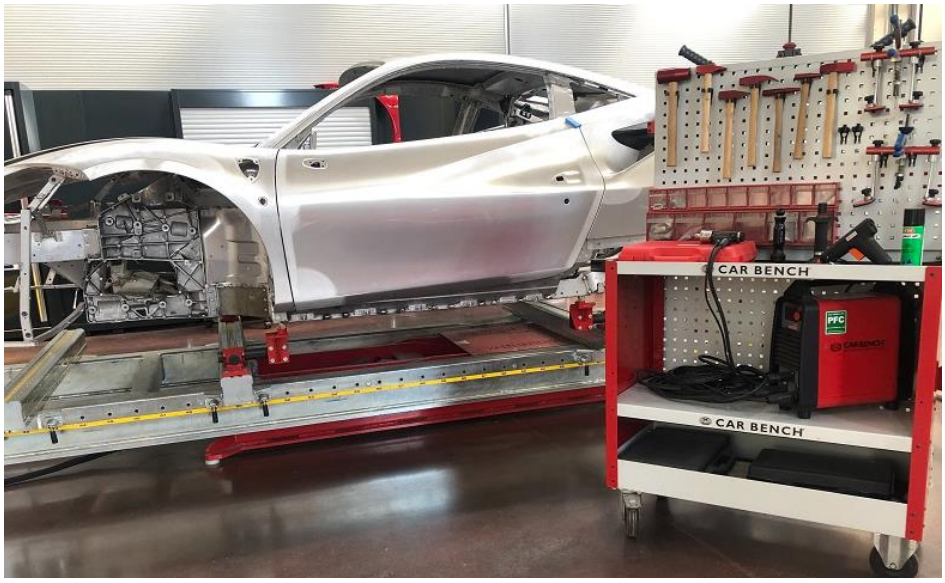
Automotive Body Repair and Paint Work

Level-IV

Based on October 2023, Curriculum Version-II



Module Title: Performing Non-Metallic and Aluminum Body Part Repair

Module Code: EIS BRP4 M05 1023

Nominal Duration: 70 Hours

Prepared by: Ministry of Labor and Skills

October 2023

Addis Ababa, Ethiopia

Table of Contents

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciate 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

DA----------	Double Acting
MIG----------	Metal Inert Gas
OSHA----------	Occupational Safety and Health Admiration
TIG----------	Tungsten inert gas
TTLM----------	Teaching, Training and Learning Materials
WHS----------	Work, Health and safety

Introduction to the Module

In automotive body repair and paint work field, performing non-metallic and aluminum body parts repair module equips trainees with knowledge and skill required to repair vehicle with aluminum body panels. While a dent in steel may able to be popped back to shape, repairing a dent in aluminum body panel without damaging the surrounding area requires special skill and advanced techniques. Hence, this module enable trainees to repair aluminum body panels with and without body fillers using specialist tools and equipment.

This module covers the units:

- Fundamentals of non-metallic and aluminum body parts
- Aluminum Annealing and Heat Shrinking
- Repairing aluminum body panels
- Completing work processes

Learning Objective of the Module

- Understand the Fundamentals of non-metallic and aluminum body parts
- Perform Repairing and heat shrinking aluminum body parts
- Perform Repairing aluminum body panels
- Apply Completing work processes

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
5. Read the identified reference book for Examples and exercise

Unit One: Fundamentals of Non Metallic and Aluminum Body Parts

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

- Introduction to non-metallic materials
- Application of non-metallic materials for vehicle body
- Introduction to Aluminium materials
- Application of aluminium for vehicle body
- Aluminium repairing tools and equipment
- WHS procedures

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:

- Introduce non-metallic materials
- Understand application of non-metallic materials for vehicle body
- Introduce aluminium materials
- Understand Application of aluminium for vehicle body
- Identify aluminium repairing tools and equipment

Apply WHS procedures

1.1 Introduction to Non-Metallic Materials

Non-metallic materials can be defined as any material that does not contain any metallic element in its composition. Because of the absence of metals, the properties of non-metallic materials are significantly different from metallic materials. Some common non-metals are:

- Solid Non-Metals: Carbon, Phosphorous, Iodide, Sulphur, Selenium.
- Liquid Non-Metals: Bromine, Sulphur, fluorine
- Gaseous Non-Metal: Hydrogen, Oxygen, Nitrogen, Helium, Argon, Krypton, Neon,Chlorine, Xenon, and Radon.

Non-metals do not produce heat or electricity and they are structurally brittle (can not be easily rolling, molding, extruding or pressing). Non-metallic substances possess chemical and physical properties that are quite different from metallic materials. Unlike metallic elements, non-metallic materials have the following properties:

- Little electrical and thermal conductivity
- High resistance to chemical reactions.
- Very good corrosion resistance
- Low heat resistance.
- Lower strength
- Low density and lightweight.
- Usually low melting and boiling point, etc.

1.2 Application of Non-Metallic Materials for Vehicle Body

Some of non-metallic materials and their application to vehicle body is listed as follow:

Rubber: Rubber sealing solutions are found throughout vehicle systems, from the engine and transmission to the doors and windows.

Natural and synthetic rubber (also known as polymer) are the main components of a car tire. Depending on the variety, these materials provide a high level of slip resistance and, after processing, the preferred elasticity.

Plastics*:* The performance of plastic in the automotive industry gives them a clear advantage due to their lower weight and cost, better adaptation to environmental or the possibility of being recycled. Cars already have plastic body panels. Thermoset materials are used for a wide range of automotive from headlamp housings to under-the-hood electrical and heat-shielding components to exterior body parts and interior structural and cosmetic components

Fiber glass: Most fiberglass yarn is called E glass, which is excellent for all parts of automobile fabrication which it is still the most widely used in the most economical all-purpose composite reinforcement. Fiberglass is mainly used in the front and rear bumpers, hoods, doors, and casings.

Ceramics: They are made of clay, earthen elements, powders, and water. These components are combined, molded into the desired shape. Components for automobiles made from ceramics includes; spark plug insulators, catalysts and catalyst supports for emission control devices, and sensors of various kinds.

Adhesives: Adhesive is any substance that is capable of holding materials together in a functional manner by surface attachment that resists separation. Adhesive chemistries include epoxies, polyurethanes, rubber-based anti-flutters, PVC, butyls, bitumens, thermoplastics, and in-component manufacturing silicones. Panel Bonding Adhesive is a two-part epoxy used to bond steel, aluminum, SMC, and FRP (traditional fiberglass).

1.3 Introduction to Aluminum Materials

Aluminum is a silvery-white metal, the 13th element in the periodic table that is the most widespread metal on Earth, making up more than 8% of the Earth's core mass. It's also the third most common chemical element on our planet after oxygen and silicon.

Aluminum is a fast-growing rival of steel and is now used more often in modern vehicles because it’s light and reduces the vehicle’s weight, which is beneficial in a specific emissions class. This is one of the biggest reasons aluminum is preferred better gas mileage. Parts of a vehicle that are typically made from aluminum include various

engine components and wheels, but can also be found in some vehicle hoods.

Properties of Aluminum

Aluminum has many outstanding properties, making it famous and commonly used in most applications. Here are some of them:

- *Corrosion Resistance:* Aluminum produces a natural thin oxide layer that protects the metal from reacting with the environment. Therefore, it is suitable for several applications where it may be exposed to corrosive agents like vehicles.
- *Lightweight*: The standard weight of aluminum is precisely 2.7 g/cm^3, approximately one-third the weight of steel. Its lightweight property helps to reduce its costs of manufacturing significantly. Usually, automobile industries use aluminum in automobiles to reduce weight and increase load capacity.
- *Electric and Thermal Conductivity:* Aluminum is a great conductor of electricity and heat due to its weight. Its level of electric and thermal conductivity is twice that of copper.
- *It is recyclable:* Aluminum is a hundred percent recyclable. Aluminum also requires less energy to recycle than many other metals, making it an eco-friendly material choice.

Different Grades of Aluminum Alloys

These aluminum alloys generally have greater strength than cast alloys. They also have a four-digit system, although without the decimal point. Just like the cast iron designation, the first number indicates the primary alloying element.

If it is non-zero, the second number refers to an alteration to the alloy, while the last two digits identify the specific alloy in the series.

There are seven series of alloys as listed below:

- **1xxx series:** These aluminum alloys must have 99% aluminum content, and they are therefore often referred to as pure aluminum. They have low strength and machinists select them for use based on their excellent corrosion resistance and electrical conductivity.
- **2xxx series:** This series has copper as its major alloying element. A solution heat-treatment procedure is the best way to treat these alloys. As a result, alloys in this series possess exceptional strength and hardiness but lack the corrosion resistance of other alloy series.

- **3xxx series:** These alloys have manganese as their primary alloying element. They possess moderate strength but have excellent heat and corrosion resistance. This makes them extremely suitable for use as cooking utensils. Exchange parts of vehicles and power plants are examples of common areas of application of these aluminum series.
- **4xxx series:** Alloys in the 4xxx series have low melting points, making them suitable for use as filler materials when welding. Combining aluminum with silicon forms metal in these series.
- **5xxx series:** These are the non-heat-treatable aluminum alloys with the greatest tensile strength. They are formed with magnesium as the primary alloying element. As a result, they possess great corrosion resistance and are easily weldable.
- **6xxx series:** Alloys in this series are exceptionally resistant to corrosion. They possess ultimate tensile strengths ranging from 18ksi to 58ksi. The main alloying elements in this series are magnesium and silicon. These alloys can serve as plating material for metals that are susceptible to corrosion.
- **7xxx series:** These aluminum alloys use zinc as a primary alloying agent. They possess some of the greatest tensile strengths of all aluminum alloys. Other elements such as copper can also be added to tweak the properties of this series of wrought cast aluminum.

Table 1-1: Aluminum Alloy Categories

Aluminum Series Guidelines	
Alloy Series	Main Alloying Elements
1000 Series	Pure aluminum
2000 Series	Aluminum and copper. High strength used in aerospace manufacturing.
3000 Series	Aluminum and manganese. Beverage cans and tubing.
4000 Series	Aluminum and silicon. Automotive use and filler materials.
5000 Series	Aluminum and magnesium. Automotive structural and sheet.
6000 Series	Aluminum, magnesium and silicon. Sheet, extrusions and plate for automotive.
7000 Series	Aluminum and zinc, possibly other elements added. Aerospace and sheet for automotive.

There are three types of aluminum component designs

1. **Sheet aluminum:** It is formed just like sheet steel, where sheets of the aluminum material are stamped in to shapes such as apron panels, pillars, rockers and outer panels. They can be used for cosmetic and structural body components. Some of these components maybe repaired, such as outer panels and certain select structural components.

Damage indicators are, but not limited to, deformities, visual fractures (cracks) and tearing. They can be riveted, rivetbonded, bonded and rope hemmed flanged, flow-drilled, clinched or MIG welded.

2. **Aluminum extrusion:** They are similar in design to the hydro formed steel components we see on late-model steel vehicles.

Extrusions are only used for structural components to form inner reinforcements on pillars, inner roof rails, uni-rails (frame rails), frame rails, suspension cradles and structural cross members.

Generally, they are not repairable. Again, damage indicators are, but not limited to, deformities, visual fractures (cracks) and tearing. Aluminum extrusions can be riveted, rivet-bonded, bonded, flow-drilled or MIG welded.

3. **Aluminum cast:** They have multi-thickness variations and generally rough surfaces. Cast components can only be used to make structural components structural pillars, structural cross members, reinforcements, cradle support ends and strut towers and are never repairable and must be changed. Damage indicators will generally be obvious and would include visual fractures (cracks) and tearing, but surprisingly, cast is ductile and will bend a great deal prior to fracturing.

The amount of ductility a cast component has is dependent on the alloying agents and type of casting process utilized. Cast aluminum will almost always be MIG welded, but you will see other components attached with flow-drill screws.

1.4 Application of Aluminum for Vehicle Body

Aluminum carries very desirable characteristics, being lightweight, high strength to weight ratio, high thermal conductivity, 100% recyclable, lack of decay, and a good electrical

conductor. For all of these reasons, it can imagined why it has become the go to material for automobile body parts.

In addition, corrosion resistance is another strong point of aluminum auto bodies makes it a great choice for car doors, wheel arches, bumpers, and other parts of the body that may be exposed to moisture on the road. Some of body components are: Hood, quarter panel, fender, bumper, spoiler, roof rack, grille, cowling, decklid, header panel, pillars, rims and hubcaps, trunk, valance. Recent models employ aluminum panels for trunk lids, rear doors and roofs. It is widely used in automobile parts such as automobile body panels, reinforcements, panels, brackets, etc.

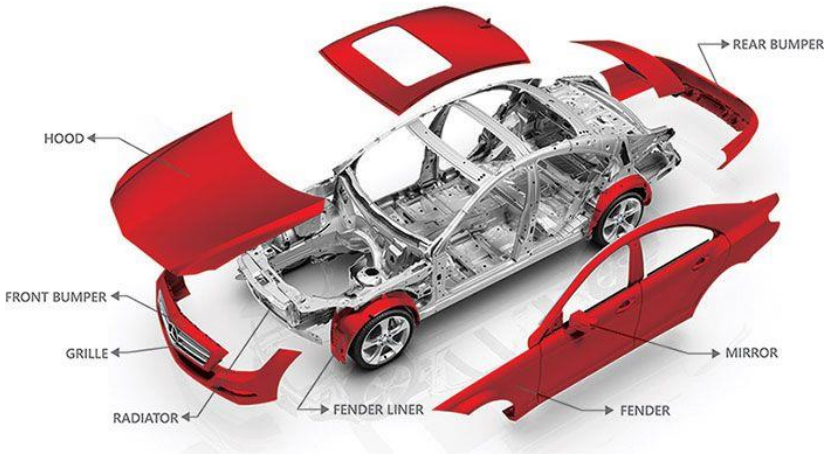


Figure 1.1: Different parts of a vehicle body parts from aluminum

1.5 Aluminium Repairing Tools and Equipment

Body shop repair of aluminum components can be made based on the same principles applied to the steel; however, both the equipment and some items require specific attention. Repairing aluminum car body panels is not necessarily more difficult than steel body panels, but it does require understanding types and use of different aluminum-specific repair tools and materials and welding equipment to repair it efficiently.

1.5.1 Aluminum Repairing Tools

Repairing aluminum dents also requires a special tool set. If a body shop uses the same tools on aluminum that they use on steel, they can cause further damage to the aluminum than when the vehicle first showed up at the shop. One mistake can damage the panel beyond repair.

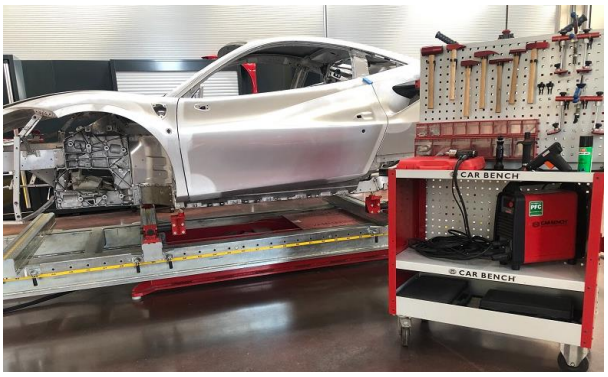


Figure 1.2: Aluminium repairing kit

- Knock down pen heads: Used with knock down pen for bulge leveling repair.
- Fender Remover: Used to pry out the fender clips
- Big Curved Rod: Suitable for the repair of fender.
- Pen Heads & Ball accessories: Used with knock down pen and a hammer to repair the raised part of the car; It can be used with a crowbar to repair the car dent.
- Countersink Punch: Use to punch a 6mm countersink hole into a panel
- Panel File: Use to remove all light dents and deep scratches.
- Stainless Wire Brush: Used to clean and prepare aluminium surfaces.

Alumium hammer

Self-Piercing RivetGun

Adhesive Gun

Body puller Knock down pen heads Fender Remover

Curved Rod Pen Heads & Ball accessories

Countersink Punch Panel File Stainless Steel Wire Brush

Figure 1.3: Aluminum-specific repair tools

1.5.2 Aluminum Repairing Equipment

A. Tungsten inert gas (TIG) welding equipment

Tungsten inert gas welding is one type of arc welding method where we use a non-consumable tungsten electrode, to weld the two metallic bodies. The weld spot is protected from contamination by helium, argon, and other inert shielding gases. This process makes this kind of weld highly resistant to the effects of corrosion. TIG is the better option for welding aluminum because it allows for better results on lighter gauge materials. When done correctly, TIG welding aluminum can produce quality welds.

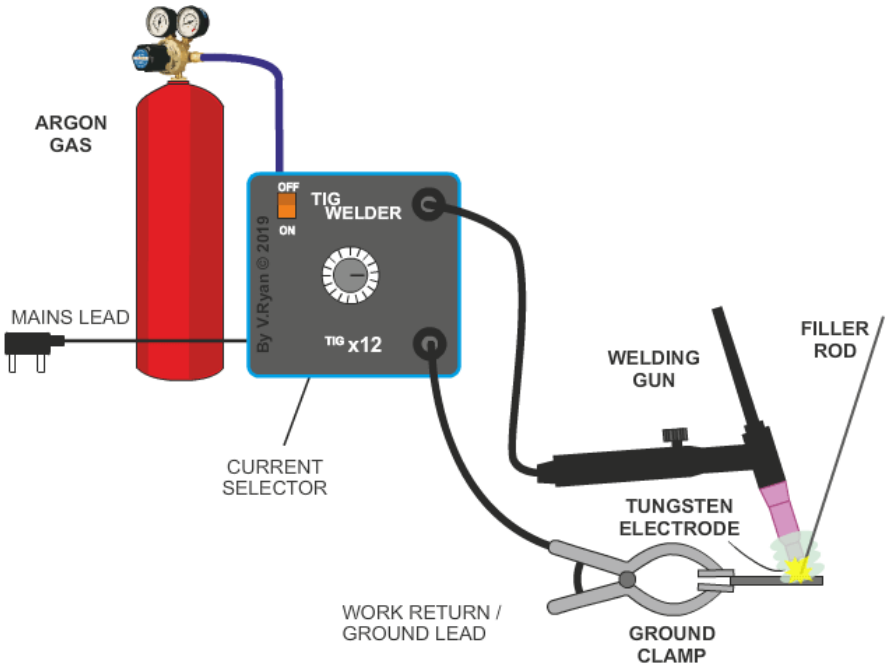


Figure 1.4: TIG Welding Equipment

B. Metal Inert Gas (MIG) Welding Equipment

Metal inert gas welding is commonly referred to as gas metal arc welding (GMAW), this type of welding is today the most popular and versatile method of welding.

It welding uses a power source and a wire feeder that feeds the wire electrode through the welding gun to the weld. The wire feed consists of a set of drive wheels for the wire and a constant-speed motor to turn the drive wheels. Most Welding machines have various functions allowing timed feeds and variable speeds.

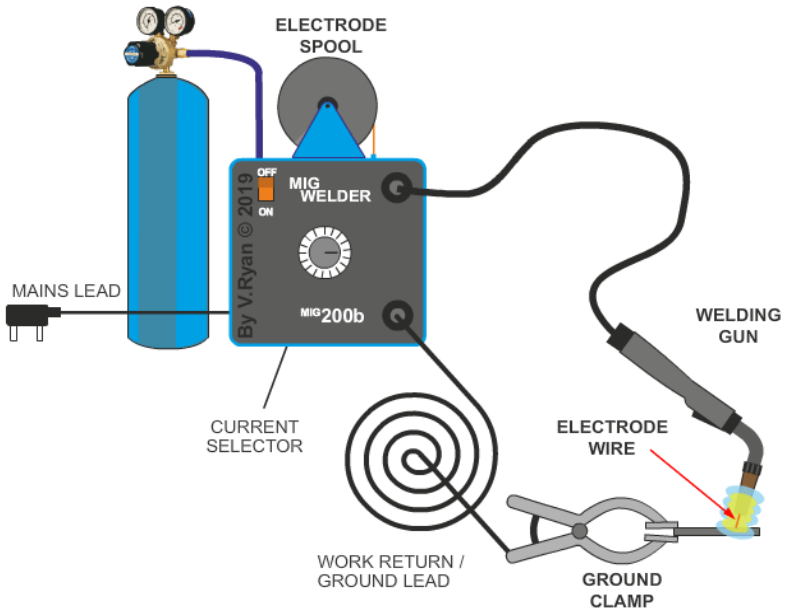


Figure 1.5: MIG welding Equipment

1.6 Work, Health and safety (WHS) Requirements

When aluminum is cut, bent, or broken, it will behave differently than steel, so repairing centers need to have specific equipment to perform aluminum repairs. Additionally, for the health and safety of employees, a separate work area for aluminum needs to be implemented in order to eliminate any contamination issues.

In general, there are two primary safety concerns for collision employees when working with aluminium: Aluminum grinding safety and respiratory protection safety.

1.6.1 Aluminum Grinding Safety

When aluminum grinding is performed, it is possible for sparking, aluminothermic reaction, and combustible dust is possibly occur. When an aluminum particle and a metal oxide, such as rust, are ignited by a heat source, the reaction is similar to a firework explosion.

This reaction can occur when a grinder is used on steel prior to being used on aluminum materials and vice versa. Because of this, all aluminum work must be separated from steel work. Grinding alone could require the need for a hot work permit.

The OSHA regulation defines hot work as “riveting, welding, burning, or other fire or spark producing operations.” Thus, regardless of the type of material being ground, if fire or sparks are produced under any of the conditions, then a fire watch is required to be posted. In general to prevent sparks, an application of water any time aluminum grinding occurs is recommended.

Aluminum dust also can be combustible or explosive if it becomes suspended in the air at the right concentration. For example, one employee was killed and three others were severely burned in an Indiana plant that manufactures aluminum automotive wheels after a series of explosions was fueled by aluminum dust. In addition, OSHA has issued a fact sheet, “Hazard Alert: Combustible Dust Explosions” Both of these documents describe the hazards and preventive measures associated with combustible dusts, like aluminum.

1.6.2 Respiratory Protection Safety

In order to cut an aluminum alloy, a plasma torch is typically used. OSHA standards require a two-step approach to protect employees from health hazards caused by air contaminants, such as dust from plasma torch activities.

The first step is to determine whether it is feasible to implement engineering controls to prevent the air from becoming contaminated. This may include limiting the activity to an enclosed space or using less toxic materials. However, if no feasible means exists to prevent air contamination, the next step is to provide employees with suitable respiratory protection, such as a personal respirator.

OSHA provides a guide called the “Small Entity Compliance Guide for the Respiratory Protection Standard” that provides a checklist of requirements for a suitable program, information on selecting appropriate safety equipment, and a sample written respiratory program. Additionally, if activities onsite require that respirators are worn, a medical evaluation and respiratory fit test would be required before a respirator is worn by an employee.

Self-Check 1.1

Part-I: Choose the best answer

1. One of the following can be categorized under non-metallic materials
   A. Phosphorous B. Fluorine C. Krypton D. None
2. Which one the following non-metallic materials have application to vehicle body?
   A. Rubber B. Plastic C. Fiber glass D. All
3. Which Properties of Aluminum protects from reacting with the environment?
   A. Lightweight
   B. Corrosion Resistance
   C. Thermal Conductivity
   D. Recyclability
4. Non-metals do not produce heat or electricity and they are structurally brittle.
   A. True B. False

Part-II: Matching

A	B
TIG welding	a. Any substance that is capable of holding materials together
MIG welding	b. Used to clean and prepare aluminium surfaces
Stainless wire brush	c. Uses a non-consumable tungsten electrode
Adhesive	d. Made of clay, earthen elements, powders, and water.
Ceramics	e. Uses a power source with wire electrode

Part-III: Explanation

1. List down three properties of non-metallic materials?
2. List down aluminum alloys with their respective application?
3. Write down four vehicle body components made from aluminum alloy?
4. List and explain the primary safety concerns when working with aluminum?

Unit Two: Aluminum Annealing and Heat Shrinking

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

- Purpose of aluminum annealing
- Purpose of aluminum heat shrinking
- Performing annealing and heat shrinking aluminum
- Repairing aluminum panels to pre-paint condition

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 aluminum annealing
- Understand the purpose of aluminum heat shrinking
- Perform aluminum annealing and heat shrinking

Repairing aluminum panels to pre-paint condition

2.1 Purpose of Annealing Aluminum Panels

Annealing is a heat treatment process that changes the physical and sometimes the chemical properties of a material to increase ductility and reduce the hardness to make it more workable. The annealing process requires the material above its recrystallization temperature for a set amount of time before cooling.

Annealing is a heat treatment process that is well known for soft metals. The primary purpose of the annealing process is to increase the ductility of the metals. It can likewise ensure that the metals can be formed and shaped more effectively and efficiently. Soft metals tend to lose their ductility as they undergo work hardening, especially when they are exposed to bending, cold forming, or drawing processes. With annealing, the original properties of the materials can be obtained again.

Annealing is used to reverse the effects of work hardening, which can occur during processes such as bending, cold forming or drawing. If the material becomes too hard it can make working impossible or result in cracking.

By heating the material above the recrystallization temperature, it is made more ductile and therefore ready to be worked once more. Annealing also removes stresses that can occur when welds solidify. Hot rolled steel is also shaped and formed by heating it above the recrystallization temperature. While steel and alloy steel annealing is common, other metals can also benefit from the process, such as aluminum, brass, and copper.

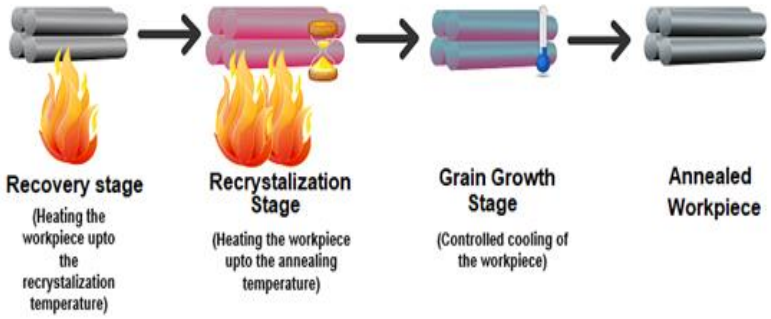


Figure 2.1: Aluminum anealing process

The purpose of annealing is to produce a refined grain, to induce softness, improve electrical and magnetic properties, and sometimes to improve machinability.

Annealing is a process used to counteract certain effects of cold working (working aluminum without heat). As you cold work the material, it builds up internal stresses, which increase its strength and hardness. However, this comes at the cost of ductility and formability, an effect known as work hardening. Work hardening can be desirable for making a product stronger.

However, if you subject the product to further forming processes afterward, the decreased formability can lead to cracking and ultimately scrapping of the product.

Annealing can also relieve the internal stresses in cast aluminum parts to prevent future cracking. And the process involves heating the alloy to a specific temperature, holding it there for a set amount of time, then slowly cooling it back to room temperature.

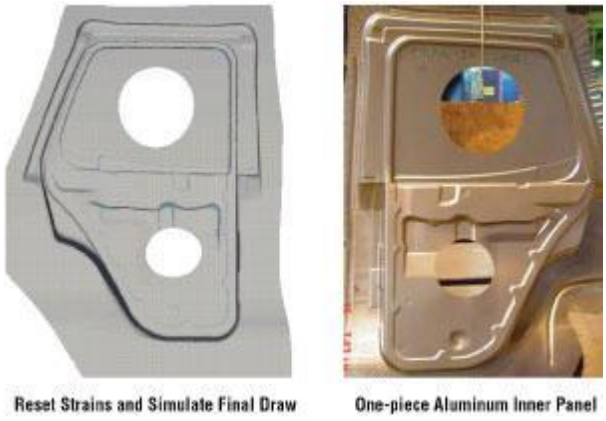


Figure 2.2: The preform-anneal process for car door panel

2.2 Purpose of Heat Shrinking Aluminum Panels

Hot shrinking is a process in car bodyworks. As the name suggests, heat will be involved, while "shrinking" is the process of straightening a metal section. This is a method of panel beating where a panel is first heated to make it softer. In most cases, heating will be done by use of the oxyacetylene flame.

Locate the highest point of the panel, light the torch and heat the spot to a cherry red. Strike the area using a mallet around the heat spot. After several blows the sop will turn black, quench it immediately with a damp cloth. Repeat the process around the heated spot until the stretched part became fully shrinked.

Making aluminum shrink is a handy trick to master if you need to reduce the size of metal. Thin aluminum if often stretched wide to prefabricated lengths. The idea, according to Body Shop Business, is to make the aluminum thick again. The trick to shrinking aluminum is to

heat the surface of the metal to encourage the molecules to move back into the hot area, thus reducing the size.

2.3 Performing Annealing and Heat Shrinking

The main reason to anneal aluminum is to improve malleability. Any involved forming can lead to cracking or fatiguing the material, but annealing can reduce these problems. Repairing Aluminum Panels to Pre-paint Condition

Repairs usually involve a combination of operations ranging from straightening procedures to renewal of either individual panels or panel assemblies. The repairer will determine the repair method and this decision will take into account a balance of economics between labor and material costs and the availability of repair facilities in both equipment and skills. It may also involve considerations of vehicles down-time, replacement vehicle availability and repair turn-around time.

It is expected that a repairer will select the best and most economic repair method possible, making use of the facilities available.

The objective is to restore the vehicle to a safe running condition by carrying out a repair which is close as feasible to original standards. The result will not advertise to the experienced eye the fact that the vehicle has been damaged, although the repair will not necessarily be identical in all respects to original factory build.

2.3.1 Performing Aluminum Annealing

The main reason to anneal aluminum is to improve malleability. Any involved forming can lead to cracking or fatiguing the material, but annealing can reduce these problems. Annealing resets those aluminum grain structures, allowing the material to undergo further shaping with ease. To anneal aluminum, the metal must be heated between 570°F and 770°F, with specific temperatures and durations determined according to each aluminum alloy's own characteristics and the amount of material.

Aluminium is annealed to reduce hardness and therefore reduce brittleness. It relieves internal stresses in the grain structure and increases the ductility of the material. This is useful as it allows the material to more easily be reshaped and be less likely to crack when

subjected to impact. Annealing is the name given to the process that alters the physical properties of metal to make it less hard and more malleable. By heating the metal beyond its recrystallisation temperature and keeping it there for a certain period of time, the atoms within the crystal lattice of the metal move

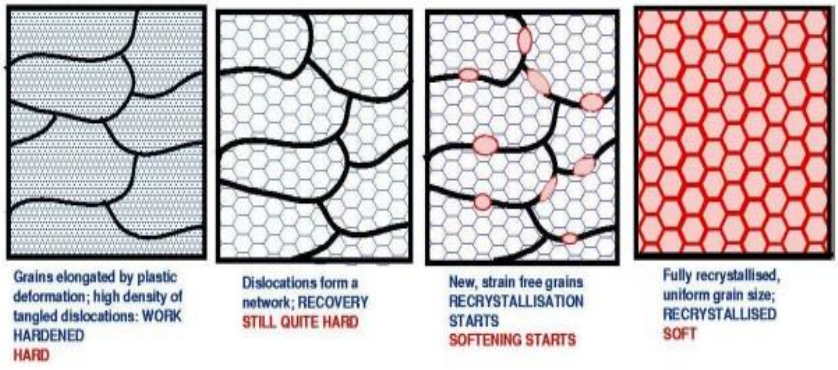


Figure 2.3: When a large amount of cold work is followed by annealing, new grains are formed by the process of recrystallization

2.3.2 Performing Aluminum Shirking

Heat application can be made from a heat gun, torch or carbide tool. However, when heating (other than heat-shrinking), the lower-temperature methods, such as heat gun and propane torch, work better than a carbide tip. It can be used for aluminum repair, although more care must be followed to stay within the heat tolerances.

When heat-shrinking aluminum, quenching (quick cooling) with water and hammering can be used. A shrinking hammer, one with the check design cut in the head, shouldn't be used. In a shrinking process the area should be heated to approximately 250°C. Aluminum alloy panels do not turn red when heated like steel plates.

Shrinking by heater: This way the number of passes with the gas burner needed to achieve the correct temperature can be determined. A thermometry pen may be applied to the repair area before heat application. Apply the thermometry pen to the heated part. When measuring temperature, use two thermometry pens of different specified temperatures. This allows the top and bottom of the temperature range to be judged accurately.

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

Figure 2.5: Shrinking by electric welding

Operation sheet 2.1

Operation Title: Aluminum heat shrinking

Purpose: To hot shirk aluminum panel

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Leather work gloves
- Safety glasses
- Dust mask
- Oxy-acetylene torch
- Hammer

Precautions:

- Wearing proper clothes, eye glass, glove

- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps to do the task:

Step 1: Slide on a pair or leather work gloves, safety glasses and a dust mask to protect your skin, eyes and lungs.

Step 2: Place the aluminum sheet onto a work surface. Fit an appropriate tip between size to an oxy-acetylene torch. Then, ignite the torch.

Step 3: Heat up a quarter-sized spot on the aluminum sheet. Hold the torch flame just off the surface for 30 seconds. Turn off the torch.

Step 4: Touch the tip of a prefabricated 550-degree and Hold it for 10 seconds. Repeat steps 4 and 5 as often as necessary until the turns orange. While not 550 degrees itself, the crayon will change colors once the tip reaches 550 degrees.

Step 5: Hammer the aluminum with short, rapid strokes around the hot spot as soon as the shrink temperature is reached. Continue for 15 to 30 seconds. Avoid striking the hot spot directly to prevent additional thinning.

Quality Criteria: Quality Criteria: Assured performing of all the activities according to the procedures

Operation sheet 2.2

Operation Title: Repairing aluminum panel to pre-paint condition

Purpose: To repair aluminum panel to pre-paint condition

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

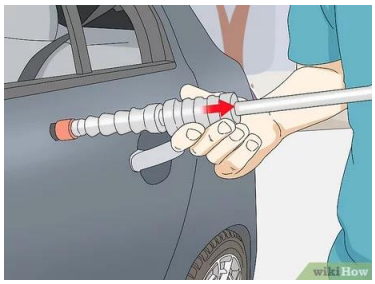
- Dent puller
- Scrap cardboard
- Orbital sander
- Sand Block
- Body filler
- Sand paper

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: Pull out large dents using a dent puller.

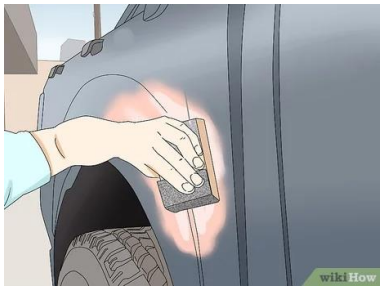


Step 2: Mix your filler material to a cream consistency on a mixing board or piece of scrap cardboard. surface.

Step 3: Wait for your filler material to harden. This will typically take 10-30 minutes. In the meantime, avoid handling the putty.

Step 4: Sand the edges around the hardened filler to smooth it out, then go over it with a sheet of sandpaper 150-180-grit sandpaper.

Step 5: Sanding block to prepare it for minor touch-ups. Glide sanding block in small circles over each section



Step 6: Use orbital sander to remove paint from large areas with a piece of 500-1,200-grit sandpaper.

Step 7: Run the sander in a circular motion over each area and apply a consistent pressure to make sure removing the same amount of paint from each part of the car's exterior.

Step 8: Wipe the painting area with a clean, wet rag to remove debris.

Quality Criteria: Assured performing of all the activities according to the procedures

Unit Three: Repairing Aluminum Body Panels

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

- Identifying aluminum body repair methods
- Repairing aluminum body panels without body fillers
- Repairing aluminum body panels using body fillers

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:

- Identify aluminum body repair methods
- Repair aluminum body panels without body fillers
- Repair aluminum body panels using body fillers

3.1 Identifying Aluminum Body Repairing Methods

Though the same techniques used for steel repair also are used with aluminum repairs, such as hammer-on-dolly and hammer-off-dolly, caution must be taken because aluminum work hardens more quickly than steel, after which the repair becomes more difficult to move. To avoid this, aluminum must be heated to its repair threshold.

Aluminum spreads heat faster than steel (four to six times) and doesn't change color as it's heated; therefore, heat-monitoring devices must be used. Aluminum melts at a lower temperature than steel, 1,220 degrees F, which is less than half the temperature to melt steel.

Minor damage often can be repaired with the addition of heat between 400 degrees F and 570 degrees F, though the vehicle maker's recommendations should be consulted and followed. Additional repairs can be made with normal techniques through often planishing (smoothing) with wooden hammers or leather covered slapping spoons.

Pulling methods are similar, though glue-on pulling tools are used often with aluminum repairs, as are aluminum weld-on devices. Monitored low heat is used to help the pulling process because less mechanical force is needed for the same results.

It is important all aluminum panel repairs are completed in a controlled area of the Collision Center and utilize a separate set of aluminum-dedicated tools to prevent panel contamination.

3.2 Repairing Aluminum Body without body fillers

Aluminum panel repair describes the characteristics of aluminum panels as well as the repair considerations for these panels.

To repair and pull the damaged area, the panel must be heated to 400°F to allow the metal to soften. Aluminum dissipates heat very quickly but can become permanently changed if heated past a certain point, and that point is approximately 750°F. Repairing aluminum car body panels is not necessarily more difficult than steel body panels, but it does require different welding equipment and an understanding of some of the characteristics to repair it efficiently.

Minor damage often can be repaired with the addition of heat between 400 degrees F and 570 degrees F, though the vehicle maker's recommendations should be consulted and followed. Additional repairs can be made with normal techniques through often planishing (smoothing) with wooden hammers or leather covered slapping spoons.

Pulling methods are similar, though glue-on pulling tools are used often with aluminum repairs, as are aluminum weld-on devices. Monitored low heat is used to help the pulling process because less mechanical force is needed for the same results.

Repairing aluminum body panels can be quite different than repairing steel. Aluminum is more prone to dents and scratches than steel, while steel is less likely to warp or bend from weight, force, or heat. So, while a dent in mild steel may be able to be “popped” back to

shape; repairing a dent in an aluminum body panel without damaging the surrounding area requires special skill and, in some cases, advanced repair techniques.

3.3 Repairing aluminum body using body fillers

Body fillers are generally a polyester resin based filler with a cream hardener that can be used to even out dents and cover blemishes on vehicles. Sometimes even the term "body filler" makes auto guys cringe, but understanding the different types of body fillers and their optimal use is extremely helpful.

Body fillers can be applied directly to the aluminum or over the epoxy primer, depending on the vehicle maker's recommendations. Precautions are needed because the aluminum oxide forms almost immediately after paint removal has been completed. The general recommendation is that bare aluminum must be covered as soon as possible (20 to 30 minutes) after it's exposed to air, and it never should be sanded with coarser than 80-grit abrasive. The plastic is worked in the usual fashion, primed and then prepared for paint.

Body fillers all fall into three general categories:

1. Standard Body Fillers: Standard grade body fillers are a lightweight substance or putty that spreads easily and cures in about 20-25 minutes. They sand easily to blend in with the rest of the vehicle once primed and painted. Standard grade also offers the least stain-resistance.

2. Medium Body Fillers: Medium grade body fillers adhere well to a wide variety of body surfaces since they are fiber-glass filled. Due to being a slightly higher quality than the standard grade, medium grade body fillers hold better stain-resistance. They are perfect for repairing small holes, tears and cracks in metal and fiberglass.

3. Premium Body Fillers: Made from top-quality resin that has the highest stain-resistance of the three, premium grade body fillers are the easiest to sand down and offer the best adhesion of filler materials to underlying surfaces. This type of body filler is best used when high-quality work is required or there are large areas or dents needing to be repaired.

Operation sheet 3.1

Operation Title: Fender damage repair

Purpose: To repair damaged aluminum vehicle fender without body filler

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Big Curved Rod
- Fender remover
- Aluminum Hammer
- Knock Down Pen
- Manual for the vehicle

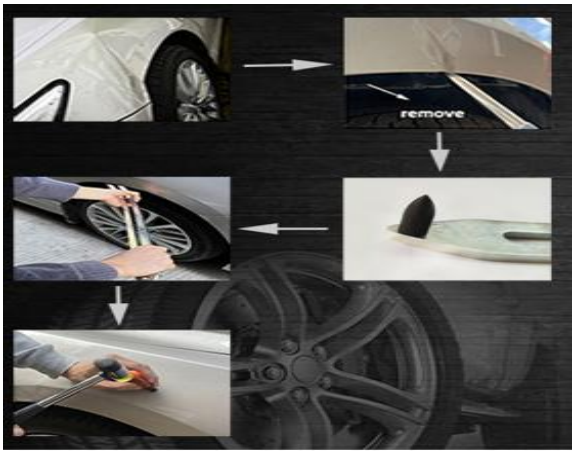
Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

1. Confirm the range of the dent
2. Remove the inside fender

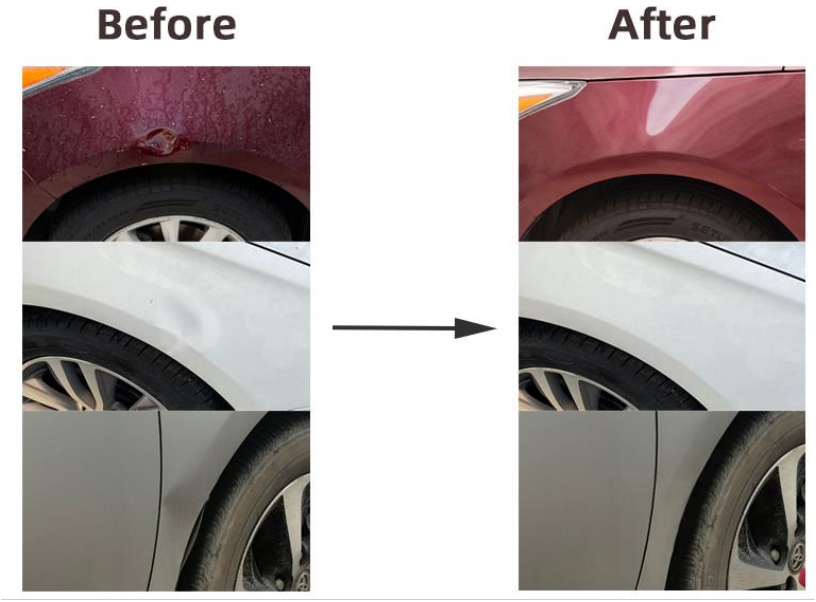
3. Install a suitable pen heads on the crowbar
4. Insert crowbar and aim the backside of the dent, push the dent out
5. Hammer high point, then high point disappear



Task-2: Fender Back Side Repair

1. Confirm the range of the dent.
2. Remove the Inner fender.
3. Select a suitable pen head and in-stall it on the nut port of the big curved crowbar.
4. Extend the crowbar into the back of the dent and force the dent out
5. If there is a bulge, use a suitable pen head and install it on the pen holder
6. Aim the bulge and hit the pen with a hammer frequently and slightly until the bulge disappears.

Quality Criteria: Assured performing of all the activities according to the procedures



Operation Sheet 3.2

Operation Title: Repairing body panel repair

Purpose: To repair body panel repair using body filler

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Body filler
- Steel rule
- Plastic scraper
- Dent puller
- Sand paper
- Welding machine
- Primer-filler
- Masking Tape
- Surface grinder

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual, which guide you how to use tools and equipment.

Procedures:

Step1: Clean vehicle before moving it into repair area

Step 2: Study repair order and vehicle damage to determine repair procedure.

Step 3: Remove badly damaged bolt on parts.

Step 4: Measure the damage.

Step 5: Straighten frame damage on frame rack.

Step 6: Replace badly damaged welded-on parts.

Step 7: Straighten minor body damage (Fig 2)

Fig 2

A Panel minor damaged

B Pull the welded pins by changing puller

C Nail weld gun used to pull the damaged panel

D Cut and grind off the pins

Step 8: Apply body filler and coarse sand repair area

Step 9: Apply a primer-filler around body filled area (Fig 3)

Fig 3

A Mixing body filler and hardener

C File to roughout the shape in multiple direction

B Apply body filler to clean body surface

D Feather edge the filler and old paint

Step 10: Fine sand repair area and all parts to be refinished

Step 11: Mask the areas not to be painted

Step 12: Clean surface to be painted (Fig 4).

Fig 4

Step 13: Refinish (prime, seal, paint) damaged body parts.

Step 14: Detail vehicle (unmask, clean and polish) as needed

Quality Criteria: Assured performing of all the activities according to the procedures

Unit Four: Completing Work Processes

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

- Cleaning Tools, Equipment and Work Area
- Conducting Final Inspection
- Workplace Reporting and 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:

- Clean Tools, Equipment and Work Area
- Conduct Final Inspection and Documentation
- Prepare Workplace Reporting and Documentation

4.1 Cleaning Tools, Equipment and Work Area

Cleaning is the removal of all visible dirt in an approved way with the use of mechanical and chemical action or both, so that all areas are cleaned and sanitised to a high standard. Storing dirty tools without cleaning them can cause them to deteriorate. Routine cleaning reduces the chances of rust and can reduce the rate of wear and tear. To ensure effective cleaning of tools and equipment, it is important to follow manufacturer guidelines and use appropriate cleaning agents or methods. Additionally, proper storage of cleaned tools and equipment helps maintain their cleanliness and readiness for future use. Cleaning tools and equipment immediately after use is necessary for several reasons:

- Hygiene and Sanitation: Cleaning tools and equipment after use helps maintain a clean and hygienic environment

- Equipment Longevity: Proper and timely cleaning of tools and equipment helps extend their lifespan. Accumulated dirt, debris, or residue can cause wear and tear, corrosion, or damage over time if not promptly removed.
- Performance and Efficiency: Dirty tools and equipment may not perform as effectively or efficiently. Regular cleaning ensures that tools and equipment function at their best, delivering the desired results.
- Cross-Contamination Prevention: Cleaning tools and equipment after use minimizes the risk of cross-contamination.
- Professionalism and Organization: It promotes a positive work environment and demonstrates attention to detail and pride in the quality of work performed.

Figure 5-1: Clean and Organized Garage

1. Keep your work area cleanly. This will help you work more efficiently and safely
2. Have a waste bin close to your work area and place any waste in it as soon as possible.
3. Dispose of liquid and solid waste, such as oils, coolant and worn components, in the correct manner.
4. Do not pour solvents or other chemicals into the sewage system. This is both environmentally damaging and illegal.
5. Always use chemical gloves when using any cleaning material because excessive exposure to cleaning materials can damage skin.

6. Some solvents are flammable. Never use cleaning materials near an open flame or cigarette.
7. The fumes from cleaning chemicals can be toxic, so wear appropriate respirator and eye protection wherever you are using these products.

4.2 Conducting Final Inspection

Auto body repair is a very complex process. It needs to be, to ensure that vehicle is transformed back to its original shape. All damages, including those that took place before the collision, should be fixed as well.

Hence, final inspections take place when repair is complete. The repair process is measured against product specifications, customer requirements, and standards. Final inspections and device approvals play an integral role in the decision to move items to stock or shipment.

Finally, the vehicle is prepared for collection or delivery. It should be provided with a detailed and itemized list of all repairs and parts involved in the car work. The technician will also give the final computation of the expenses with a complete breakdown of the items.

Performing inspection on the exterior and interior of the car to see if everything is done well is critical. A representative from the auto body repair center will be present to accommodate concerning the repair process.

Final inspection allows to catch any quality control issues that may have been missed earlier in the repairing process.

Post-repair checks

- Examine the appearance of the repaired area.
- Check freshly painted areas for colour match.
- Check that mechanical parts (e.g., doors and trunk lid) open and close smoothly.
- Check electronic accessories for proper operation.
- On the drive home, check for unusual noises and test the handling of the vehicle.

Major inspections include:

- Stripping of all mechanical components for measurement and replacement as required

- Checking of all structural components for cracks, corrosion and damage.

Further information on the inspection and component specification should be available from the manufacturer or alternately, seek advice from a professional engineer about completing the inspection. Any replacement components and fittings must be as specified by the manufacturer or be equivalent in material and design. If a redesign of fittings or components is proposed, advice should be first sought from the manufacturer or a professional engineer before undertaking the modification.

4.3 Workplace Reporting and Documentation

4.3.1 Reporting

A car repair report is an essential document that makes work easier for both owners and mechanics. It ensures there is transparency in the repair and maintenance of vehicles. Hence, it is crucial to ensure that all vehicle has a reliable technology for generating the repair report. Report displays, for each vehicle, the due date of the next service and highlights any services that are overdue, which helps to ensure that all vehicles are maintained and serviced.

A report document contains the repair history of a particular vehicle. Moreover, the report will contain the vehicle's former owners, the history of mileage, history of accidents, and any other fundamental damage. It will help you to select a vehicle that has undergone fewer repairs. Hence, you will select a strong vehicle that will provide valuable service for your money. This document is a sign of good faith and should always be kept safely.

4.3.2 Workplace documentation

Proper documentation can help in more ways than one. With new technologies coming our way, look for methods that will help you document easier through the transfer of data from your diagnostic tools right into your repair orders automatically. Additionally, using smartphone or tablet to capture video and audio can go a long way towards helping clients understand more about their vehicles and what it takes to keep them operating properly.

Workplace documentation includes all the paperwork from each employee. These documents provide a written record of every onboarding, performance and disciplinary action taken. Documentation can help eliminate duplicative work by providing a clear understanding of

what has already been done. When employees have access to documentation, they can easily see what tasks have been completed, what needs to be done next, and avoid duplicating work that has already been done.

Record process is the data that is held about customers, their vehicles and the work carried out on them. New records can be created from a number of points within the system. The following would be typical of a process:

1. A new customer has a problem with their car and requests an estimate
2. Customer and vehicle details are added, with the help of post code and vehicle registration look-up features
3. The estimate is now created, with the use of repair times look up if needed, and can be printed
4. The customer agrees the price and the vehicle is booked in using the booking screen

Self-Check 4-1

Part I: Choose the correct answer from the given alternatives

2. Choose the necessity of cleaning tools and equipment immediately after use.
   A. Helps maintain a clean and hygienic environment
   B. Helps extend their lifespan of tools and equipment
   C. Minimizes the risk of cross-contamination.
   D. All of the above

3. _____allows catching any quality control issues that may have been missed earlier in the repairing process.
   A. Repairing

B. Final inspection

C. Cleaning

D. Maintaining

4. A car repair report is an essential document that ensures there is transparency in the repair and maintenance of vehicles.

A. True B. False

Part II: Explanation

1. _____ is the removal of all visible dirt in an approved way with the use of mechanical and chemical action or both.

2. List and explain the major inspections methods in auto body repair workshops.

LAP Test

Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

Task 1: Perform hot shirking aluminum panel

Task 2: Prepare aluminum panel to pre-paint condition

Task 3: Perform repairing damaged aluminum vehicle fender

Task 4: Performing repairing body panel repair using body filler

References

Books

Toboldt, W. K. (1972). Auto Body Repairing And Repainting Modern, Simplified Methods. (No Title).

Discovery 1995-On Body Repair Manual. Rover Group Limited Publication Part No. LRL 0103ENG

Sakurai, T. (2008). The latest trends in aluminum alloy sheets for automotive body panels. Kobelco technology review, (28), 22-28.

Duffy, J. E. (2014). Auto body repair technology. Cengage Learning.

URL

https://www.autoaluminumsheet.com/product/6016-aluminium-alloy-for-car-body.html

http://mmcmanuals.ru/manuals/pajero_iv/online/Service_Manual/2007/03/html/M4030000000700ENG.HTM

http://www.landy.ee/manuals/cars/discoi/Discovery%20Body%20Repair%20manual.pdf

Developer's Profile

No	Name	Qualification (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Andinet Asnake	MSc	Automotive technology	Wolkite PTC	0913767250	andinetasnake31@gmail.com
2	Tesfaye Bedada	MSc	Automotive technology	Hawassa PTC	0927831195	tesfaybedada51@gmail.com
3	Zinabu Solomon	MSc	industrial engineering	mulegeta buli	0960964523	zinabusolomon565@gmail.com
4	Gashaw Zewde	MSc	Automotive technology	atelete kenenesa	0910730747	gashawgashaw69@gmail.com
5	Yebeltal Getahun	MSc	Automotive technology	Arbaminch PTC	0916467687	yibemadi@gmail.com
6	Tilahun F/Silase	BSc	Automotive technology	w/sihene PTC	0914604592	mailto:tilahunfikre@gmail.com