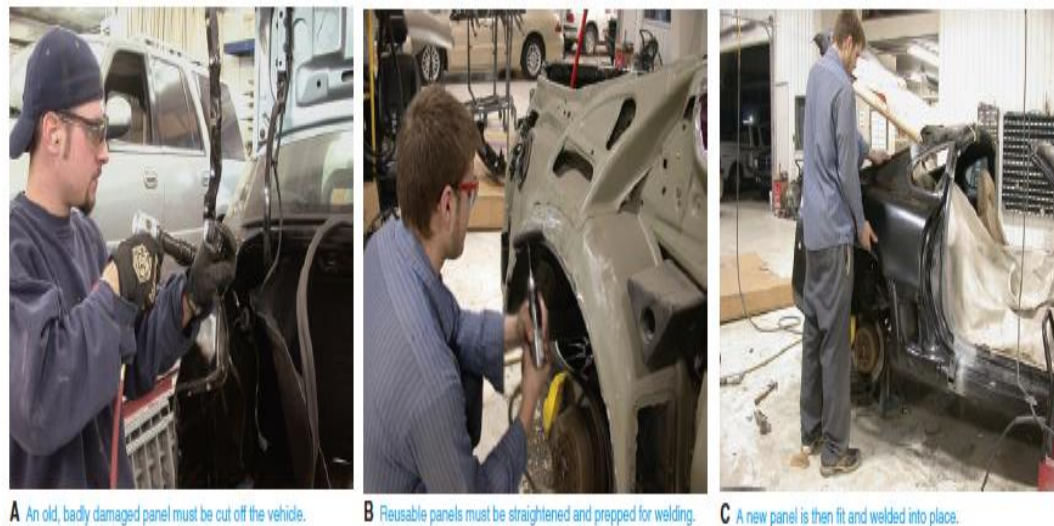


figure3. 10 Study the major steps for replacing a structural panel

Vehicles with major damage must often have their frame or body structures straightened. Frequently called “frame straightening,” body aligning, or pulling, is often thought to be a “rough and tough” physical operation. Actually, it is a relatively easy step-by-step task if proper equipment and methods are used.

An important requirement when straightening is accuracy. If the frame or Unibody is not straightened exactly, panels will not fit and the wheels may not be alignable.

Unibody/frame straightening or realignment involves using high-powered hydraulic equipment, mechanical clamps, and chains to bring the full frame or Unibody structure back into its original shape.

Improper straightening techniques are costly and time consuming mistakes. Accurate vehicle alignment positively affects safety, repair time, repair quality, and the confidence of your customers. This chapter summarizes the most important methods for realigning a vehicle with major Unibody or frame damage.

Realignment Basics

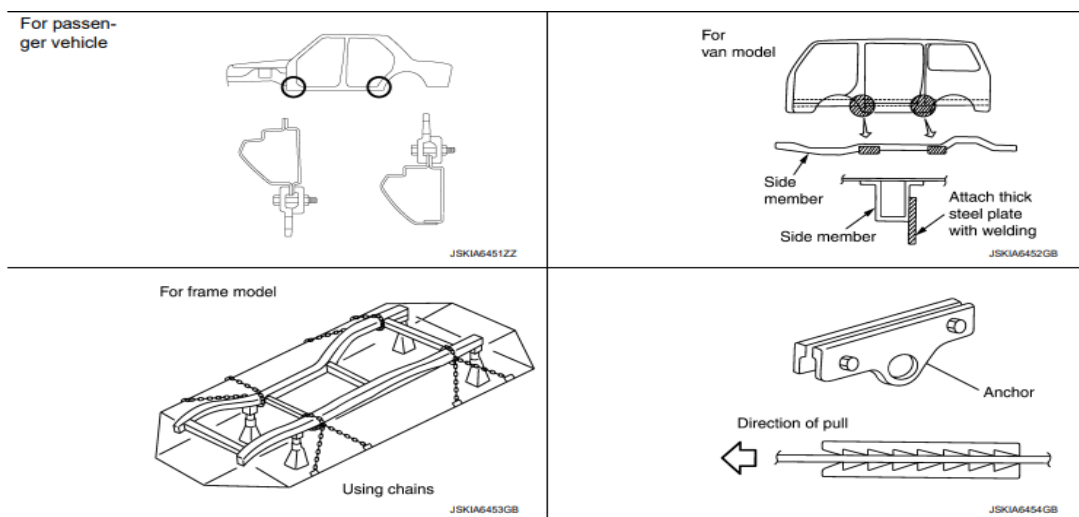
A frame machine, also called a frame rack or frame bench, is a large framework with hydraulic equipment for pulling out major structural damage. Even though equipment designs and setups vary, frame straightening equipment use is similar from machine to machine.

NOTE Always follow realignment equipment operating instructions. The information in this book is general and does not apply to all equipment types and applications

Repair Techniques Using Body Straightening Equipment Securing the Vehicle procedure

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

(1) Anchoring Point

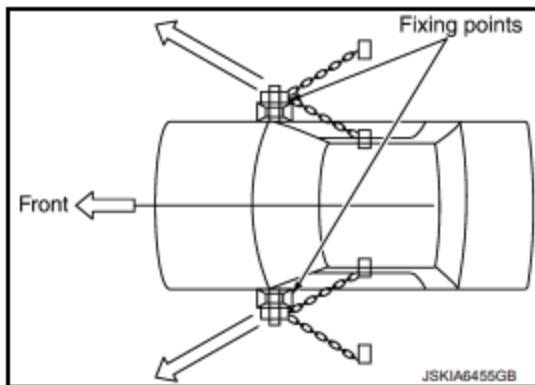


CAUTION:

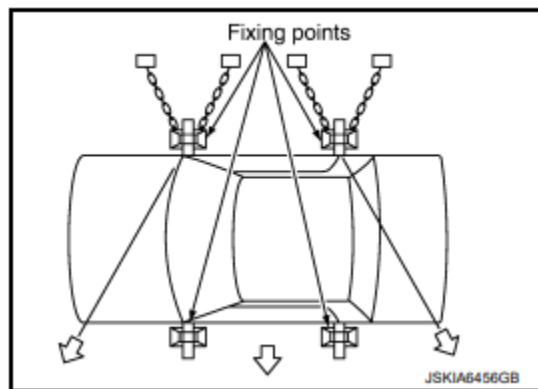
- Choose the foundation of a rigid pillar or a member for anchoring point.
- Set the equipment so that the direction of claw clamp is opposite to the direction of pull.

(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.

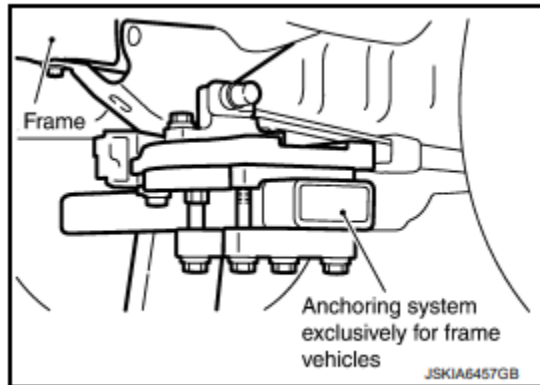


Pulling to the left or right side Pull the vehicle within the range indicated by arrows.



(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.

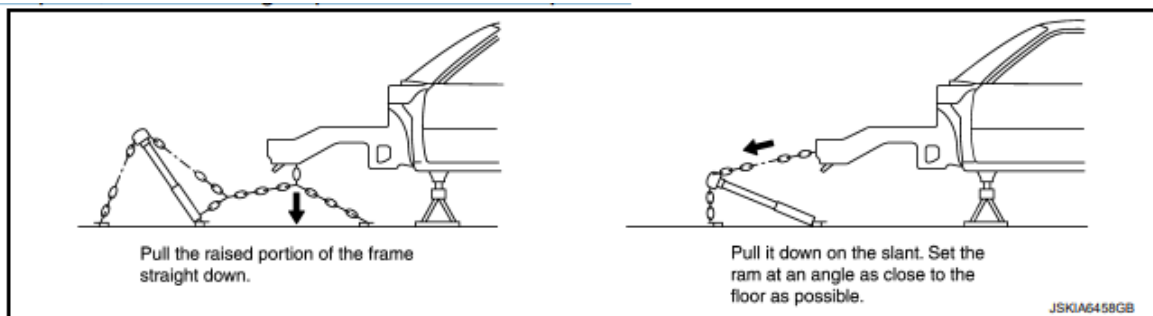


Repair Techniques Using Body Straightening Equipments Securing and Pulling

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.

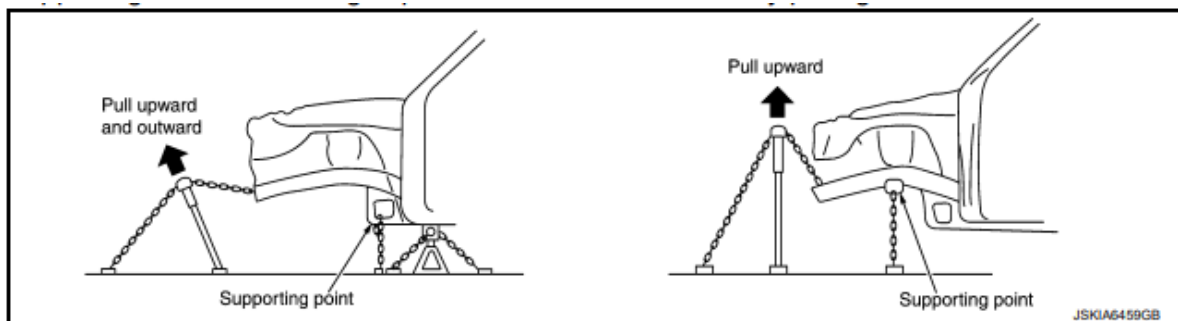
(1) Downward Pull

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.



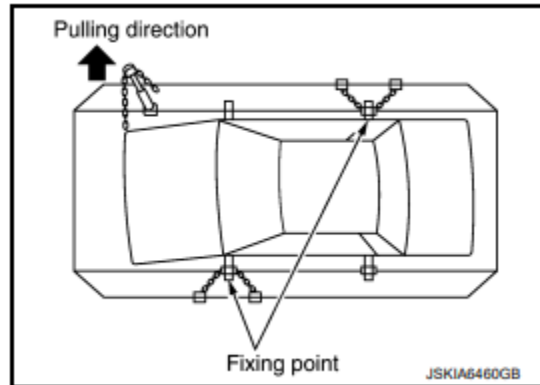
(2) Upward Pull

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



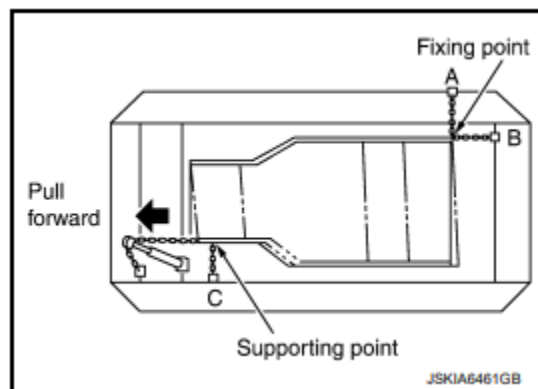
(3) Fixing And Pulling Method For Side Bend

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



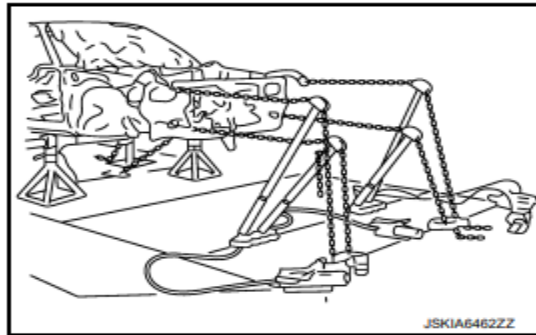
(4) Fixing And Pulling Method For Diamond

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



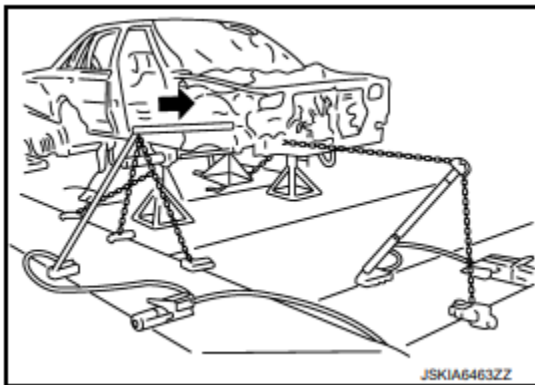
(5) Simultaneous Pulling In Multiple Directions

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



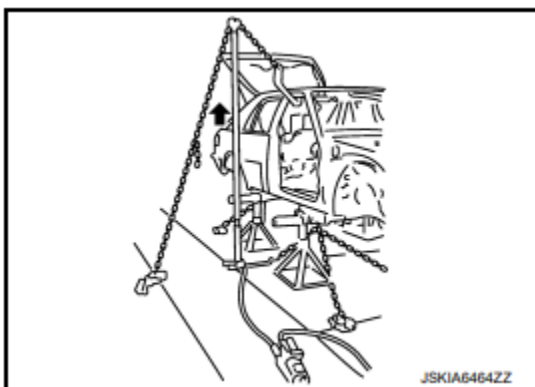
(6) Simultaneous Push-Pull Method

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

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.

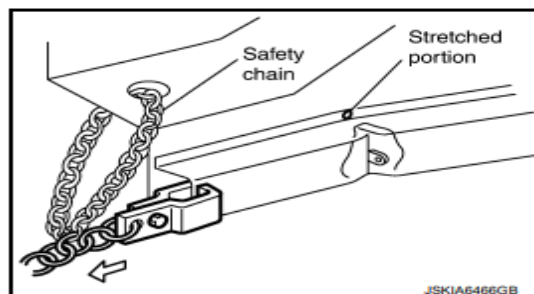


Repair work should basically be performed in this order of damage.

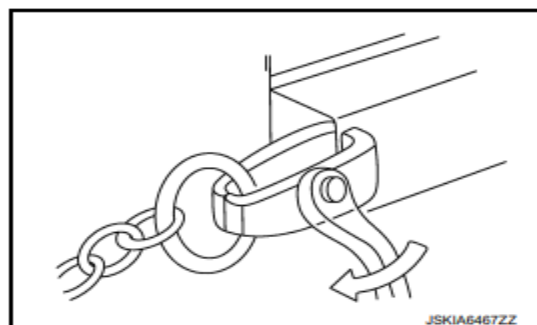
Repair Procedure for Pulling Key Points in Actual Repair Work

(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-inside 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.

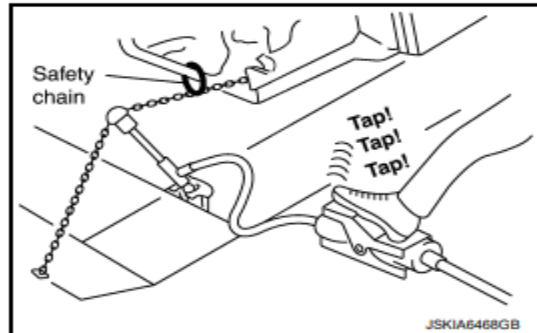


Sometimes a load of approximately 5,000 kg (11,025 lb) is applied during repair work. Accordingly, the clamp must be tightened securely. Be sure to use safety chain

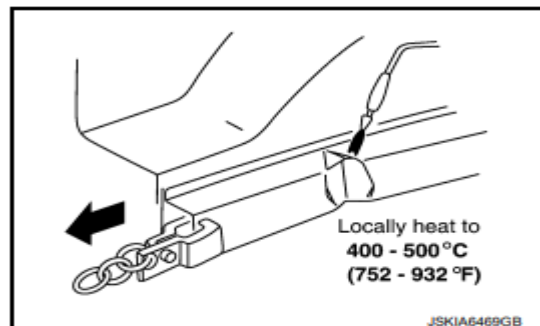


(2) Gradual Pull

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



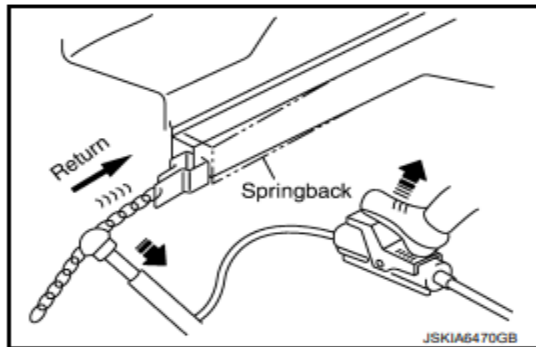
- Reduce The Hardness Of The Work-Hardened Portion. Locally heat the panel to 400°C - 500°C (752°C - 932°F) to the extent that the panel is not colored. Do not heat above 700°C (1,292°F), or strength will be reduced. Do not raise to a temperature of more than 550°C (1,020°F) for HSS parts.



(3) Consider Spring-Back

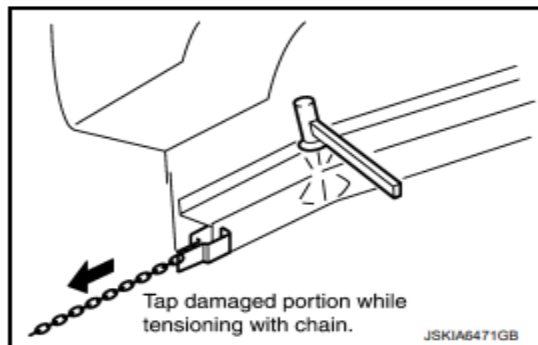
- When pulling force is applied to a panel, spring-back is generated by the residual stress.

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.



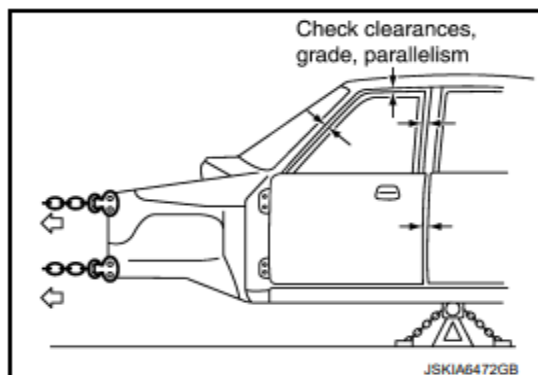
- **Use of hammer**

Residual stress caused by kinetic energy of the collision can be removed by hammering



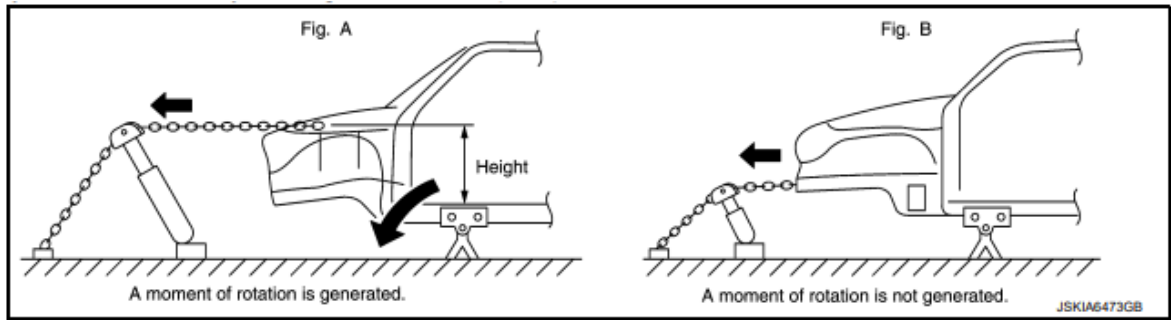
(4) **Determining Proper Amount Of Pull By Observing Door Fit**

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

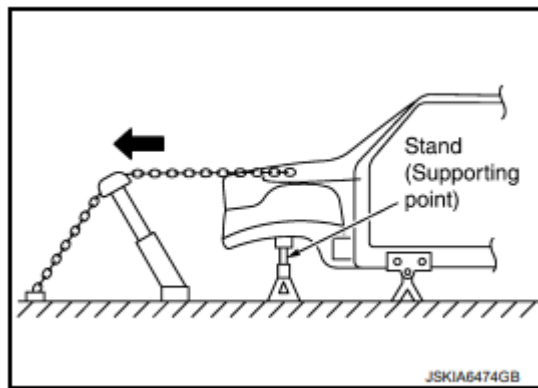


(5) **Pulling Upper Portions From Underbody Clamp**

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.

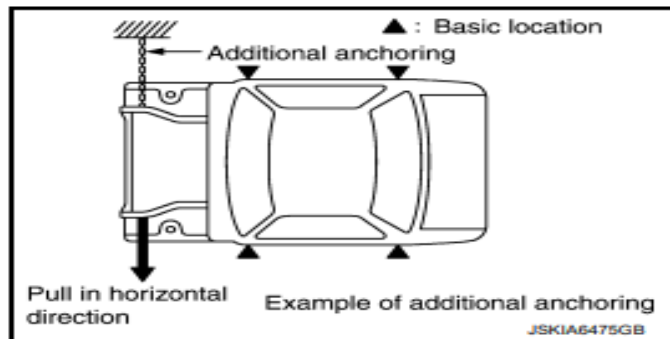


Provide a supporting point under the side member to prevent generation of this moment of rotation



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.

3.2 hydraulic reforming, Heating, sectional repair, Panel beating

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

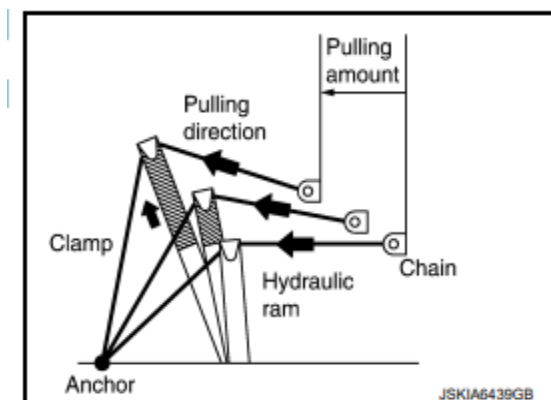


figure3. 11 Hydraulic Ram

(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

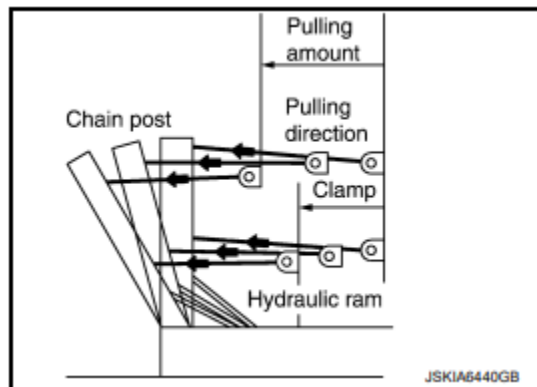


figure3. 12 Tower Type I

(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.

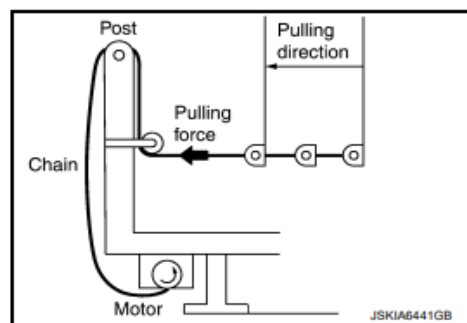


Figure3. 13 Tower Type II

Repair by Heating

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).

Operation sheet-3.1

Operation Title: - Frame Straightening Work

Instruction: - The basic straightening procedures are described below for the respective frame deformation types previously outlined.

Purpose: - 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 Unibody vehicles.

Required tools and equipment:

- Power hacksaw
- Tape
- Oxy acetylene
- Arc welder
- Hammer

Precautions: for Frame Repair 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 Unibody 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.

1. When tack welding is finished, always verify that the crash horn is assembled in the proper dimensions before starting final welding.
2. 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.
3. 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

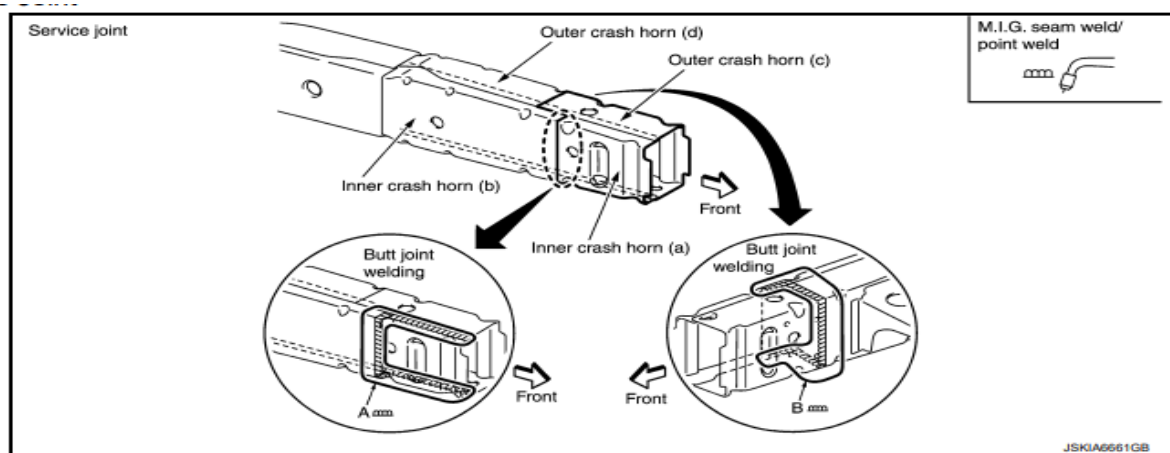
Procedures:

Task 1 Frame Straightening Work Cut and Butt Joint Weld

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 instruct so. As an example, the butt joint weld procedure for A60 is outlined below.

Step 1 Crash Horn (Partial replacement)

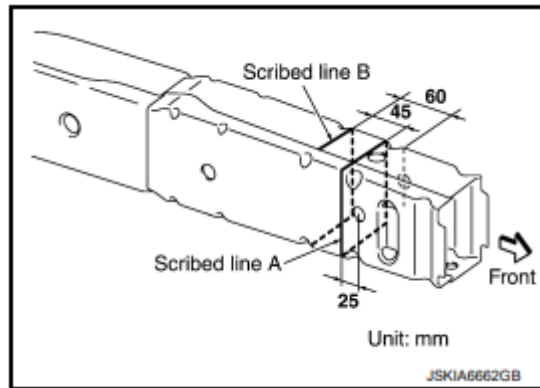
(Work after 1st cross member has been removed.) Service Joint



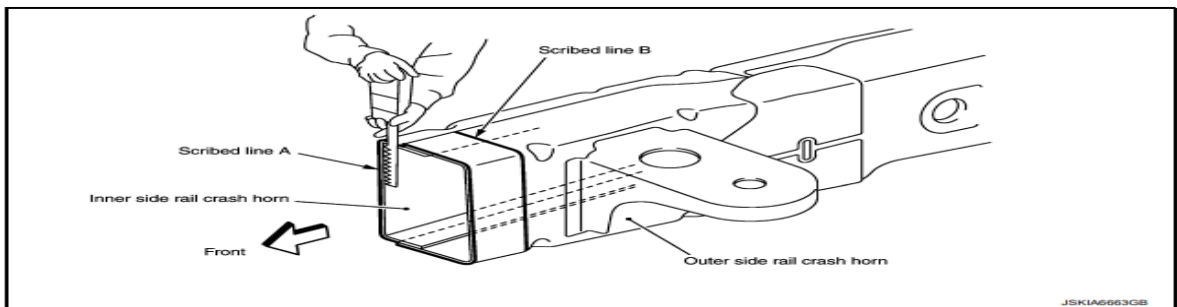
Portions to be welded: A: Inner side rail crash horn (a), inner side rail crash horn (b) and outer side rail crash horn (c) B: Outer side rail crash horn (c), outer side rail crash horn (d) and inner side rail crash horn (b)

Step 2 Removal

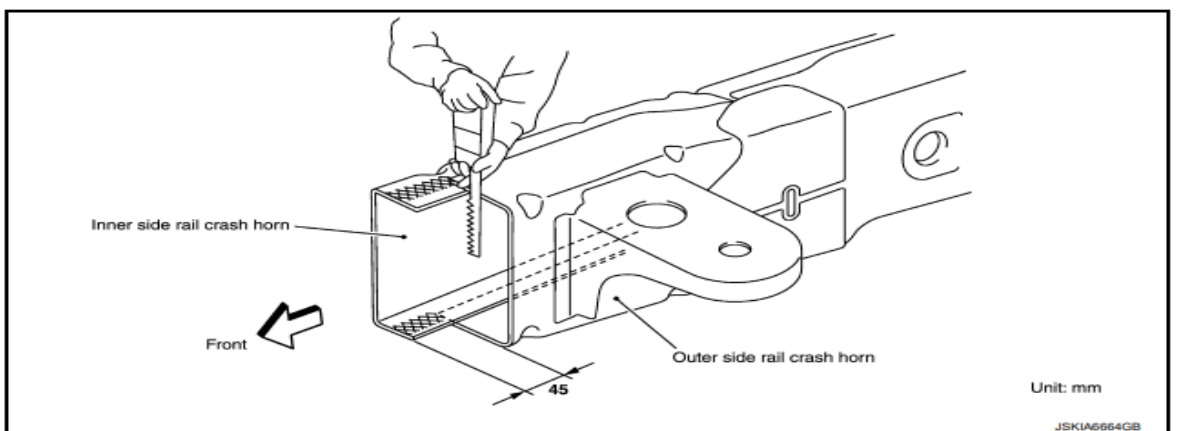
(a) Scribe a straight line on the outer side rail crash horn and inner side rail crash horn along the hole center as shown in the figure.

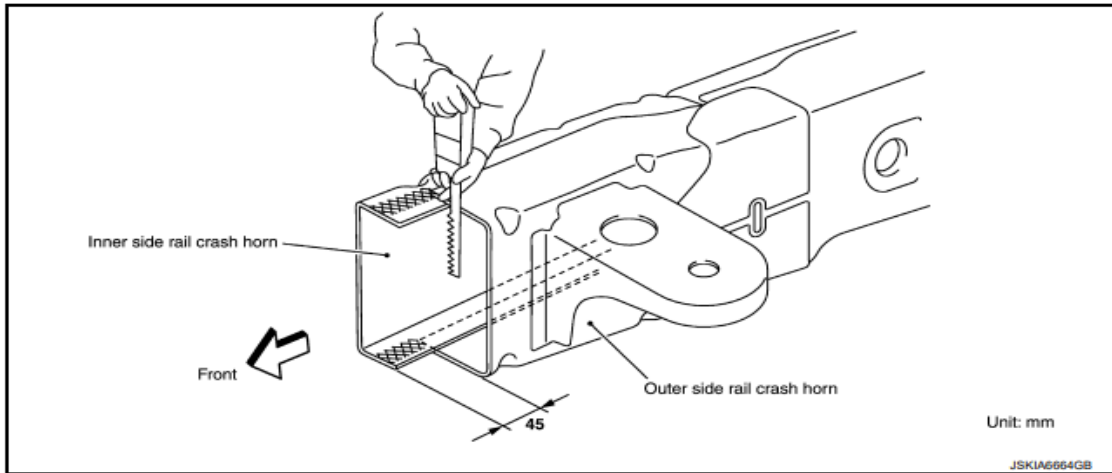


(b) Cut off the outer side rail crash horn and inner side rail crash horn along scribed line (A). Do not cut on the hole



(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)]

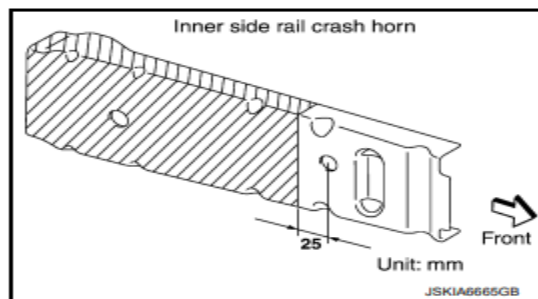




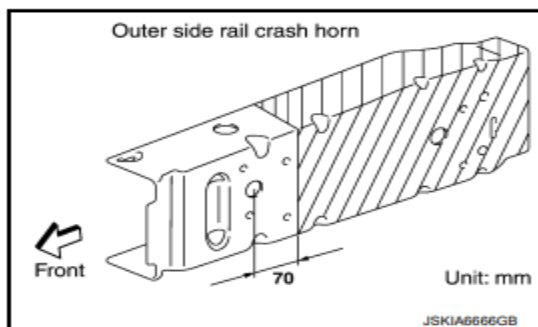
After removing the outer panel, dress the area on the inner panel surface with a sander or equivalent.

Step 3 Installation

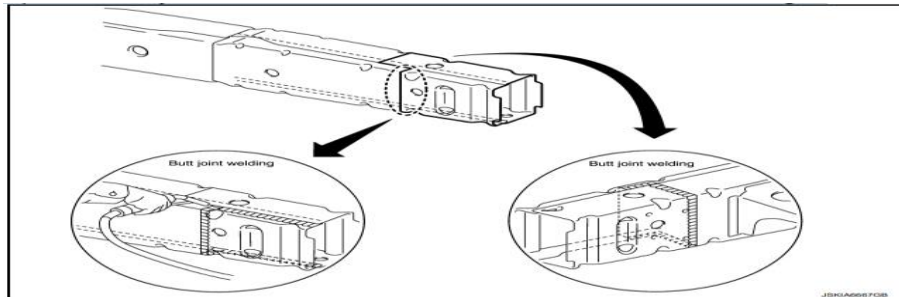
(a) Scribe a straight line on the inner side rail crash horn along the hole center as shown in the figure. Cut off the inner side rail crash horn along the scribed line.



(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



Quality criteria

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.

Unit Four:- Welded Panel Replacement Procedures

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Repair welded panel
- weld panel replacement

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Repair Welded Panel
- Weld panel replacement.

4.1 Repair welded panel

Before you begin any repair process, refer to the estimate for guidance on how to proceed. The estimator will have determined which parts need to be repaired and which should be replaced. You should use this information and shop manuals to efficiently remove and replace parts.

The estimate or repair order is an important reference tool for doing repairs, and it must be followed. The insurance company and estimator have both agreed on which parts must be replaced or repaired. If you fail to follow the estimate or repair order, the insurance company may not pay for your work.

The estimate is also used to order new parts. You might want to make sure all ordered parts have arrived. Compare new parts on hand with the parts list. If anything is missing, have the shop's parts person order them. This will save time and prevent your work area or stall from being tied up while you wait for parts.

In general, to replace a welded-on structural panel you should use the following procedure:

1. Remove fastened parts that prohibit repairs to structural parts.
2. Measure the amount and direction of structural damage.
3. Use a frame rack to pull, realign, and straighten repairable panels (Figure 4.1).
4. Find and clean off flanges to find spot welds on panels to be replaced.
5. Grind or drill out spot welds holding panels on the vehicle.

6. Separate flanges and remove damaged panels.



A This panel has been kinked and badly damaged. A frame rack has been attached to the panel for pulling, even though the panel will be replaced.



B Hammer blows with pulling traction will help relieve stress and aid in pulling other panels into alignment.

figure4. 1before removing any badly damaged welded-on body panels; pull out as much damage as possible to realign adjacent panels that will be reused

7. Clean, grind, and straighten flanges on all panels to be welded.

8. Look up recommended weld types, counts, and locations in applicable service literature.

9. Drill or punch holes in new panels for plug welds.

10. Coat panel flanges with weld-through primer to prevent corrosion.

11. Fit and secure new panels to the vehicle with locking pliers or screws.

12. Measure the alignment of new panels.

13. Tack weld new panels and recheck alignment of adjacent panels.

14. Final welds new panels to the vehicle.

15. Apply sealer and anticorrosion materials to new panels as needed.

4.2.2 Welded panel replacement

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.

4.2.1 Replace body panels and components

Panel replacement is often the only permanent remedy for corrosion damage. For instance, a rusted-out rocker panel and cab corner on a truck would be repaired by cutting away the rusty metal and welding new partial panels in place.

At this point it should be emphasized that great accuracy is required in straightening work in order that doors and windows will operate correctly, and in the case of front end work the front suspension cross member is made to unusually close limits. This is necessary to insure proper front wheel alignment. Therefore, in many cases it is better practice to replace a member than to attempt to straighten 'it.

The alignment of a new front fender. **Figure4. 2** Is simplified, for in most cases the bolt holes are elongated so that the position of the panel can be shifted and correctly aligned. In general, only front fender panels are bolted in position, while rear fender panels, or rear quarter panels, as these are known, are generally welded in position

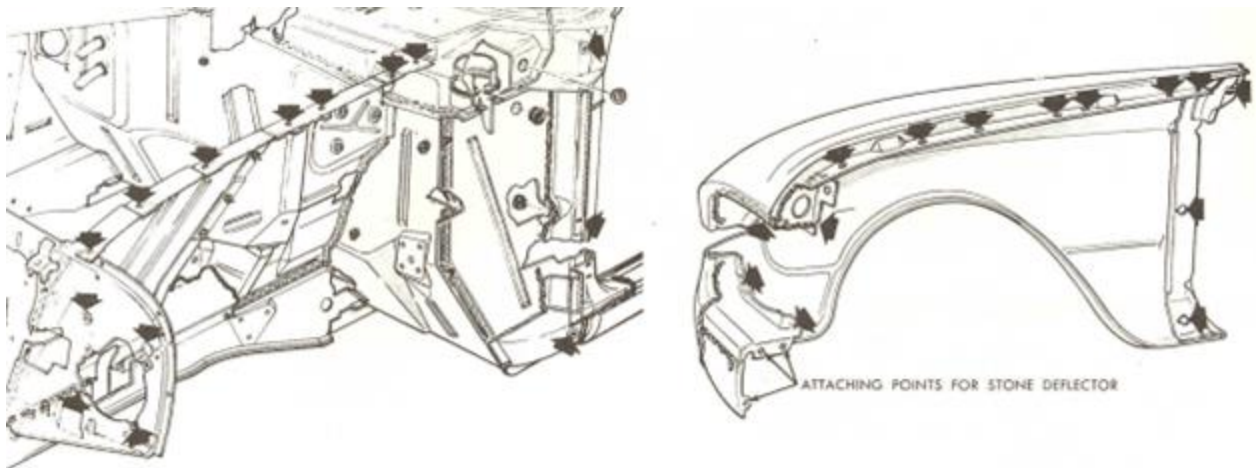
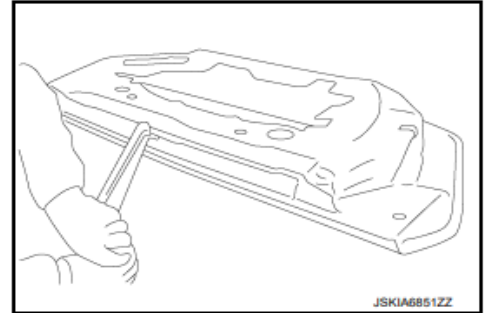


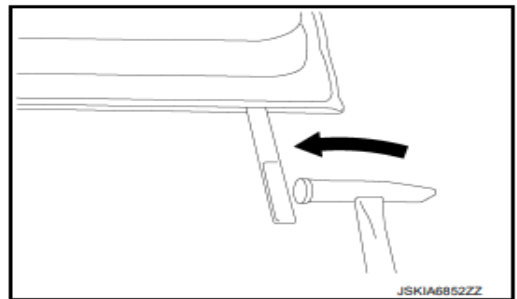
Figure 4. 3 Attaching Point of Fender and Stone Deflector

Replacement of Panel: Door Hemming

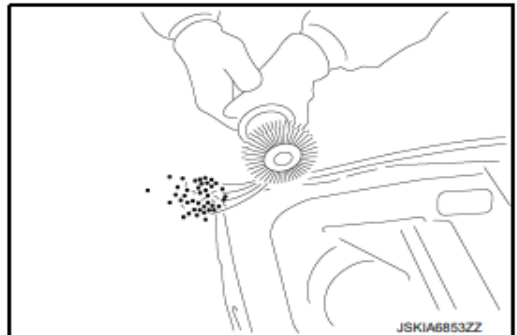
(a) Sand the edge part of door outer panel using belt sander.



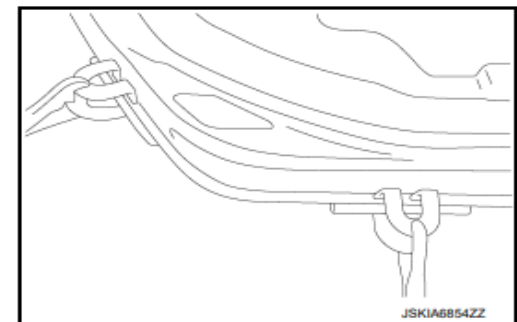
(b) Insert the tip of a sharp-edged tool, such as a chisel, into the clearance at door outer panel. Use a hammer to tap the tool inserted into the clearance from the side to separate the door inner panel and door outer panel



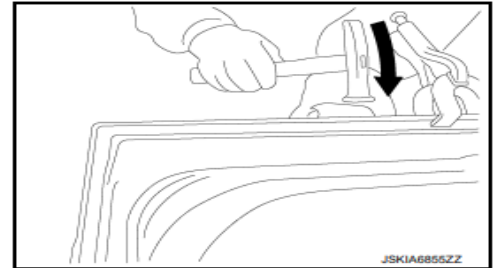
(c) Remove the adhesive adhering to the door inner panel flange area surface



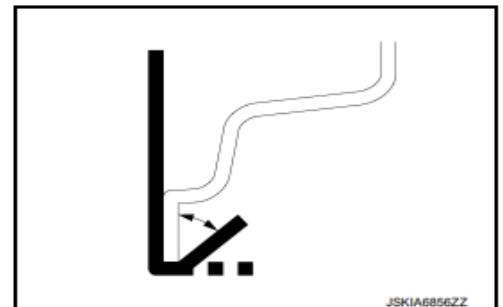
(d) Adjust the position where the new door outer panel and door inner panel overlap. Once these are positioned correctly, fix them with clamps to prevent them from being displaced. Apply new adhesive to both door outer panel and door inner panel.



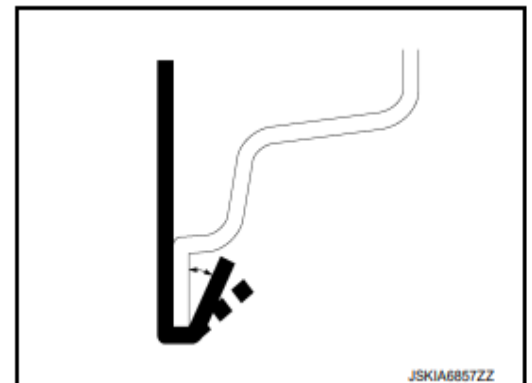
(e) Hold the dolly on the corners of the flange at door outer panel. Tap the dolly with a hammer to bend the door outer panel flange area gradually.



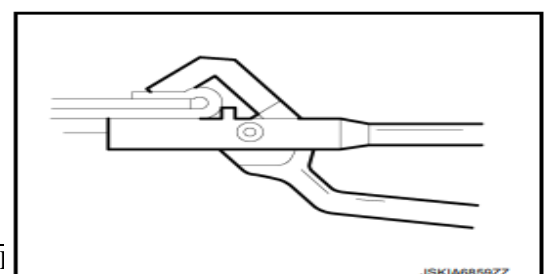
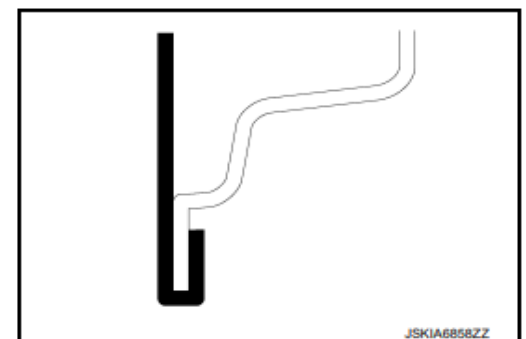
(f) Bend with hammer until the angle of the whole circumference of the door outer panel flange area becomes approximately 45°.



(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°.



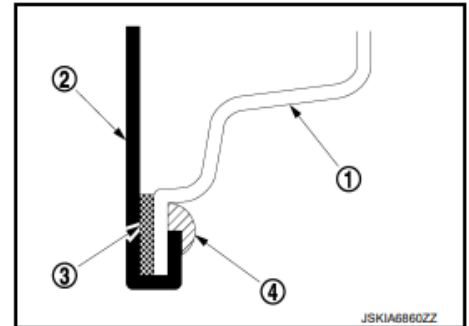
(h) Check that the position of the door outer panel and door inner panel is not displaced while tapping it with a hammer to bend it until the angle of the whole circumference of the door outer panel flange area becomes approximately 0°.



(i) Use the hemming SST tool to adjust the shape of the whole circumference of the door outer panel flange area.

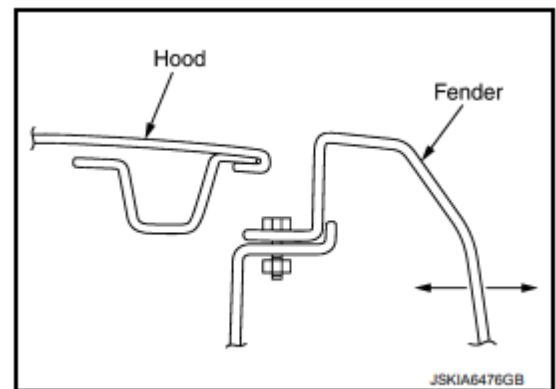
(j) Seal up the area around the hemmed end of the flange.

- Door inner panel
- Door outer panel
- Adhesive Sealant



Replacement of Panel: Adjustment Fitting Of Front Fender

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.



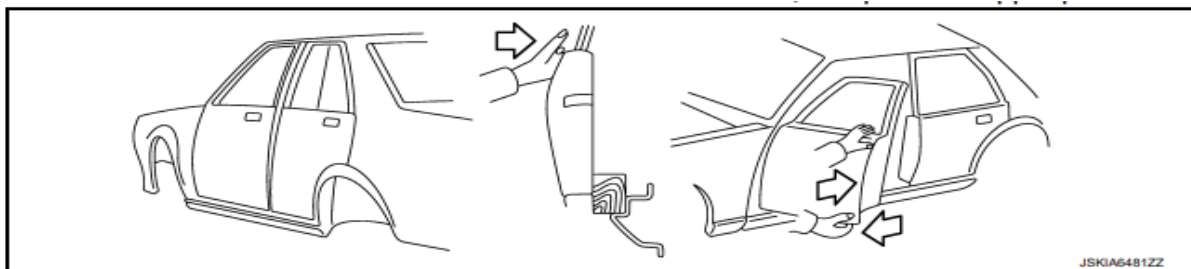
- Adjust the front fender bend angle. If a proper fit cannot be obtained by step (1) above, change the bending angle of the front fender.

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.		

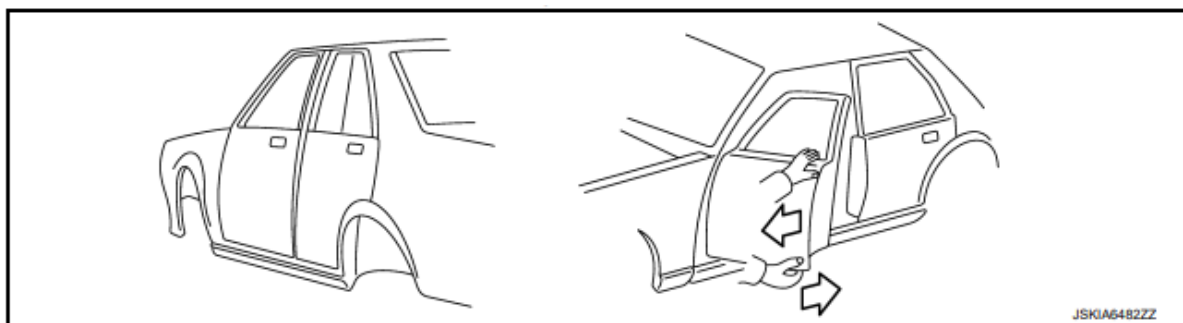
Adjustment Fitting of Door Assembly

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.



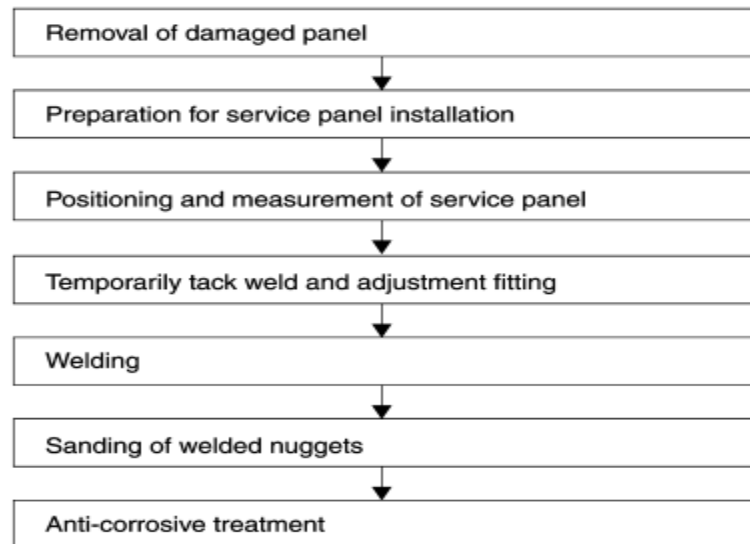
When there is excessive clearance on the lower part of door.



Partial Replacement of Panel (Welded Panel)

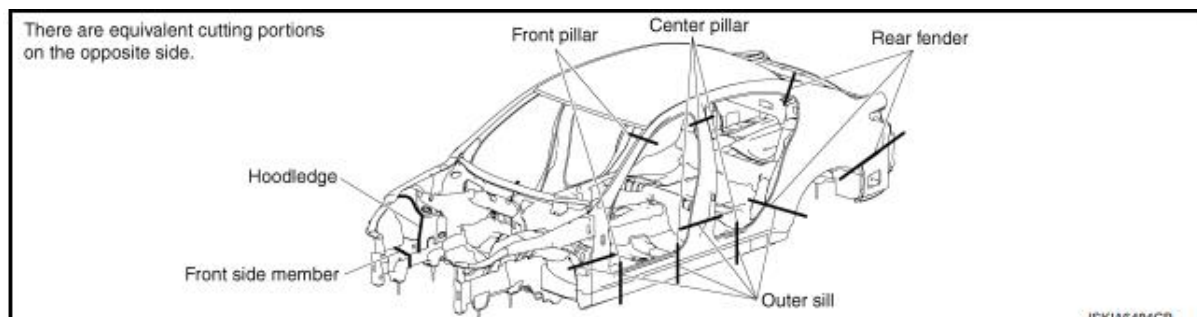
If damage occurs in a welded panel, it can be entirely replaced by a service panel or partial replacement can be done by cutting and replacing damaged portion with a service panel.

Welded Panel Replacement Procedure



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

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

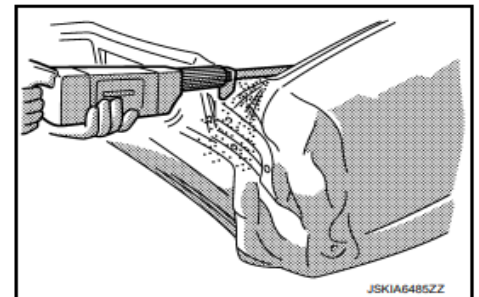
Rough Cutting of Panel

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, then 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

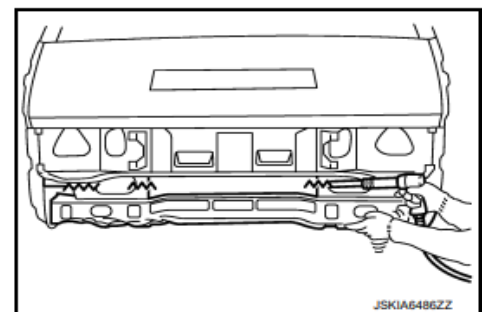
(1) Rough Cutting Using an Air Saw

- Major application Members and pillars including side member, cross member, rear pillar, etc..
- Features Clear cut line. Suitable for cutting both thin and comparatively thick sheet metal.



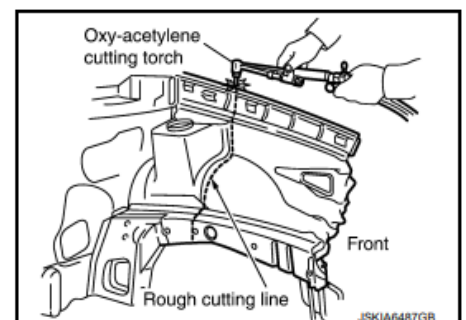
(2) Rough Cutting Using an Air Chisel

- Major application thin sheet metal including the rear fender and rear floor
- Features Faster cutting speed High noise level Not applicable to thick sheet metal Irregular cut line Excessive sparking.



(3) Rough Cutting with an Oxy-Acetylene Cutting Torch

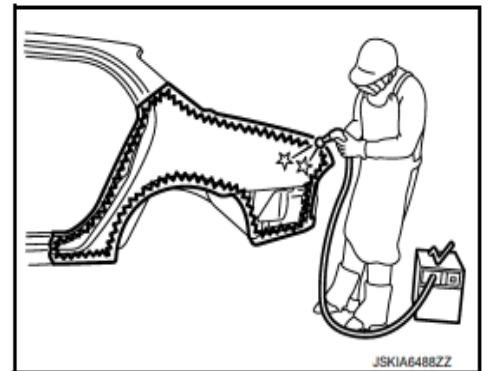
- Major application Thick sheet metal including side member, cross member, hood ledge, etc.
- Features faster cutting speed



(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.



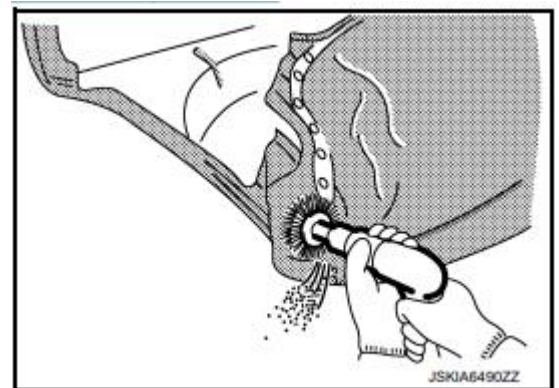
Cutting off Welded Portions

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.

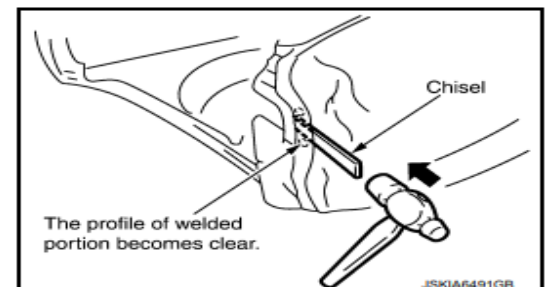
(1) Confirming The Spot Welded Position

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

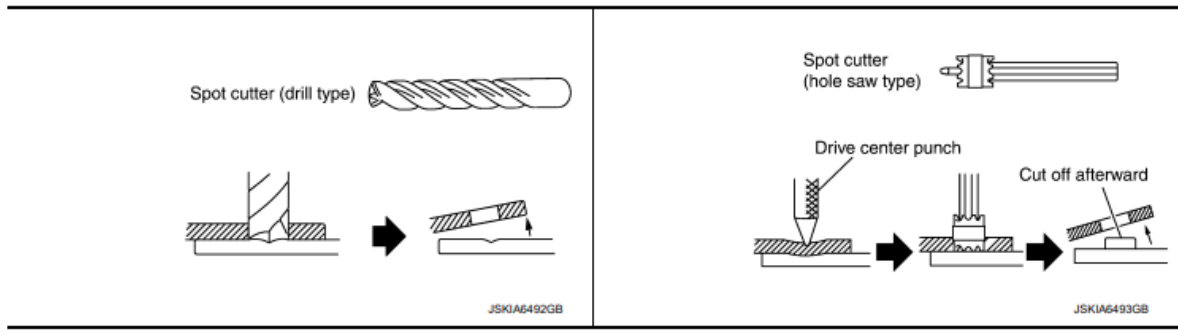


(b) Using a chisel: If the spot welded portion is indiscernible even after removing paint, insert the chisel blade between the panels and tap lightly with a hammer for confirmation.

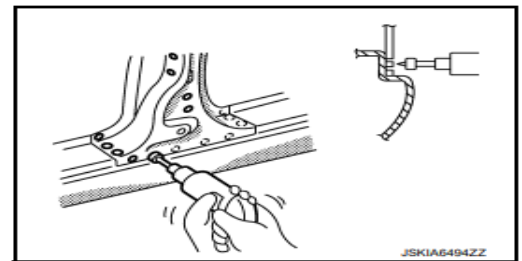


(2) Cutting off Spot Welded Portion

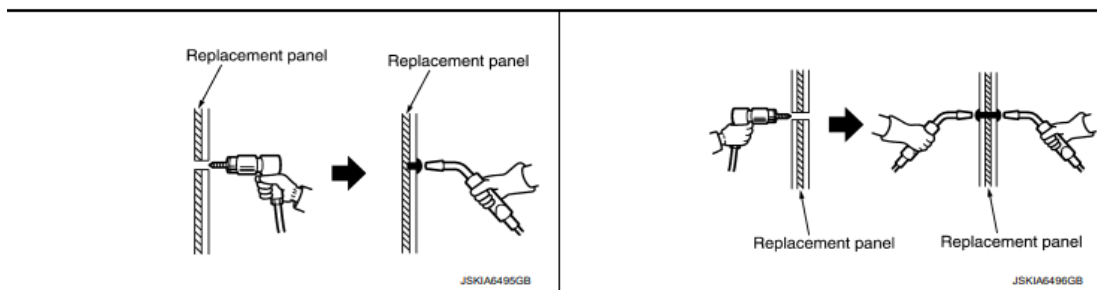
(a) Using a spot cutter: There are two types of spot cutters (a drill type and a hole saw type). When using the spot cutter, be careful not to cut the lower panel.



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.

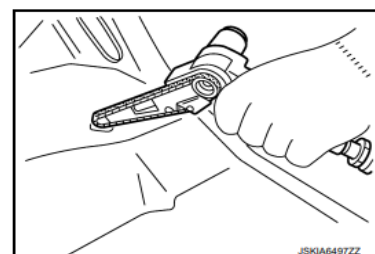


(b) Using drill: The drill may be used to cut welds from any portion welded by plug welding, by drilling out the plug welded portion.



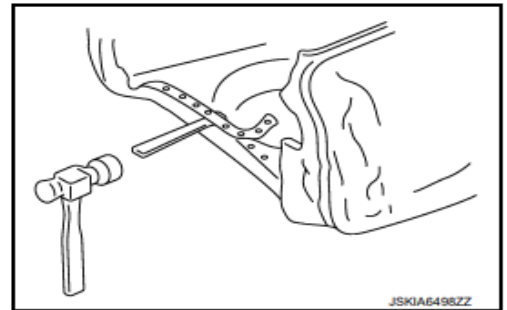
(2) Cutting Spot Welded Portions with an Air Sander

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



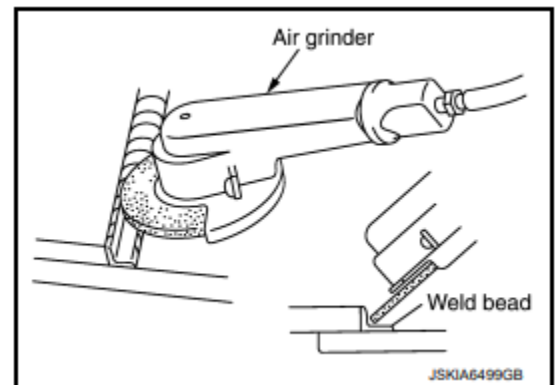
(3) Removing Panel With A Chisel

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.



(4) 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.

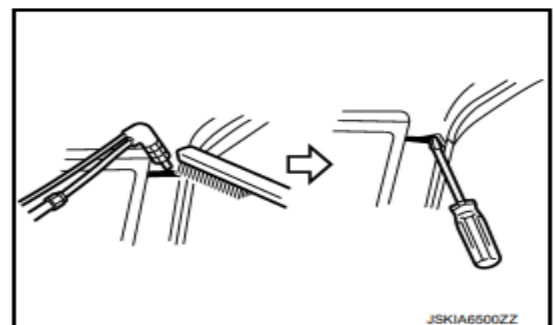


GSA = Gas Shielded Arc welding

6) Cutting off Brazed Portion of Panel

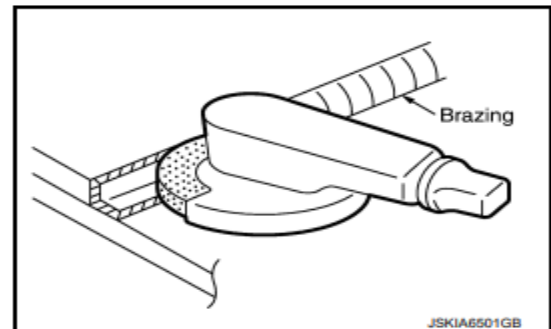
Brazing is used to improve the external appearance of the joined portion (roof and fender) of the body outer panel as well as to improve sealing. Brazed portions can be generally disconnected by dissolving the braze with an oxy-acetylene torch. If arc brazing was used, cut off the welded portion with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

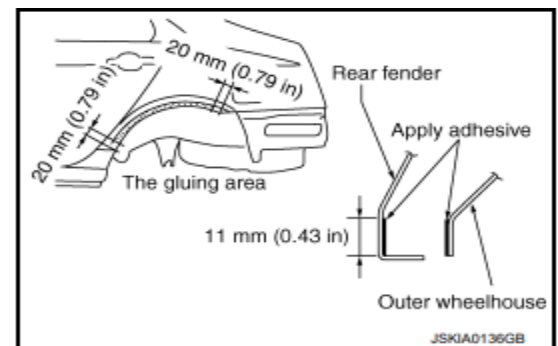
- (b) Cutting with an air grinder cut off the brazed portion with the air grinder. Do not grind excessively the panel to be reused.



Rear Fender Hemming Process

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



Operation sheet-4.1

Operation Title: - Rear Fender Hemming Process

Instruction: The basic hamming procedures are described below for the respective deformation types.

Purpose: - 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 Unibody vehicles.

Required tools and equipment:

- Power hacksaw
- Tape
- Oxy acetylene
- Arc welder
- Hammer

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.)

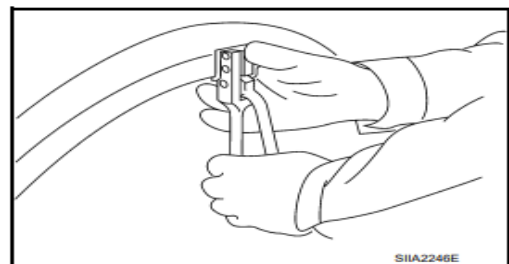
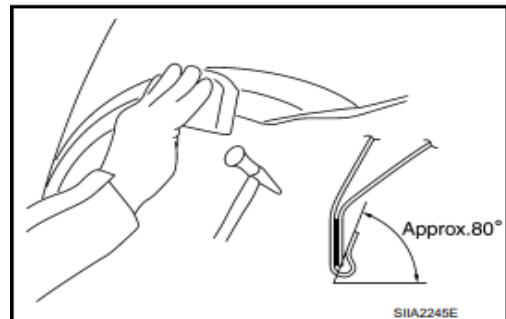
(c) Apply new adhesive to both specified areas of outer wheelhouse and rear fender.

(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.

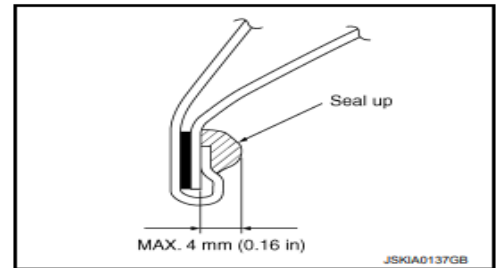
(Also hem the end of the flange.)

(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.

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

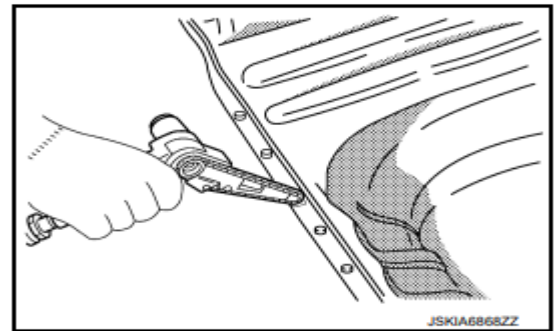


Preparation for Service Panel Installation

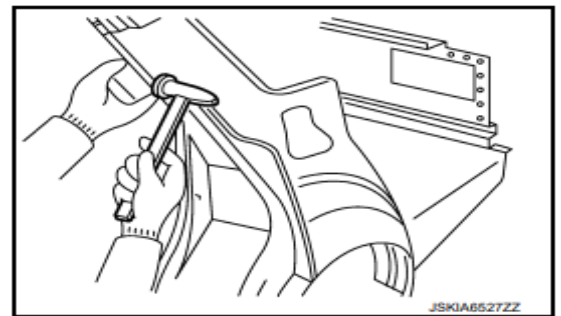
After removing the damaged panel, two operations are needed. Preparation for service panel installation and finishing of the panel mounting portion of the body.

(1) Finishing Body

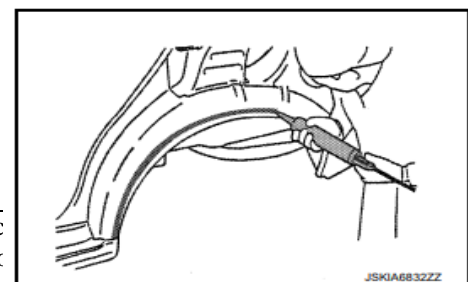
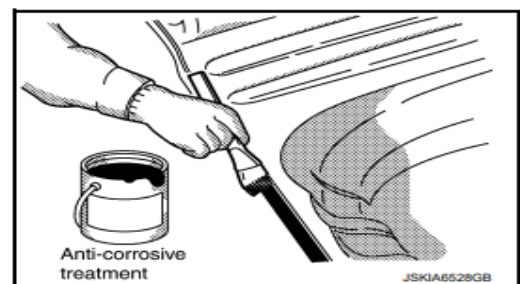
(a) Grind cleans around the area where the spot-welded panel has been removed. Thoroughly remove rust and other contamination from the mating surface. Also, remove paint from the portion to be welded. Any brazing metal should be thoroughly removed, otherwise welding will be impaired.



(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.



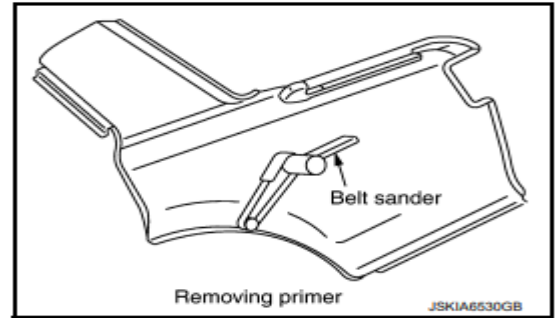
(c) Apply conductive anti-corrosive treatment [spot sealer for spot welding or weld through primer (metallic solution) for GSA welding] in places that cannot be painted in the subsequent painting process.



(d) If it is impossible to apply sealer after welding the service panel, sealer should be applied before welding.

(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.

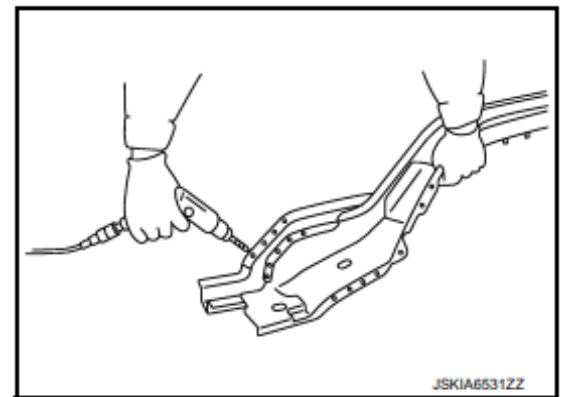


(c) Drill the service panel for plug welding,

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.

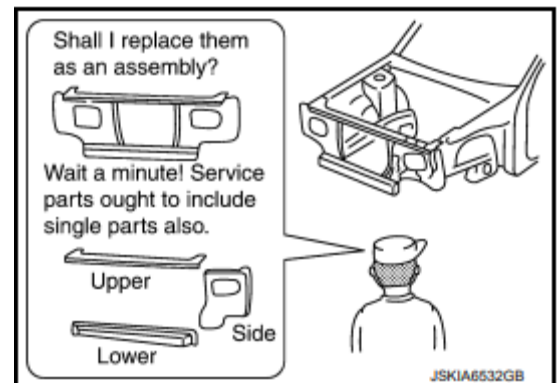
Plug hole diameter and panel thickness

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)

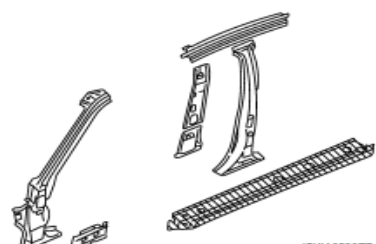
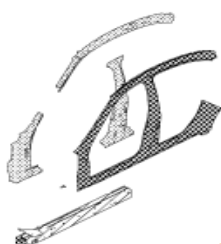


(4) Understanding Service Parts

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



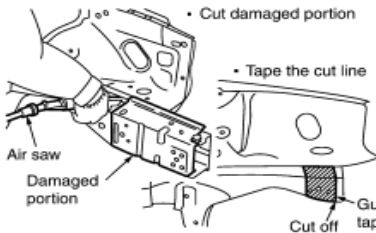
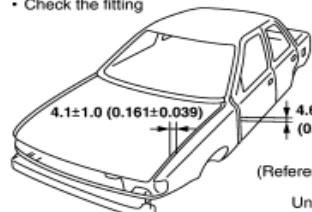
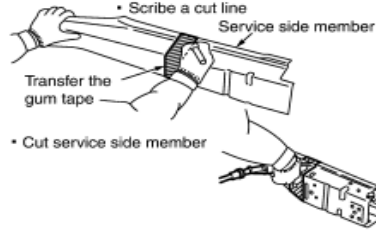
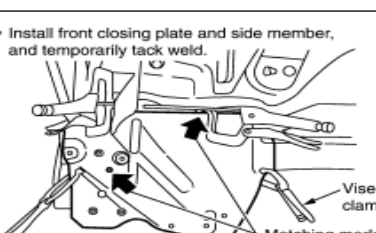
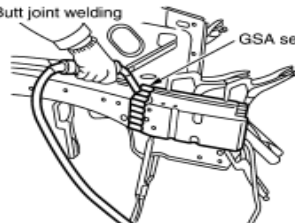
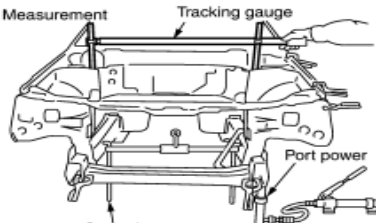
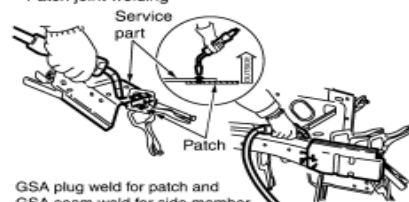
degree of the damage.

Separate type outer body side panel	Integral type outer body side panel
 <p>JSKIA6533ZZ</p>	 <p>JSKIA6534ZZ</p>

Partial Replacement of Panel

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

 <ul style="list-style-type: none"> • Cut damaged portion • Tape the cut line <p>Air saw Damaged portion Gum tape Cut off tape</p> <p>JSKIA6535GB</p>	<ul style="list-style-type: none"> • Check the fitting  <p>4.1±1.0 (0.161±0.039) 4.6±1.0 (0.181±0.039) (Reference) Unit: mm (in)</p> <p>JSKIA6536GB</p>
<ul style="list-style-type: none"> • Scribe a cut line  <p>Service side member Transfer the gum tape • Cut service side member</p> <p>JSKIA6537GB</p>	<p>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.</p>
<ul style="list-style-type: none"> • Install front closing plate and side member, and temporarily tack weld.  <p>Vise clamp Matching marks</p> <p>JSKIA6538GB</p>	<ul style="list-style-type: none"> • Butt joint welding  <p>GSA seam weld</p> <p>JSKIA6539GB</p>
<ul style="list-style-type: none"> • Measurement  <p>Tracking gauge Port power Centering gauge</p> <p>JSKIA6540GB</p>	<ul style="list-style-type: none"> • Patch joint welding  <p>Service part Patch GSA plug weld for patch and GSA seam weld for side member</p> <p>JSKIA6541GB</p>

Unit Five: Cleanup Work Area and Maintain Equipment

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Cleaning and inspecting tools and equipment
- Completing operator maintenance

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- perform Cleaning and inspecting tools and equipment
- Conduct a Job Completing operator maintenance

5.1 Cleaning and Inspecting Tools and Equipment

5.1.1 Introduction

The proper care and storage of materials, tools and equipment are not only the concern of the management but of the workers who use the equipment. A major responsibility of the technician is to ensure that materials, tools and equipment are maintained in a good condition and are readily available when required for the various work activities. Faulty tools and equipment are a common reason for delays on technical activities.

5.1.2 Proper storage of material to reused

One of the responsibilities of a shop instructor/trainer is to organize and handle storage in order to protect tools equipment's and materials against loose and deterioration. These, the following factors should be given due consideration.

Accessibility: - classification and making

Ease of handling: - based on the weight and bulk of the piece

Inventorying: - protect against un authorized withdrawals of materials

Safety Procedure: - unauthorized usage and unnecessary damage or deterioration.

However general storage should be:-

- Convenient storage
- Safe storage
- Visible storage

Waste Disposal Practices

There are eight major groups of waste management methods, each of them divided into numerous categories. You can start using many techniques right at home, like reduction and reuse, which works to reduce the amount of disposable material used.

Methods of Waste Disposal

- I. Landfill** which is the most popularly used method of waste disposal used today. This process of waste disposal focuses attention on burying the waste in the land
- II. Incineration/Combustion** which is a type disposal method in which municipal solid wastes are burned at high temperatures so as to convert them into residue and gaseous products. .
- III.Recovery and Recycling** It is the process of taking useful discarded items for a specific next use. These discarded items are then processed to extract or recover materials and resources or convert them to energy in the form of useable heat, electricity or fuel.
- IV. Recycling** is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is the third component of Reduce, Reuse and Recycle waste hierarchy. The idea behind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use.
- V.Plasma gasification:-** It is another form of waste management. Plasma is a primarily an electrically charged or a highly ionized gas. Lighting is one type of plasma which produces temperatures that exceed 12,600 °F. With this method of waste disposal, a vessel uses characteristic plasma torches operating at +10,000 °F which is creating a gasification zone till 3,000 °F for the conversion of solid or liquid wastes into a gas.

Trainers are concerned how to handle the disposal of the following three types of materials or tools or equipments.

Scrap:-it is an item or equipment which becomes salvaged after giving service for ample period of time

Surplus:-this refers to the existence of items or equipments in excess of the requirements. Materials or equipments become obsolete as a result of change in technology.

There are three ways of disposing materials. They are:-

1. Transferring to another equivalent organization
2. Selling
3. Discarding the material/equipments

Cleaning and inspecting tools and equipment

Cleaning up is not just a measure of respect for the workspace, it also removes hazards. Cleaning is so important because when we clean an area, we are also doing some inspection or checking of machinery, equipment, and work conditions. An operator cleaning a machine can find many mal-functions. When a machine is covered with oil, soot, and dust, it is difficult to identify any problems that may be developing. While cleaning the machine, however, one can easily spot oil.

Leakage, a crack developing on the cover, or loose nuts and bolts. Once these problems are recognized, they are easily fixed. It is said that most machines breakdowns begin with vibration (due to lose nuts and bolts), with introduction of foreign particles such as dust (due to the crack on the cover, for instance), or with inadequate oiling and greasing. For this reason cleaning is useful to make discoveries while cleaning machines.

Cleaning Solvents and Uses

Table 5. 1 Uses of Cleaning Solvents

Cleaning Solvents	Uses
1. Gasoline	It is used to wash oil/greasy tools/equipment.
2. Diesel	It is used to wash oil engine, transmission and other parts of the vehicle.
3. Kerosene	It is used to remove dust, grease oil, paint, etc.
4. Thinner	It is used to remove spilled paint on the floor, walls and tools.
5. Soap and water	It is used to wash/clean upholstered furniture such as seats, tables, cabinets, etc.

Clean up procedures

- Clean up every time whenever you leave an area, including sweeping the floor.
- Clean and return all tools to where you got them.

- Use compressed air sparingly; never aim it at another person or use it to clean hair or clothes.
- Shut off and unplug machines when cleaning, repairing, or oiling.
- Never use a rag near moving machinery.
- Use a brush, hook, or a special tool to remove chips, shavings, scraps etc. from the work area. Never use the hands.
- Keep fingers clear of the point of operation of machines by using special tools or devices, such as, push sticks, hooks, pliers, etc.
- Keep the floor around machines clean, dry, and free from trip hazards. Do not allow chips to accumulate.
- Mop up spills immediately and put a chair or cone over them if they are wet enough to cause someone to slip.

Inspection of work tools/equipment

The purpose of inspection is to identify whether work tool/equipments and working area can be operated, adjusted and maintained safely. Not all work area, tools/equipments needs formal inspection to ensure safety and in many cases a quick visual check before use will be sufficient. However inspection is necessary for any work area, tools/ equipments where significant risks to health and safety may arise from incorrect installation, reinstallation, deterioration or any other circumstances. The need for inspection and inspection frequencies should be determined through risk assessment.

Tags

The use of tags is considered an administrative control and as such only provides limited protection to people and plant; therefore in all cases a physical isolation must be used in conjunction with a tag to prevent the accidental activation of an isolation point.

Attaching the Tag

The person attaching the tag must completely fill the tag with the following information:

- Name & company of person placing tag
- The classification/department the person works for
- The date that the tag was placed
- The equipment / plant the tag was placed on

- Contact number
- Work order / job number if applicable
- Signature

It is important to clearly identify the exact piece of equipment that the tag and lock was placed on to allow identification of those personnel working on the plant.

5.2 Completing operator maintenance

Maintenance is controlling the condition of tools, machines and equipments against deterioration. There are different failure modes and their behavior in time is met with different maintenance strategies

All tools, equipment and vehicles must be properly maintained so that workers are not endangered. Construction regulations require inspections of vehicles, tools, machines and equipment before use.

5.2.1 Maintaining Equipments/Machines

The following are some of machines / equipment maintenance strategies.

1. Preventive maintenance
2. Predictive maintenance
3. Break down maintenance

1. Preventive maintenance

Understood as periodic or schedule activates in which the main objective is the direct prevention of modes or defects. It includes

- Periodic lubrication
- Inspection
- Cleaning
- Testing
- Charging
- Draining
- Balancing
- Overhauling
- Repairing
- Adjusting
- Varnishing
- Replacement

Predictive maintenance

Is a periodic inspection followed by replacement or overhaul if incipient defects are detested? This method does not directly reduce the deterioration rate but indirectly control the consequences of accidents, breakdowns, malfunctions, and general troubles .It involves the observer's sense of seeing, hearing, feeling and smells.

This strategies dictates continues search for defects i.e. continues monitoring of machinery /equipment conditions and performance coupled with continues feedback.

Break down maintenance

Is the maintenance activities necessary to restore machines and equipments back to service after failure modes developed which were:-

- Preventable but not prevented
- Preventable but not predicted
- Predicted but not acted upon
- Not preventable or predictable

A vehicle maintenance log (or auto maintenance log) is used by commercial fleet owners to document maintenance work and repairs. It can assist to record crucial vehicle information and keep track of the vehicle's condition. The fleet vehicle maintenance checklist items include:

1. Record work done on the vehicle (i.e. inspection, maintenance or repairs)
2. Take photo evidence of vehicle condition after maintenance
3. Add notes and indicate estimated cost of repairs (if any)
4. Provide recommendations of service
5. Sign-off with a digital signature from assigned personnel

Self-Check-5

Directions: Answer all the questions listed below

Part I: Match Each Words of Definitions

Column A

1. Accessibility
2. Ease of handling
3. Inventorying
4. Safety Procedure

Column B

- A. Protect against unauthorized withdrawals of materials
- B. Based on the weight and bulk of the piece
- C. Unauthorized usage and unnecessary damage or deterioration
- D. Classification and making

Part II Fill the Blank Question

1. _____ which is the most popularly used method of waste disposal used today?
2. _____ It is another form of waste management?
3. _____ is controlling the condition of tools, machines and equipments against deterioration?

Part III: Give Short Answer

1. Write equipment maintenance strategies?
2. Write ways of disposing materials?

LAP Test

Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hours.

Task 1: perform Crash Horn (Partial replacement)

Task 2: perform Removal Partial replacement

Task 3 perform Installation Partial replacement

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