	Federal TVET Agency and Regional TVET Provider

Vehicle Body Repairing and Painting

NTQF Level II

Learning Guide -#24

Unit of Competence: - Carry-out Panel Repairs to Pre-paint Condition

Module Title: - Carrying-out Panel Repairs to Pre-paint Condition

LG Code: EIS VRP2 M08 LO2-24

TTLM Code: EIS VRP2 TTLM 0919v1

LO 2: Carry out basic Panel Repairs

Instruction Sheet	Learning Guide - #24

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Shaping damaged panels
- Carrying-out body filling and metal finishing
- Complete panel repair to pre-paint

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Shape damaged panel is using basic panel beating techniques according to workplace instructions and safety and environmental requirements, and without causing damage to components, tools or equipment
- Carry out body filling and metal finishing are according to workplace procedures and safety and environmental requirements
- Complete Panel repair to pre-paint condition according to workplace instructions and procedures, and safety and environmental requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in **number 3 to 17**.
3. Read the information written in the "**Information Sheets 1**". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-check 1" **in page 5.**
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to "**Information Sheet 2**". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning "**Information Sheets 1**".
7. Read the information written in the "**Information Sheets 2**". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
8. Accomplish the "Self-check 2" **in page 16**.

9. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
10. If you earned a satisfactory evaluation proceed to "**Information Sheet 3**". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning "**Information Sheets 2**".
11. Read the information written in the "**Information Sheets 3**". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the "Self-check 3" **in page 19.**
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
14. If you earned a satisfactory evaluation proceed to "**Operation Sheet-1 up to 4**". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning "**Information Sheets 3**".
15. Read and understand the information written in the "**Operation Sheet-1 up to 4"** Try to understand what are being discussed and make a practice with the help of the teacher. Ask you teacher for assistance if you have hard time understanding when doing a practical.
16. Accomplish the "LAP test" in **page 26.**
17. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Shaping Damaged Panels

1. Shaping Damaged Panels

1.1. Repairs part of accident damaged and dents

Correcting a Deformed Panel

Damage diagnoses

- Determine the direction and force of impact, and whether damage is confined to the body
- Inspect the parts along the path of impact, measure the major parts and check body height, suspension and body damage Impact Effects
- In body-over-frame construction, the passenger area is enclosed with panels of steel attached in the uni-body construction, the metal body panels are welded together to make a unit. Damage assessment and repair also differs.

Level of Vehicle Damage

1.	**Minor damage** typically means scratches, scrapes or dings. Example, a cracked headlight or small dent in your hood	
2.	**Moderate damage** usually means large dents in the hood, fender or door of your car.	
2.	**Severe damage** (very heavy damage) this includes broken axles and bent or twisted frames	

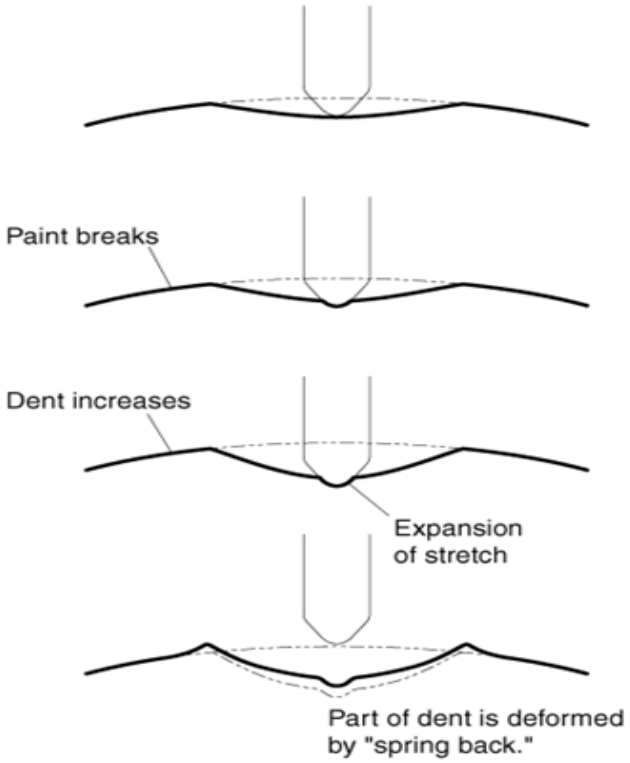
Sheet Metal Deformation Analysis

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

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

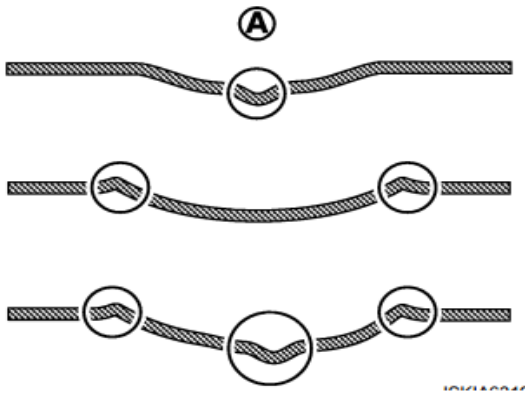
(c) If the external force continues to increase, breaks around the dent enlarge, and the sheet metal at the center of the dent stretches.

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

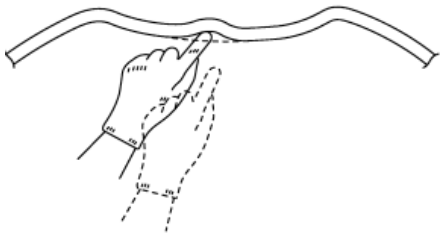
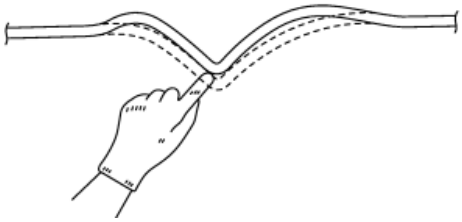


Basic Types of Damage

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



Elastic VS Plastic Deformation

	Elastic deformation: If pressed, the deformed portion will move or further deform.
	Plastic deformation: If pressed, the deformed portion will remain unchanged, and other portions will move.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Discuss the level vehicle damage. (4 Point)
2. What is the difference between elastic and plastic deformation? (4 point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

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Information Sheet-2	Carrying-out body Filling and Metal Finishing

2. Carrying-out Body Filling and Metal Finishing

2.1. Filling and Metal Finishing

2.1.1. Filing Techniques

Filing is one of the most important aspects of finishing a body panel. It is carried out using an adjustable file holder, fitted with flexible blades which can be adjusted concave or convex to suit most contours on the average vehicle body. Initially the file was used for smoothing off panels prior to sanding and locating high and low spots. With the introduction of body solder and later metal and plastic fillers, filing took on an even greater importance in the finishing of repairs on body panels. Filing indicates any irregularities in the repaired surface of a panel and is carried out as the panel is plan shed. First of all fasten the correct blade to the file holder with the cutting edges of the teeth facing away from the handle or operator. Adjust the contour of the file holder so that it is almost, but not quite, matching the contour of the surface on which you intend to work.

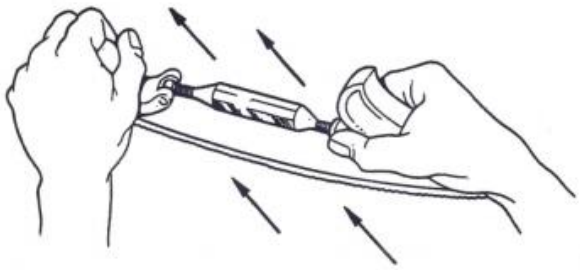


Figure 1: Removes High and Low Spots on Metal Surface

One hand is used to hold the file handle, while the other grasps the knob at the opposite end. The file should be applied with long, straight strokes, pushing it away from you along the length of the panel. Short, jabbing strokes should never be used, as these will only scratch the panel and will not indicate low spots. If the file digs in, too much pressure is being applied and hence a need for reduction is essential. At the end of the first stroke, raise the file and without dragging it over the metal, bring it back to the starting position and make a second stroke.

Repeat this procedure until the area has been covered, making the file marks parallel to one another. This is termed line filing and indicates the levelness of the panel in the direction in which it has been filed. At this point both the high and low areas will show up. The high spots can be corrected by spring hammering and the low spots by direct hammering, pick hammering, or in some cases by using the corner of the dolly block. Line filing indicates curvature in one direction only and as most panels are double curved the panel surface must be cross filed to give an accurate contour check. Cross filing means a change in the direction of the file strokes so that the file is moved at an angle between 45º and 90º over the previous file strokes, thus checking the accuracy of the curvature in that direction. After filing, and prior to refinishing the panel, the damaged area is sanded using a fine-grit sanding disc which leaves a smooth, even surface ideally suited for painting.

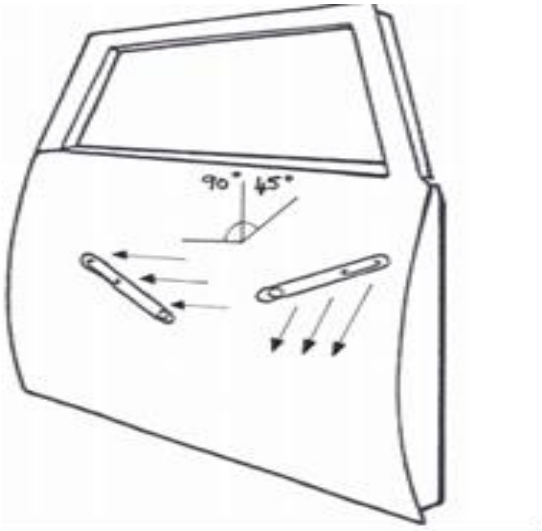


Figure 2: Filing a Door Panel

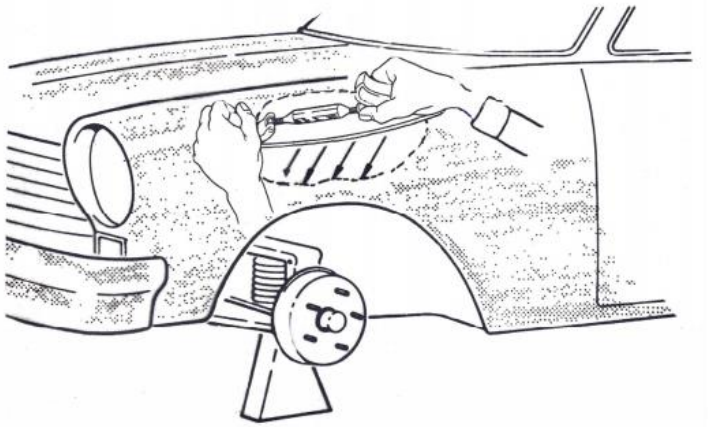


Figure 3: Cross Filing at 45º

2.1.2. Grinding Techniques

Several general rules govern the use of the disc grinder. If these are observed they will enable the operator to become proficient very quickly in the use of the grinder. The rules are considered good shop practice and are directed towards the safety of the operator. In the first instance, if the device is electrically operated see that it is properly connected and earthed. Shop floors are usually of cement, they are generally moist and therefore, relatively good conductors of electricity. If the grinder is not properly earthed it is possible to receive a fatal electric shock when the machine is in use.

Summary

Metal finishing is a skilled job and perfection can only be achieved by plenty of practice. The correct selection and use of tools for the job in hand is vital to produce the perfect finish. Metal finishing is a hand craft that still retains its place in body work and as yet is irreplaceable by more modern methods, in spite of mechanical methods of repairing panels.

2.2. Metal Finishing

Filing is a means of metal finishing a damaged panel prior to sanding operations for paint spraying. Essentially, panel beating is a hand method of producing hollow or double-

curvature shapes by means of hammering and metal finishing nevertheless the panel beater's craft still retains its place in body work and as yet is irreplaceable by more modern methods, in spite of the tremendous developments in recent years of mechanical methods of forming, panel beating remains as essential means of fabrication of special parts. Some metal shapes cannot be produced at all by mechanical methods and others only with great difficulty and in such cases panel beating is used to finish the shape that has been rouged out by power processes. Often, too, the prototype of a component ultimately to be made in quantity by stamping or pressing is hand made to allow minor modifications to be studied before mechanical production begins, the part produced by panel beating is used as the pattern for press or stamp tools. Panel beating may also be used where a small number of components only are required and where the cost of press or stamp tools would be uneconomic. In body repair work, panel beating is used to advantage where sections which are either unobtainable or uneconomical to replace completely can be fabricated by hand either in part or as a whole. In many cases corroded areas can be repaired by fabricating new sections for replacement purposes. In the body building trade, panel beating is still used to large extent where new vehicles are built either in aluminium or mild steel. Many of the components for these vehicles are still made using the traditional hand shaping methods. Also a lot of the aluminium moulds used in fiberglass construction, where highly developed double-curvature shapes are needed, are made by hand, welded and dressed, planished or wheeled to a final finish. Panel beating is essentially a hammering process, involving different kinds of blows that can be struck on sheet metal. It should be borne in mind that most metals used in body work possess high malleability and may be overstretched even with a wood tool. The three types of blow that can be struck on sheet metal are:

Solid Blow Where the work is struck solidly over a steel stake.

Elastic Blow where either the head or the toll or both is made of a resilient material such as wood.

Floating Blow

Where the stake is not directly under the hammer Each type of blow has its uses for particular purposes. A solid blow will stretch the sheet and may be necessary when forming a panel, bending a curved strip or angle, removing a loose or tight place in a sheet, or throwing an edge over when thickness is not a consideration. An elastic blow will form metal without undue stretching, indeed metal can be thickened if desired, as in working out a tuck or pucker. The floating blow is given to the metal when it is held over a suitable head and hit off the solid', so forming dents at the point of impact.

Metal Finishing Safety

When filing metal panels care should be taken with the edges of the panels as they become very shape from the filing. Always use gloves and goggles to protect your eyes from flying sparks and paint debris. Fireproof overalls, safety boots and ear muffs are also essential.

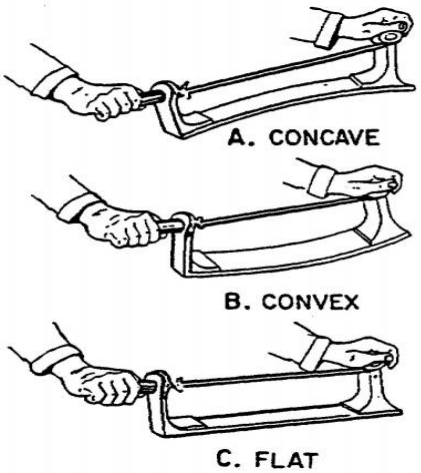
Grinding/Filing a Door Panel

Body Filling

(1) A body file is used for many things: to remove paint, smooth metal, find low spots, remove excess solder, quickly remove aluminum, and to form the correct contour of areas that have been built up with solder. The gage of metal on sedan bodies is as light as practical, and every precaution must be taken not to file or grind away any metal unnecessarily. When removing high spots by grinding or filing, care must be taken not to cut through or weaken the part.

(2) Using the file is a two hand job. One hand is used to hold the file handle; the other is used to grasp the file around the saddle at the opposite end of the handle.

Body File



(a) The file blade is fastened to the holder with the cutting edges of the teeth facing away from the handle. Adjust the contour of the file holder so that it almost, but not quite, matches the contour of the surface.

(b) Place the file on the work. With a straight stroke, push the file away from you, holding it at an angle of 30 degrees in relation to its line of travel. If the file digs in, you are putting too much pressure on it. At the end of the first stroke, raise the file and bring it back to where you started and make a second stroke. Remember to raise the file at the end of each stroke. It should not be pulled back over the metal because dragging will tend to dull the file blade.

(c) By filing in the above manner, the file marks are parallel and have removed all of the paint, and probably some of the metal, from the work in the filed area. This type of filing is referred to as line filing. The term "line filing" means all the strokes, and consequently, all of the file marks, are in the same direction.

(d) Now change the direction of your file strokes so they are about a 45 degree angle from the previous direction. This is referred to as X-filing. When the file is moved so that you are X-filing, you may find that the contour of the area differs slightly. If this is true, adjust the file holder again to nearly, but not quite, match the contour. Then go over the entire area once lightly. You will now find that the new file marks cross the original file marks at a 45 degree angle and that these two sets of file marks form a series of innumerable X's from which the term "X-filing" is derived. X-filing or cross-filing is necessary to establish or maintain a contour that curves in more than one direction; whereas, line filing is used on more simple surfaces. When filing, it is always a good plan to make a few cross or X-strokes occasionally to make sure that you are not destroying a secondary contour in the metal. This is particularly important when filing areas that have been built up with solder or other material.

(3) When using body files on epoxy fillers, ensure that the fillers are thoroughly cured or the file will clog and gouge the surface.

Foaming Agent Filling Operation Procedure

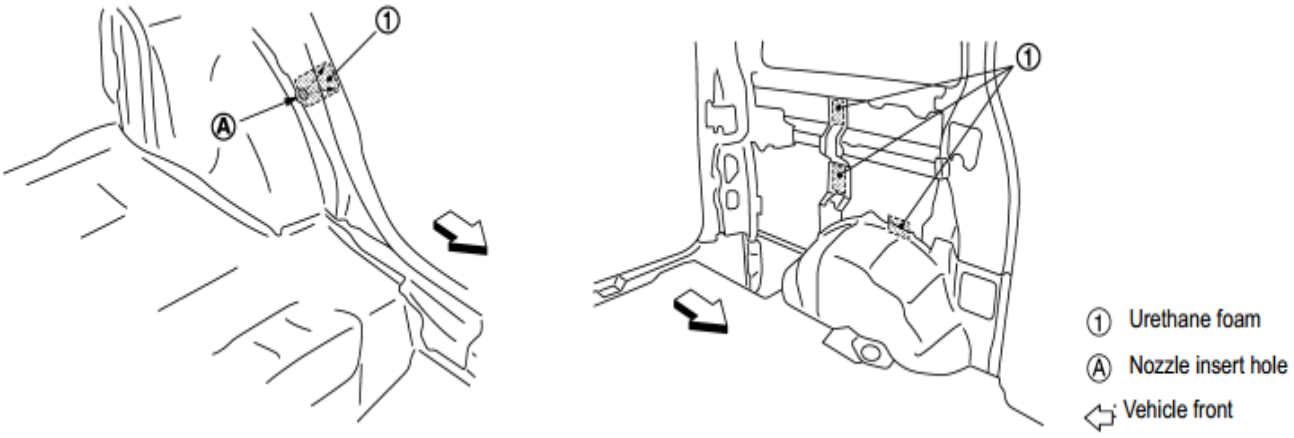
1. Fill procedures after installation of service part.

a. Eliminate foam material remaining on vehicle side.

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

c. Install service part.

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



2. Fill procedures before installation of service part.

a. Eliminate foam material remaining on vehicle side.

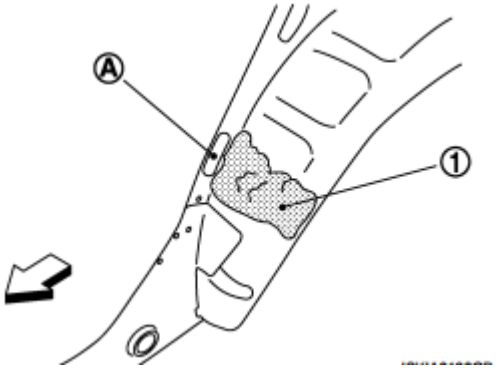
b. Clean area after eliminating foam insulator and foam material.

c. Fill foam material on wheelhouse outer side.

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

d. Install service part.

NOTE: Refer to label for information on working times



2.3. Types of Filler and Putty

Type (Standard thickness limits)		Characteristics
Body Filler Putty (For repairing of large dents or scratches) [10 mm (0.39 in)]	Surform type	• This type of filler requires surforming, (rough grinding). It will clog sandpaper if it is sanded only. • Can be thickly applied to panel. • After drying, grindability is poor as it is harder than other types.
	Light Type	• This type of filler contains tiny hollow beads. It feels gritty when applied with a spatula. • Suitable for thick application to panel • Superior grindability after application • Forms blowholes easily
	Glass Fiber or Aluminum Powder Type	• Excellent thick application to panel • Superior corrosion prevention and durability • Suitable for repairing rusty holes in panel
Intermediate Filler Putty [10 mm (0.39 in)] (For repairing of large dents or scratches)		• Good sanding characteristics. • It is difficult for fine grain pores to form in it, so poly putty can be eliminated and surfacer can be applied directly over intermediate filler.
Polyester Putty (For filling pores and sand scratches in body filler)	Spatula Type [3 mm (0.12 in)]	• Not very much thickness can be built up. • It has fine grain and good flexibility. • Since no volatile content remains, there is no depletion after baking. • Sanding characteristics are good.
	Spray Type	• Not very much thickness can be built-

	[1 mm (0.04 in)]	up. • Since a spray gun in used, it can be applied easily to any location. • Drying time is approximately two times as long as putty applied with a spatula.
Lacquer Putty [0.1 mm (0.004 in)] (Detail putty)		• It is soft and flexible. • It cannot be used to build up low areas. • Standing characteristics are extremely good. • The thicker the built-up, the longer the drying time.
Ultraviolet Curing Putty		• Since the drying time is short (approximately 20 seconds after UV irradiation), body work can be completed in a short period of time. • This is often used for minor repairs. • Putty becomes very hard after hardening, therefore its grind ability with sandpaper is not good. • It is expensive

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

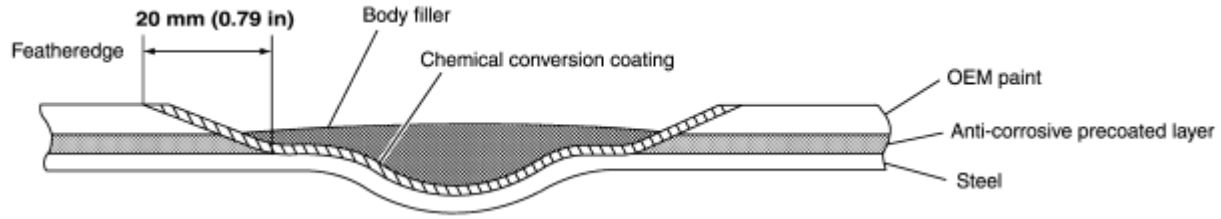
Procedure for Applying Body Filler

(1) Removal of Paint

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

(2) Chemical Conversion Coating

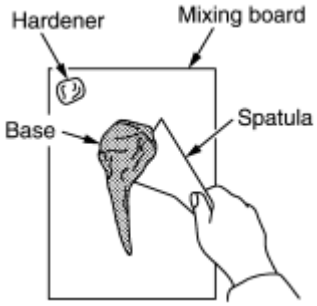
Body skin panels of NISSAN vehicles use anti-corrosive steel. These panels should be coated with chemical conversion coating before applying common body filler.

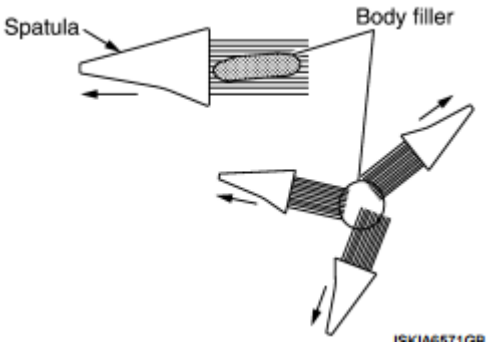


If body filler has been developed for anti-corrosive steel, chemical conversion coating will not be needed. (Please confirm this with the body filler supplier.)

(3) Spatula Movement

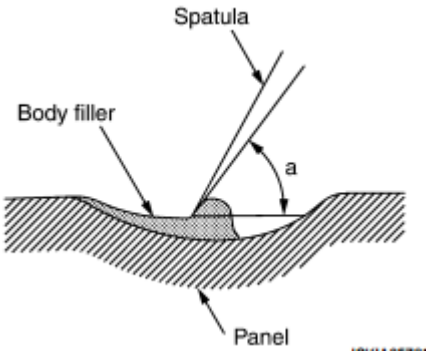
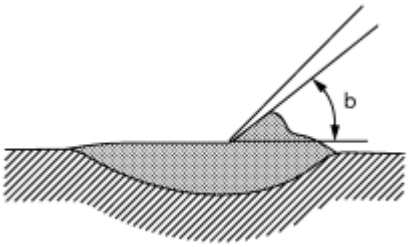
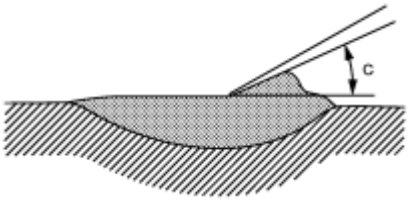
Move the spatula lengthwise when applying to an oval shaped area. If applying to a round area, move the spatula in many directions as shown in the fig





(4) Applying Technique

Apply body filler in several thin layers.

(a) Hold spatula well balanced and hold slightly standing position, then squeeze putty into scratches. **a : 60° - 90°**	
(b) Put a large amount of filler on the spatula. Hold spatula slightly lean, then apply several times (do not put much in once) until covered above datum level. **b : 30° - 45°**	
(c) Use the spatula to smooth the applied filler. Perform finishing work for smoothening the surface. The filler surface should be slightly higher than the panel surface. **c : Less than 30°**	

2.4. Panel and trim removal

Typically, the technician begins by removing trim components, body hardware, and accessories in order to gain access to the damaged metal by a process called bumping, using dolly blocks and special hammers. If damage is more extreme, hydraulic jacking equipment may be used to align a damaged area. Tiny nicks and dents are usually removed with special pick tools.

Metal Body Trim and Hardware

a. *General.* In the vehicle body, window openings are unsightly when viewed from the inside. They must have decorative trim to give them a finished appearance. In the vehicle body, finishing touches which are put on the outside as well as the inside are called either trim or hardware. On sedans, in addition to providing eye appeal, some trim is functional as well as decorative and contributes to the comfort and convenience of the passengers.

b. *Trim.* Moldings, floor mats, armrests, head linings, door trim pads, and weather stripping are known as trim.

c. *Hardware.* Door handles, window regulator handles, locks and window regulators, latches, hinges, seats, and seat adjustments are known as hardware.

d. *Grilles.* Grilles are sometimes referred to as trim. This would make it the largest single unit of trim. Grilles are usually made from several pieces of steel which are fastened together by nuts and bolts or by welding.

In some cases, grilles are made from cast aluminum, white metal alloy, stainless steel, and steel stampings. On combat type vehicles, the grille is referred to as a brush guard. This grille (3/4 ton and over) is made from lowcarbon steel stock and welded in place to form one single unit. The 1/4 ton vehicle grille is a one piece steel stamping bolted in place. Grilles are usually fastened in place by bolts which attach it to the front fenders. Brackets and supports are also provided which anchor it to the frame. Grilles are also fabricated from fiberglass and laminated material.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is filling and metal finishing? (2 point)
2. What solid blow and elastic blow? (2 point)
3. Why we perform body filling? (3 point)
4. Describe types of body filler (Putty). (4 point)
5. Write the procedure of body filler. (4 point)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

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Information Sheet-3	Complete Panel Repair to Pre-paint

3. Complete Panel Repair to Pre-paint

Complete Panel Installation

To install a complete replacement rear body panel:

1. Perform a trial fit of the replacement parts.
2. Clean the mating surfaces. Avoid removing any zinc coating.
3. Refer to the vehicle maker's body repair manual for the recommended welding method. STRSW should be used only when recommended by the vehicle maker.
4. Refer to the vehicle maker's recommendation for the location, number, and size of plug weld holes. If no recommendations are available, punch or drill 8 mm (5⁄16") holes in the outer panel at the same locations used originally by the vehicle maker. If using a lap joint, allow for a minimum of 6 mm (1⁄4") overlap. If STRSW is used, refer to the vehicle maker's recommendations for the electrode diameter, weld locations and spacing, etc.
5. Test-fit the replacement rear body panel and clamp it in place.
6. Check the alignment to the tail lamps and deck lid or hatch. Remove the rear body panel from the vehicle.
7. Apply weld-through primer to all weld mating surfaces that do not have zinc coating, or where the zinc coating was removed. Follow the vehicle maker's recommendations. Due to the poor adhesion property of some weld-through primers, it may have to be removed from all exposed surfaces after welding, before applying other coatings and sealants.
8. Position the panel on the vehicle and clamp it in place.
9. Use adjacent panels and a three-dimensional measuring system to verify that the part is properly aligned.
10. Tack weld, or securely hold, the rear body panel in position.
11. Recheck the alignment using the measuring system and the adjacent panels.
12. Make test welds before welding on the vehicle, using the same type and thickness metal that will be welded on the vehicle. Make the test welds in the same position as the welds on the vehicle, using weld-through primer if applicable. Visually inspect and destructively test the welds before welding on the vehicle.
13. Make the required welds.
14. Use the three-dimensional measuring system and adjacent panels to verify that the part is still properly aligned.
15. Dress the welds, if necessary.
16. Apply corrosion-resistant primer to all interior and exterior surfaces damaged by the collision, repairs, or anchoring.
17. Apply seam sealers, as necessary, to seal the joints and restore the appearance. Reprime if required by the product maker.
18. Refinish the interior and exterior of all straightened parts or those that were used for anchoring.
19. Refinish as required to restore the appearance.
20. Apply anti-corrosion compounds to all enclosed areas.
21. Refinish areas damaged by the collision, repairs, or anchoring, as required to restore the appearance. Refinish cosmetic surfaces after all body repairs are complete.
22. Install any labels previously removed.
23. Continue vehicle reassembly.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. How install rear body panel? (5 point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

_____

_____

_____

_____

_____

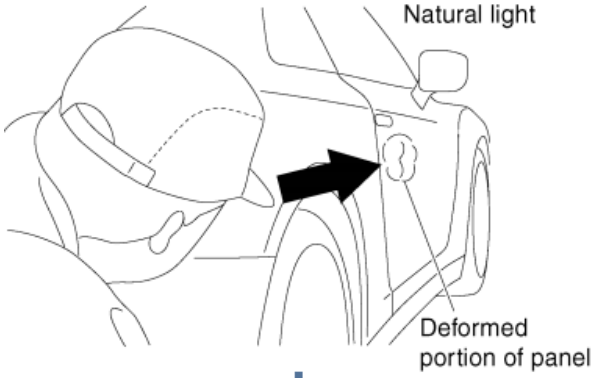
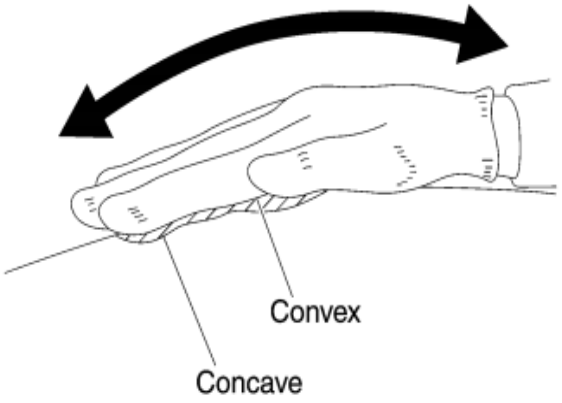
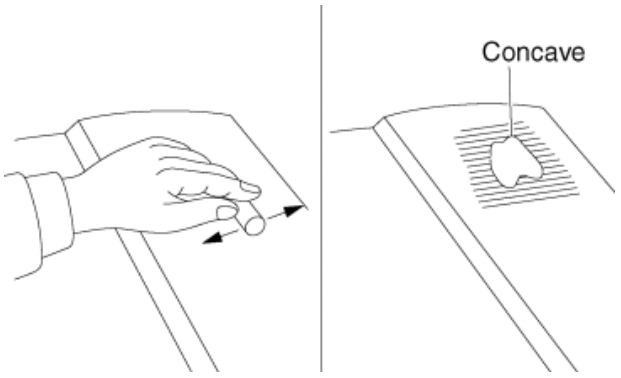
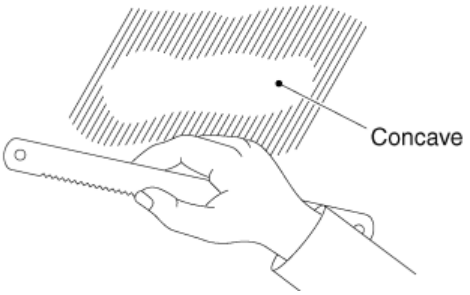
_____

_____

_____

Operation Sheet-1	Examination of Panel Damage

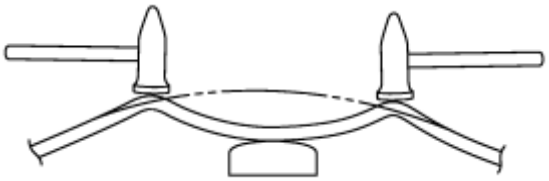
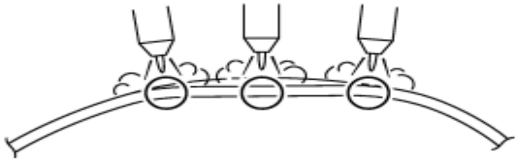
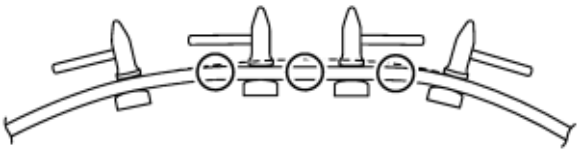
It is difficult to find minor deformation or panel irregularity, particularly, at the final stage of repair. This section explains how to determine if a vehicle has minor panel deformation.

Method-1	(**1) Visual Check** Check the affected portion of the panel by carefully examining the deformation in the light reflected on the surface.	
Method-2	**(2) Touch Check** Lightly place a hand on the surface of the panel and move it forward/backward and right/left to judge by touch with the palm of a hand. Slide and move a hand from an undamaged surface to a damaged part, all the way to the undamaged surface on the other side. **NOTE:** Wearing work gloves make it easier to tell the difference	
Method-3	**(3) Check with Tools** • Use of **chalk**: Rub the panel surface with a piece of chalk held lengthwise. Dents or concave areas in the panel will remain uncolored. • Use of **hacksaw blade**: Scrape the panel surface with the blade teeth. Dents or concave areas will not be scratched. • Use of **body file**: Scrape a body file lightly on the panel. Dents or concave areas will not be scratched. The body file should not be used for grinding. Thickness and strength of the panel will be reduced.	 

Operation Sheet-2	Shaping a Deformed Panel

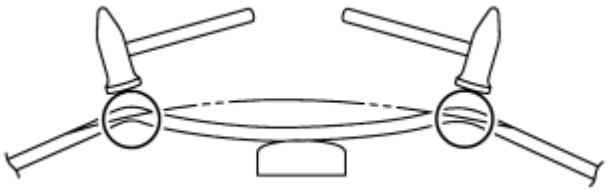
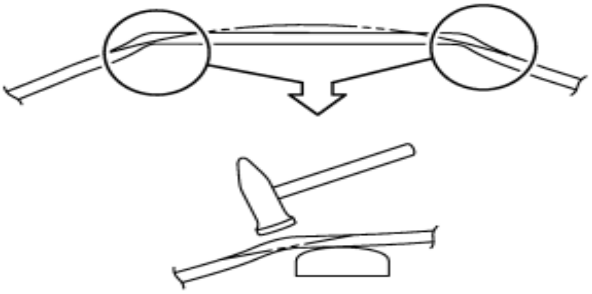
Basic Panel Repair Procedure

(1) When plastic deformation occurs at the center of the damaged portion

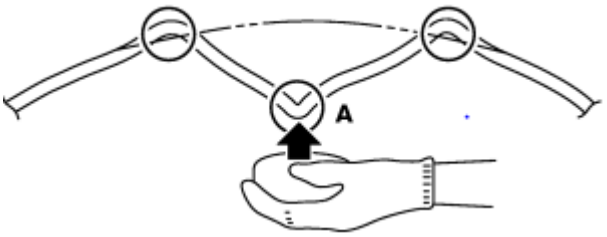
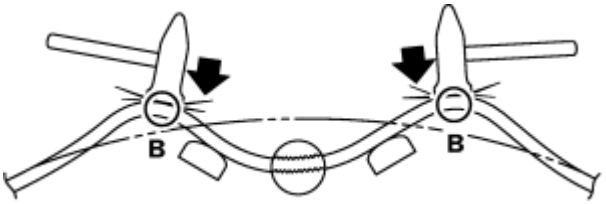
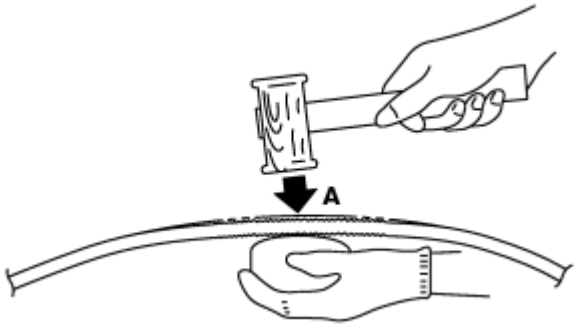
Step-1	(a) Using a hammer or dolly, strike the lowest portion of the dent from behind until it becomes flat.	
Step-2	(b) Using the hammer-off-dolly method as shown in the figure, raise the concave portion and lower the convex portion. Then smooth the surface a little lower than the original. Using a wooden hammer and dolly, correct the irregularities in the panel.	
Step-3	(c) Existence of plastic deformation can be determined by the stretched panel. The original surface can be restored by shrinking that portion with a gas welding torch.	
Step-4	(d) Use a hammer and dolly by the hammer-on-dolly method. Stretch the panel while striking the outer area of the damaged portion. The entire panel surface should be formed somewhat higher than the original surface. Note that, in this case, the stretched portion of the panel must not be hit with the hammer.	

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

(2) When plastic deformation exists around the damaged portion

(a) Apply the dolly to the elastic deformation area behind the panel. Hit the plastic deformation area with a hammer so that the elastic deformation area is lower than the original surface.	
(b) Repair the plastic deformed portion using the hammer-off-dolly method. If a shrinking hammer is available, the stretched portion can be easily shrunk.	

(3) When plastic deformation exists at the center and around the damaged portion

(a) Using a hammer and dolly, flatten the lowest portion (A) where the plastic deformation exists, so that the flattened surface is not higher than the original surface.	
(b) Flatten the highest points (B) where plastic deformation exists.	
(c) Flatten portion (A) so that the panel surface is not higher than the original surface. Correct irregularities using a wooden hammer and dolly. If the panel has been stretched, repair by shrinking.	

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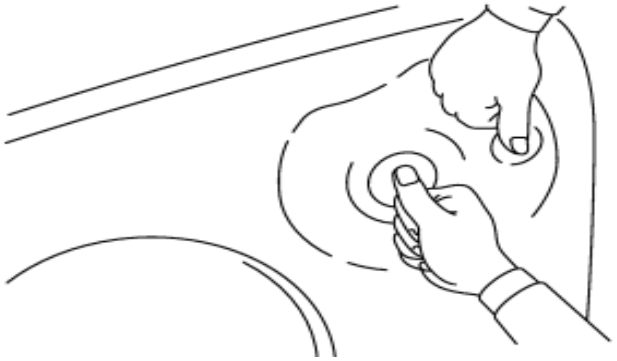
Operation Sheet-3	Correcting Panel Distortion

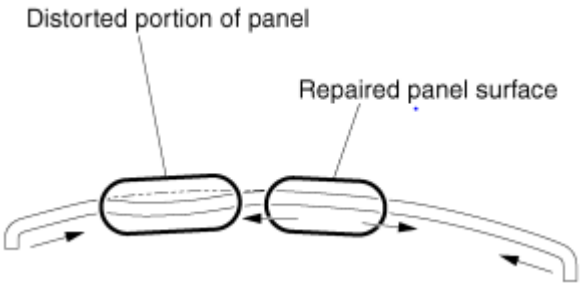
Procedures for panel correcting

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



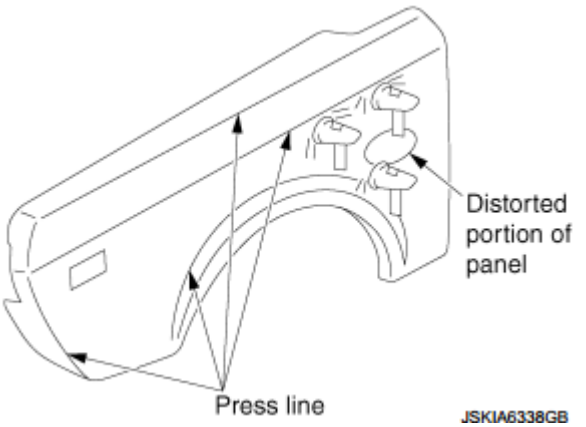
(b) Cause of panel distortion

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

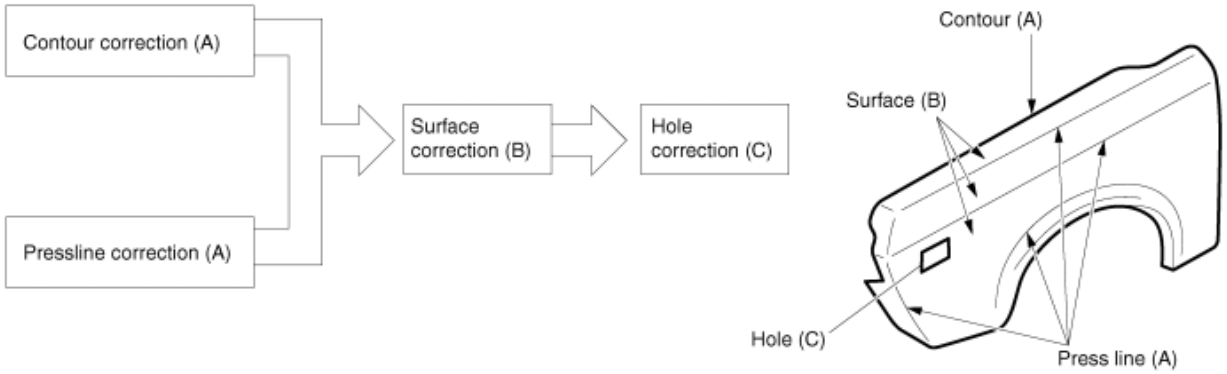


(c) How to correct panel distortion

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



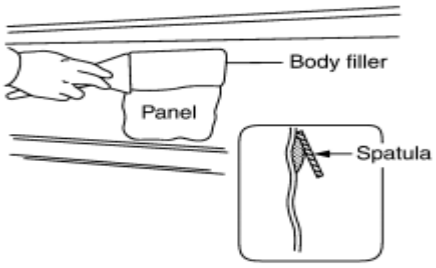
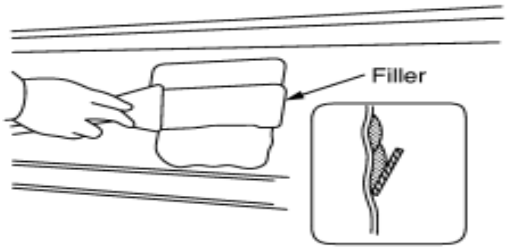
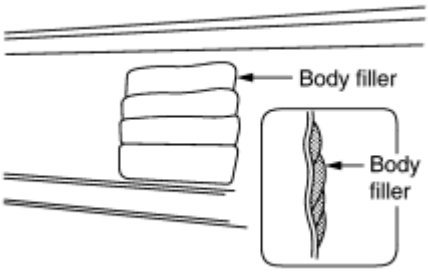
The front fender repair procedure is explained below:



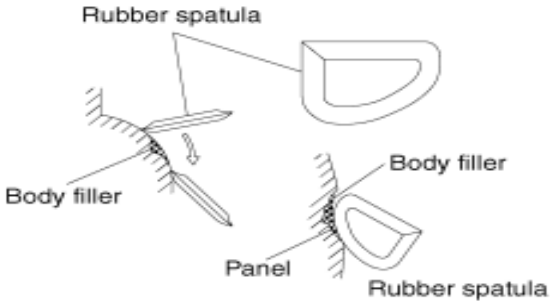
When repairing the body panel, paint and anti-corrosive wax must be thoroughly removed from the damaged area by sanding.

Operation Sheet-4	Application of Body Filler to Flat Surface

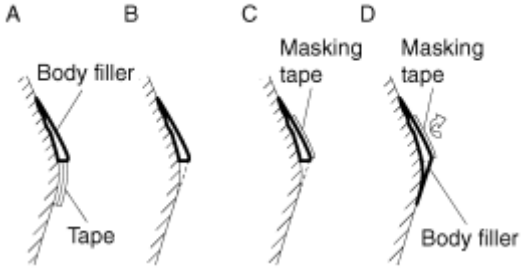
1. Techniques for applying of body filler to flat surface

Step 1	(a) Apply filler so that the corrected surface is flush with the surrounding panel surface.	
Step 2	(b) Apply another layer of filler to overlap 1/3 - 2/3 of the previous application to eliminate the step.	
Step 3	(c) Repeat (b) until the filler is correctly applied to the desired portion.	

2. Techniques for applying of body filler to Curved surface

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

3. Techniques for applying of body filler to Press Line

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

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hour. The tasks perform according to standard and workplace procedure.

Task 1: Examining body damage

Task 2: Shaping a Deformed Panel

Task 3: Correcting Panel Distortion

Task 4: Apply Body Filler (Putty)

List of Reference Materials

1- Body Repair Manual, Pg. 40-95

2- I-Car, Non-Structural Supplement Textbook, by the Inter-industry conference on Auto collision repair, 2006

3- Maurice Stack, Trade Of Vehicle Body Repair, Phase 2, Module 2, Revision 2.0 produced by SOLAS, January 2014

4- http://www.autobahncollision.com/repair-process/final-inspection-and-vehicle-delivery.htm

5- https://www.autobodytoolmart.com/types-of-body-fillers-t.aspx

6- https://www.sidesautobody.com/repair-process

7- https://www.shepherdsautobody.com/repair-steps