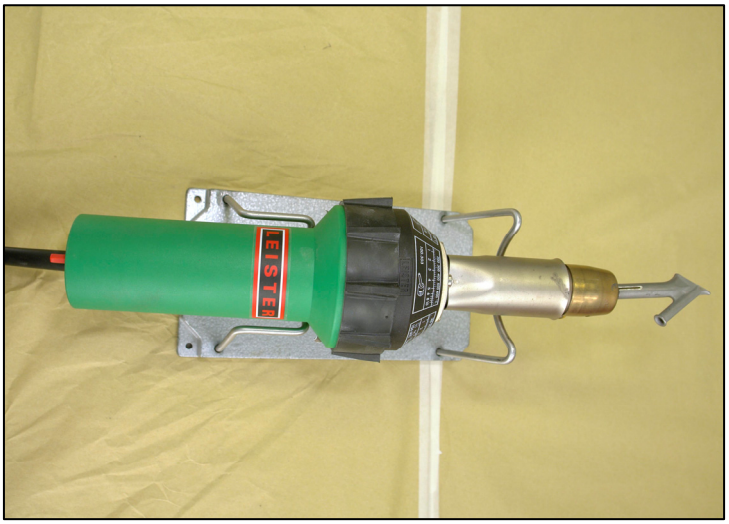
TRADE OF
VEHICLE BODY REPAIR

PHASE 2

Module 1

UNIT: 5

Plastic – Welding and Repairs



Produced by

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

In cooperation with subject matter expert:

Maurice Stack

Some material courtesy of CDX Global and FENC – Further Education National Consortium.

Table of Contents

Table of Figures

Introduction

Any solid substance which can be moulded into a new shape under pressure is said to be plastic. Today a large group of synthetic materials is known by the general term plastics. This term came into use because most of these materials are in a plastic condition at some time, usually when they are being moulded into shape or object.

When we refer to plastics we usually mean polymers, since plastic is a condition or state of a material. Metals when heated to certain temperatures can also be plastic, and on the contrary, certain polymers are no longer plastic after moulding.

Plastics can be produced in any colour. They can be moulded into very complex shapes. Numerous items such as household equipment, toys, building materials, decorative objects, containers, packaging, aircraft parts, motor car parts, safety screens, are made from plastics. This variety of uses demands that plastics have different properties. For example, a plastic grille on the front of a motor car must be decorative and tough whereas a plastic drinking cup may have to withstand temperatures up to 100ºC.

Plastics can be transparent or opaque, hard or soft, rigid or flexible. As a general rule plastics are poor conductors of heat and electricity. This makes some of them suitable for use as insulating materials.

In 1920 a German chemist, Herman Standinger, put forward a theory about the chemical nature of a whole group of substances natural and synthetic. His theory explained the nature of plastics also indicated the ways in which it could be made. It provided the foundation for the world of plastics as we know it.

Unit Objective:

Plastic Welding and Repairs

21 Hours

By the end of this unit each apprentice will be able to:

- Identify hazards created by the repair of plastic process.
- Select suitable protection equipment to eliminate hazards.
- Define the differences between thermo softening and thermo setting plastics.
- Identify faults in plastics.
- Undertake repairs using plastic welding.
- Reshape plastic components using heat.
- Repair plastics using the bonding process.
- Select suitable equipment including a suitable grit of sanding disc.
- Define the application of plastic to the vehicle body.
- Define the function and types of reinforcements in plastics.

Key Learning Points

- Safe operation of equipment
- Plastic identification
- Plastic welding techniques
- Plastic repair techniques
- Bonding process
- Sanding techniques
- Application of plastics to the vehicle body
- Identification of faults in plastics
- Methods of production
- Reinforcements

1.0 Hazards Created by the Repair of Plastic Process

HEALTH & SAFETY requirements:

- A face mask and gloves must be worn when heating synthetic or resin-based plastics.

ELECTRIC SHOCK can Kill

- Always wear dry insulating gloves.
- Insulate yourself from work and ground.
- Do not touch live electrical parts.

FUMES & GASES can be hazardous to your health

- Keep your head out of the fumes.
- Ventilate area, or use breathing device.
- Read material safety data sheets (MSDSs) and manufacturer's instructions for material used.

WELDING can cause fire or explosion

- Do not weld near flammable material.
- Watch for fire; keep extinguisher nearby.
- Do not locate unit over combustible surfaces.
- Do not weld on closed containers.
- Allow work and equipment to cool before handling.

HOT PARTS can cause injury

- Allow a cooling period
- Wear protective gloves and clothing.
- Do not use oxygen or other flammable sources for the purpose of welding.

See Mod 1. Unit 2. Induction, Personal Safety and Protection.

1.1 Safe Operation of Equipment

The plastic welding gun must be treated with care, misuse may result in burns, fume inhalation or electric shock.

Care of a weld gun

- Never drop welding gun.

- Switch off heat control when welding is complete and leave compressor running to cool down the element. Failure to carry out this process will damage the welding gun.

- Plastic welding guns require a compressed air or gas supply which must be adequately filtered of dirt and water to enable the gun to function correctly. Operating pressure range is between 2-6 psi. The use of nitrogen/water pumped gas (WP-Nit) will help in the welding of some plastics and will reduce oxidisation, e.g. Acronitrile Butadiene Styrene (ABS) and Polypropylene (PP). Tests however, have shown that these materials can be welded quite successfully using dry air.

- Welding guns with built-in compressors can be used with their welding tips removed as hot air blowers for drying polyester fillers, shrinking PVC trim sections and for the removal and attachment of adhesive exterior mouldings. Heavy duty models are also available with 'fishtail' attachments for softening protective underbody coatings.

- The LEISTER TRIAC hot air tool can supply 230 litres of air per minute at a precise temperature between 20ºC and 700ºC. For trim removal the hot air tool is used without a welding nozzle at a temperature setting of 300ºC. The temperature charts on the tool body show the rotary control setting to achieve the correct air temperature. Whenever the hot-air tool is in use the end of the element housing becomes extremely hot, always rest the tool on its stand when not in use.

- The rotary control on the rear of the hot-air tool enables accurate setting of welding temperatures up to 700ºC.

Temperature Control

On/Off

2.0 Differences between Thermo Softening and Thermo Setting Plastics

2.1 Types of Plastic Materials

The simplest way of classifying plastics is by their relation to heat. Plastic materials can therefore be classified into two main groups:

a. Thermoplastic Materials

b. Thermosetting Materials

2.2 Thermoplastic Materials

These are materials which lose their rigidity whenever they are heated. No chemical change takes place during this process. When cooled they again become hard and will assume any shape into which they have been moulded when soft. This process can take place repeatedly.

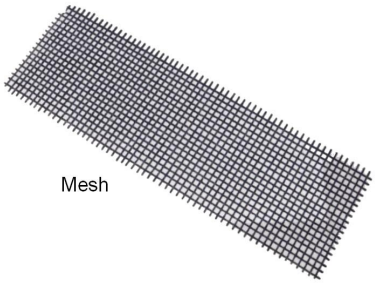
2.3 Thermosetting Materials

These are materials which undergo a definite chemical change during the moulding process causing them to become permanently rigid and incapable of being softened again, or cannot be welded, but can be chemically bonded.

They may be fused with stainless steel mesh and weld bonded with a special rod made by Steinel. The ability of thermosetting plastics to withstand heat makes them an ideal choice for applications where possible fire hazards may materialise, such as bulkhead coverings and electrical components.

Thermoplastic plastics are commonly used for less sensitive components such as bumper assemblies, radiator grilles and shrouds.

Adhesive Weld Rod



Mesh

3.0 Plastics

3.1 General Properties of Plastic Materials

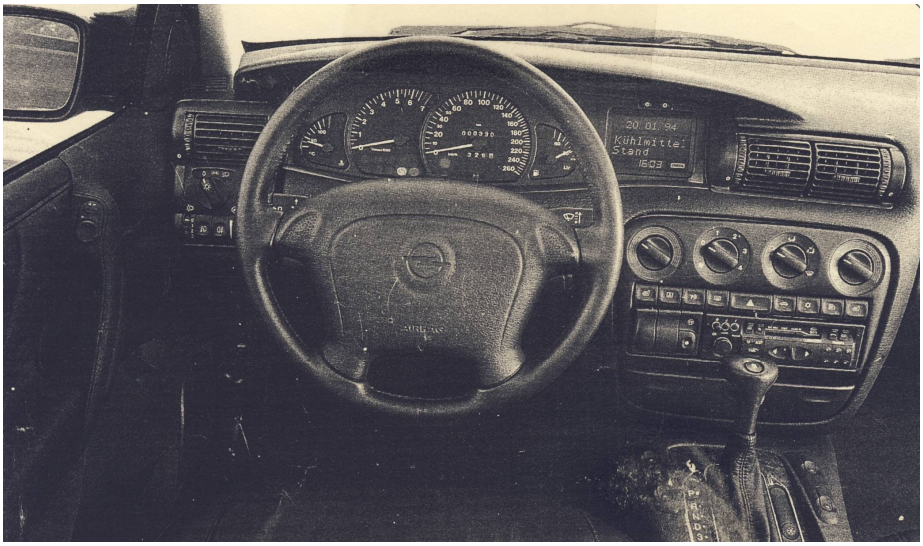
- They are resistant both to atmosphere corrosion and to corrosion by many other chemical agents.
- Many are reasonably tough and strong but the strength is less than that of metals. However, since the relative density of plastics is low, this means that many have an excellent strength/weight ratio.
- They have a low density.
- Most of the thermoplastic material begins to soften at quite low temperatures and few are useful for service at temperature much above 100ºC. Strength Falls rapidly as the temperature rises.
- Most plastics can be coloured if necessary.
- Thermoplastic types can be welded by using various forms of equipment.

3.2 Other Advantages Concerning Plastic Repairs

- Lower accident damage repair costs.
- Faster workflow through repair shops in cases where slow – moving stock items are on back order.
- High profit ratios in that more of the profit content goes into labour time than into the mark-up on new plastic parts.
- The opportunity to generate additional business with the provision of a plastic repair service.

4.0 Application of Plastic to the Vehicle Body

The motor manufacturing industry, in their constant quest for greater all-round manufacturing and performance efficiency are continually increasing the amount of composite materials used in vehicles. The main attractions of these materials are weight reduction resulting in improved fuel economy and greater freedom of design with larger, more complex assemblies being manufactured at lower production costs. At the time of this report there is an average of 100 kilograms of composite used in the average passenger car, with an increase to 200 kilograms predicted. For this figure to be reached it is likely that more vehicles will have larger areas of panel work replaced with composites. It is therefore important that Engineers and Repairers have sufficient information on the types of composite material in use together with an awareness of the techniques used for their repair. In essence the composite used in vehicle manufacture are known by the generic name of 'plastics'. These plastics may be divided into two different categories: Thermosetting and Thermoplastic.



5.0 Identification of Plastic by Code

The majority of plastics used in vehicle manufacturing are thermoplastics. Heated until they are soft, they can be moulded or welded. There are different types of thermoplastics, each having a specified temperature for welding operations.

Code	Plastic
ABS	Acrylonitrile Butadiene Styrene
ABS/PC	Polymer alloy of above
PA	Polymamide (Nylon)
PBT	Polybutylene Terephtalate (POCAN)
PC	Polycarbonate
PE	Polyethylene
PP	Polypropylene
PP/EPDM	Polypropylene/Ethylenediene Rubber
PUR	Polyurethane (Not all PUR is weldable)
PVC	Polyvinyl Chloride
GRP/SMC	Glass Fibre Reinforced Plastics (Not weldable)

Plastic identification codes commonly found at rear of bumpers and plastic components:

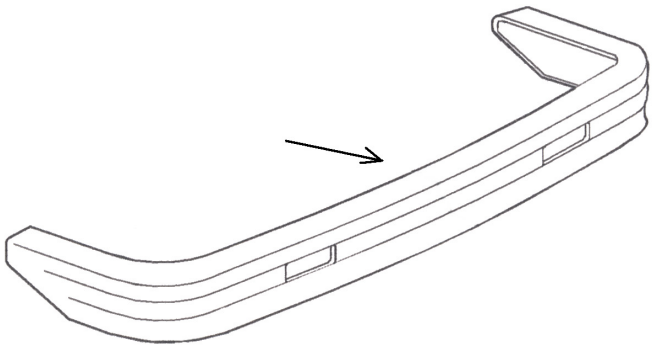


Figure 1: Identification Codes

5.1 Welding Chart for Commonly-Used Thermoplastics

Mat. Code	Material Name	Heat Resistance	Welding Temp.	Resistance To alcohol and Petrol	Precaution	Application
ABS	Acronitrile Butadiene Styrene	80	350	Alcohol is harmless if applied for a duration	Avoid petrol and organic aromatic solvents	Grilles instrument panels
PA	Polyamide	82	300	Alcohol and petrol are harmless	Most solvents are harmless	Lower panels
PC	polycarbonate	121	300		Avoid petrol brake fluid wax, wax removers and organic solvents	Grilles, instruments panels and some bumper
PE	Polyethylene	82	250-300	Alcohol and petrol are harmless	Most solvents are harmless	Lower panels
PMMA	Clear acrylic	80	350	Alcohol is harmless if applied for a short duration (quick wiping)	Avoid acetone and tetrachloride	Crash padding
PP	Polypropylene	87	300	Alcohol and petrol are harmless	Most Solvents are harmless	Interior scuff panels, hard plastic trim mouldings, splashguards, fan shrouds and some heater casings
PVC	Polyvinyl	54	350 - 380	Alcohol is harmless if applied for a short duration (quick wiping)	Avoid dipping or immersing in alcohol, petrol, solvent etc.	Upholstery and interior trim
TPUR	Thermoplastic Polyurethane	60	250 - 300	Alcohol is harmless if applied for a short duration (quick wiping)	Avoid dipping or immersing in alcohol, petrol, solvent etc..	Soft filler panels, bumper facings, chin spoilers, soft bezels

5.2 Plastic Identification

When carrying out repairs to plastic components it is necessary first to ascertain the type of material being repaired and the group to which it belongs. A thermoplastic material may be repaired by welding, fusing or adhesive bonding. Whereas repairs to thermosetting plastic may be carried out only by adhesive bonding.

When no code is available:

- A quick test for identifying whether a plastic is from the thermosetting or thermoplastic group is to cut a very thin slither off the component.
- In body repair manuals, some vehicle manufacturers give details of plastic parts or mark plastic parts with code letters.
- The use of an organic solvent test kit, these kits work by a process of solvent application to the material surface, identification is confirmed by the reaction between the plastic and the test solvent in accordance with the test kit manufacturer's instructions.
- An alternative method is combustion testing where a small strip of material is held in a butane flame and the flame colour noted.

In the case of a thermoplastic the following additional test is then conducted to identify the precise material as these materials will only weld like to like, for example: PP to PP.

Clean a small area on the reverse side of the damaged component and lay down 20-30mm of weld on this area, leaving a 'tail' of the same length on the rod.

Allow the weld to cool and pull the tail at 90ºC. If the tail separates off with little or no resistance the materials are compatible.

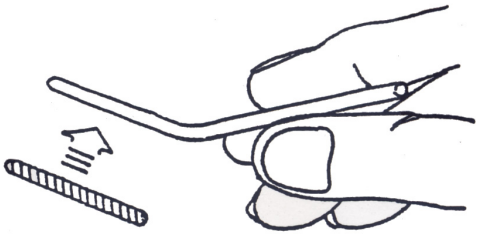
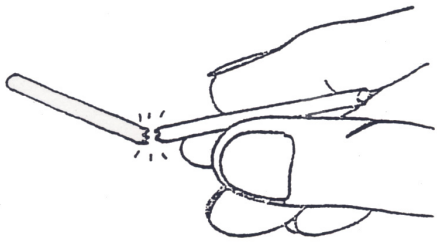


Figure 2: Material Identification

If the tail breaks without disturbing the weld the materials are compatible.

Figure 3:

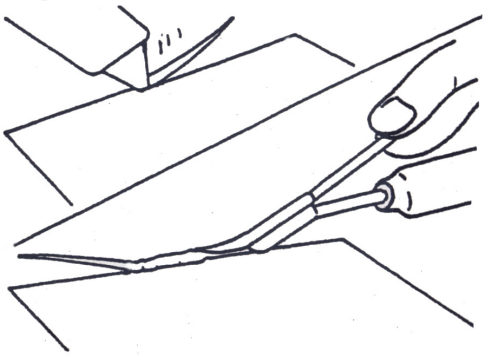


Where the rod tears in half or the weld partly breaks, either the welding technique is incorrect or the materials are slightly different. In this case repeat the process.

Figure 4

Should none of these methods work, cut a small piece off the workpiece and weld it to itself.

Figure 5



5.3 Weldable/Non Weldable Plastics

Identification Code	Plastic Material	Thermoplastic Weldable	Thermosetting not weldable
PET	Polyester		✓
PBT	polyester		✓
PPE		✓	
PVC	Polyvinyl Chloride	✓	
PUR	Polyvinyl	Some Pur is weldable	✓
PP/EDPM	Polypropylene Ethylenediene Rubber	✓	
PU	Polyurethane	✓	Do not bend
PP	Polypropylene	✓	Do not bend
(hard) PE	Polypropylene	✓	
PC	Polycarbonate	✓	
PBT	Polybutylene Terephtalate (POCAN)	✓	
PA	Polyamide (Nylon)	✓	
GRP/SMC	Glassfibre Reinforced Plastics		✓ Bond
ABS/PC	Polymer Alloy of ABS	✓	
ABS	Acrylonitrile Butadiene Styrene	✓	
XENOY	PC Alloy	✓	
PE (soft)	Polyethylene (LDPE)	✓	
TPUR	Thermoplastic Polyurethone	✓	
PMMA	Clear Acrylic	✓	
MDPE		✓	
Welding PVC, hold the rod at 90ºC and 45ºC for most other materials. maintain a welding speed of 15cm/min (6in./min).			
Note: Polyurethane (PU) and Polypropylene (PP) should not be repaired using adhesive as it is difficult to obtain satisfactory bond strength with these materials.			

5.4 Welding chart for commonly – used Thermoplastics

Potentiometer Control Setting for Leister Triac 1G3 with:

Thermo plastic code	Welding temperature˚C	Tack Weld Nozzle 28	Pendulum Weld Standards Nozzle 31A	Speed Weld Nozzle 27 (3mm)	Speed Weld Nozzle 27B (5.7mm)
ABS	350	3.4	3.4	4.0	4.2
ABS/PC	350	3.4	3.4	4.0	4.2
PA	400	4.1	4.1	4.6	4.8
PBT	350	3.4	3.4	4.0	4.2
PC	350	3.4	3.4	4.0	4.2
PE hard (hdpe)	300	3.0	3.0	3.3	3.5
PE soft (ldpe)	270	2.8	2.8	2.8	3.0
PP	300	3.0	3.0	3.3	3.5
PP EDM	300	3.0	3.0	3.3	3.5
PUR Thermoplastic	300/350	3.0/3.4	3.0/3.4	3.3/4.0	3.5/4.2
PVC hard	300	3.0	3.0	3.3	3.5
PVC soft	350	3.4	3.4	4.0	4.2
XENOY (PC Alloy)	350	3.4	3.4	4.0	4.2

Other various Plastic Metals include:

- Vinyl Plastics
- Nylon, Terylene
- Poly Tetrafluoroethylene (Teflon)
- Terylene
- Polymethyl Methacrylate (Perspex)
- Phenol Formaldehyde (Bakelite)
- Epoxy Resins

6.0 Plastic Welding Rods

6.1 Methods of Production

Methods used to shape plastic materials:

1. Extrusion

2. Moulding

3. Casting

Extrusion:

In this process the plastic material is carried forward and as it enters the heated zone it becomes soft enough to be forced through a die. The die is shaped according to the cross section required in the product. Wire can be coated with plastic by extrusion, assuming that the machine is adapted so that the wire can pass through the die can the manner of a mandrel.

Moulding

Compressing Moulding:

This is used for both thermoplastic and thermosetting materials, though it is particularly suitable for the latter. In either case that the mould must be heated, but for thermoplastic substances it has to be cooled before the work piece can be ejected. A carefully measured amount of powder is issued, and provisions are made to force out the slight excess necessary to ensure filling of the mould cavity.

Injection Moulding:

This is a very rapid process, and is widely used for moulding such materials as polythene and polystyrene. The material is softened by heating it in the injection nozzle. The mould itself is cold, so that the plastic soon hardens and can be ejected.

Transfer Moulding:

This is used for thermosetting plastics. The material is heated to soften it, after which it is forced into the heated mould where it remains until set. More intricate shapes can be provided by this process than by compression moulding.

Blow Moulding:

This is used to produce hollow articles. The plastic is first softened by heating and is then blown by air pressure against the walls of the mould.

Vacuum – Forming:

This is also used in producing simple from thermoplastic materials in sheet form. The heated sheet is damped at its edges, and is stretched by the mould as it advances into position. The ultimate shape is produced by applying a vacuum, so that the work piece is forced into shape by the external atmospheric pressure.

Casting:

The process is limited to those plastics whose ingredients are obtained as liquids. The mixed liquids are poured into the open mould and are allowed to remain at atmospheric pressure until the setting has taken place.

Slush Moulding:

This is essentially a casting process rather than the moulding process its name implies. It is used mainly for PVC the said being prepared as a thin paste which is injected into the mould. The mould is then rotated and heated until the paste forms a solid gel on the lower surface of the mould. The excess fluid is poured out, and the hollow formed article is then removed from the mould.

Raw Materials

The Raw materials used in the manufacture of plastics can be divided into three main classes.

1. Animal or Vegetable products, which include casein obtained from cow's milk and cellulose obtained principally from cotton fibre too short for spinning, and from wood pulp (cellulosics).
2. Coal by products, obtained during the distillation of coal to produce gas. (PVC, Nylon, Polyesics, Phendics, Urea and Melamine)
3. Petroleum by products obtained during the refining and cracking of crude oil. (Polythene, Polystyrene, PVC and Perspex)

7.0 Repairs using Plastic Welding

7.1 Plastic Welding Techniques

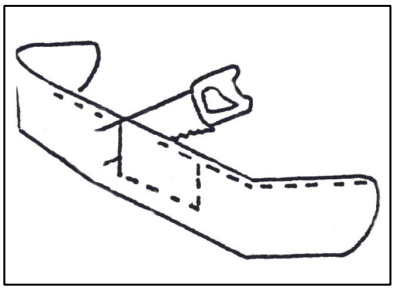
A basic rule, if the part is going to take more than 40 minutes to repair – it may not be cost effective.

40 minute repair is about 12 inches of weld.

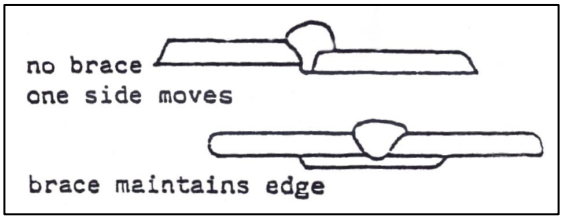
Guidelines

If you have the missing piece – clean, identify, teckweld, weld.

- **a.** Clean out the hole to remove any dirt or grass and cut a panel from an un-repairable bumper of the same type.
- **b.** Place this part behind the hole and using a sharp pencil, draw the outline of the hole. Trim to pencil line and clean, tackweld and weld.
- **c.** Is the "donor" piece of the same material as the main component?



A brace welded at the edge can limit distortion at this critical point. Braces on the back of an item require no refinishing and are therefore recommended.



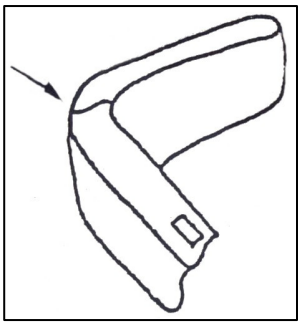


Figure 6, 7, 8: Repair Guidelines

7.2 Crack Prevention

After removing decorative trims and adhesive, the end of each crack or split should be drilled with a maximum 3mm diameter drill to prevent further lengthening of the crack. Remember, plastic swarf can be as abrasive to the eyes as metal. Wear eye protectors.

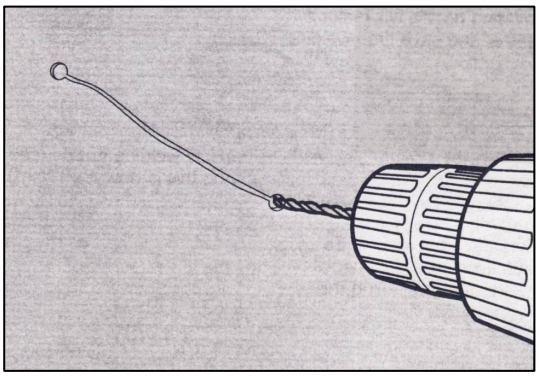


Figure 9: Crack Prevention

7.3 Reinforcements

Distortion can be effectively controlled by support using tackweld and weld braces. The braces need only be one inch in length. Plastic components can be repaired from the front or rear according to ease of access. Reinforcement welds can be used across the rear of a front repair to restore strength to areas across the rear of a front repair to restore strength to areas designed to withstand impact.

To strengthen welds further, cross welds can be added to the under side.

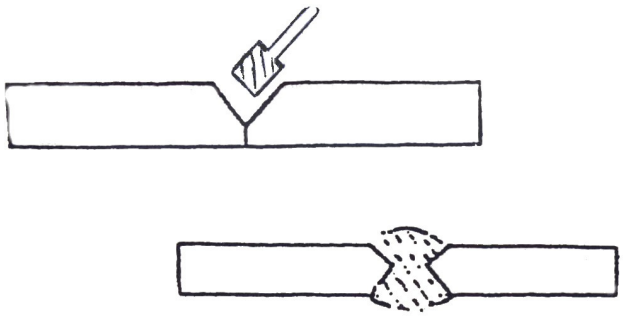
The Welding Process

Thermoplastics are welded using electrically heated guns with either a separate compressed air source or a nitrogen gas supply. This process is known as 'hot gas' welding. The principle involves passing compressed air or gas over an electrically heated element, the hot air then being played over the work piece and the welding rod. The rod is fed into the break or fracture as it melts. A 90˚ 'V' shaped groove must be prepared along the crack to accept the welding rod. Begin by removing any paint from the repair area with a body file or D/A sander. An area 10 to 15mm around the damages should be sufficient. If sections of the material have been impacted and become trapped, the application of heat up to 200˚C will help to free them. A screwdriver blade can also be used to free trapped sections. The 'V' shaped groove can be formed with careful use of a square edged file but the best tool is a rotary burning bit with a cutting edge on its circumference and end face.

This creates the 90˚ groove in one operation even following the most erratic of crack courses. Begin the groove up to 10mm beyond the start of the crack and increase the depth progressively to maximum by the time the start of the crack is reached. The depth of the groove should be no more than 2/3 of the thickness of the material. Best results are obtained when a high speed drill is employed. A slow drill or the use of a single cutting face burning tool may lead to it jumping from the groove. During the burning operations always wear eye protectors and dust mask to prevent irritation from fine particles of plastic. When the groove is finished the welding rod for the material should rest neatly in it. The upper curve-face of the rod should be protruding 1 to 2mm above the surface of the repair. This allows for weld dressing operations, eliminating the need for fillers and ensuring enough depth of penetration for the rod.

The test relates to larger components such as bumpers where 5mm profile welding rod is used more than one run may be necessary. For small or thin walled components one run of 3mm rod may be sufficient.

Figure 10: Rotary Burring Tool



Burring out to approximately ¾ of the depth of the material. Usually, welding on one side only gives enough strength.

Double weld can be used at critical areas, for example on motorcycle fairings.

7.4 Repair Processes

Before beginning the repair it is important to identify the type of plastic so that a decision may be made on the process to be used. This is particularly important if the work piece is to be welded as the material in the filler rods must be fully compatible with the material being repaired. To aid identification, most vehicle manufacturers now stamp plastic components with internationally recognised code letter groupings.

Tack Welding

Welding operations are completed in two stages. First, tack weld of the base of the crack together and holds both sections of the component in alignment.

Tack welding nozzle 28 (push fitted onto the standard nozzle of the LEISTER TRIAC) is used at the temperature specified for the material. The weld is best completed in one continuous run from end to end drawing the welding nozzle tip along the base of each 'V' groove. The nozzle should be held with its toe in contact with the base of the groove and the heel slightly raised. The sole of the nozzle should be inclined at an angle not exceeding 20˚ to the groove base. As the nozzle is drawn along, hot air softens the plastic below the heel of the nozzle and the toe draws the soften material together.

Avoid applying pressure to the weld via the tool as the material at the base of the groove is thin and not strong. While tack welding, minor misalignment of the panel sides or new inserted material can be corrected by holding the sections in position until the weld has knitted and cooled. After each welding run, brush the nozzle clean with a brass suede brush. Remove any difficult residue by increasing the heat level to maximum to soften it.

Main Welding

The important rule in plastic welding is that it is only possible to weld like with like, hence the need to identify the plastic material and select a matching welding rod. The main welding operation begins with a preparation of the welding rod. Cut the end to a pencil point using a trimming knife or side cutters; this provides a progressive fill in the 'V' groove, particularly where it starts in the centre of a panel, preventing the formation of bulbous protrusions of plastic.

Fit speed welding nozzle 27b to the LEISTER TRIAC hot-air tool. Set the correct temperature for the material and allow the tool so that the speed welding nozzle sole runs along the crack parallel to the component surface. The protruding rod must be held beyond the start of the 'V' groove so that heat is directed onto the start point for welding. When the surface plastic shows signs of slight 'wetting' move the welding nozzle along the groove. The nozzle toe should rest on the rod in the groove while under the heel there should be an air gap of 3mm. Feed the rod steadily into the nozzle with a downward hand pressure of about 2.5kg, sufficient to push the softened rod into the groove. To judge what pressure of 2.5kg feeds like, take a short piece of weld rod and use it to press down on a set of scales until 2.5kg registers. (Do not apply downward force to the weld via the hot air tool itself). Wherever possible the weld should be completed in one continuous run along the contour of the crack.

Correct mating between the welding rod and the material occurs when the rod is seen to soften and the new rod moves down the nozzle feed. As the rod melts into the groove two smooth continuous ridges will appear at the edges, accompanied by a slight wash at the sides of the weld. Do not move too fast, failing to create a wash, nor too slowly, overheating and scorching or distorting the plastic. When the weld has been completed, remove the hot-air tool, sliding the nozzle off the remaining welding rod. Once cool, the un-welded rod end is cut off as close to the weld as possible. The completed weld appears as a smooth continuous line with the wash still visible alongside it, confirming that the rod has welded successfully with the component.

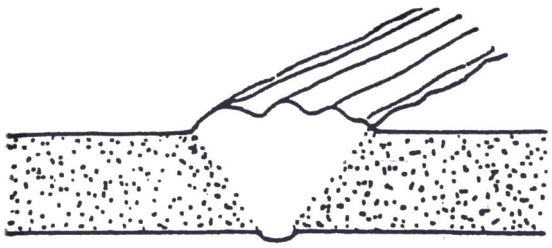
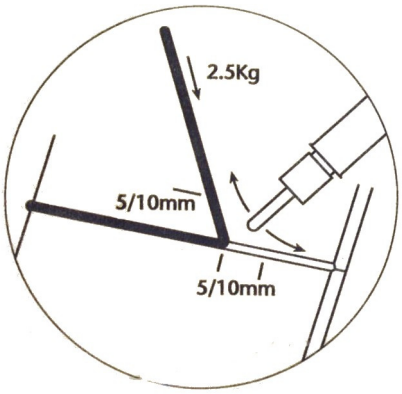


Figure 11: Weld Correct

During the welding, previously unseen cracks may open up. These are not new but are impact cracks that have been present since the initial damage. These must be treated and welded as any other crack damage. If the weld is successful, reinforcement welds can be added to the reverse of the material across the axis of the repair. The same preparation and weld operations apply.

Pendulum Welding

Where cracks or splits pass through tight corners it may be difficult to use the normal speed welding nozzle. In such cases the technique of pendulum welding is effective. Prepare the crack in the normal way then feed the welding rod manually into the 'V' at an angle between 80º and 90˚ to the groove. Exert about 2.5kg downward force on the rod while playing the hot-air tool, fitted with standard nozzle 31A, onto the base of the rod and into the 'V' groove in a constant pendulum action.



The bias of the action is determined by the comparative thickness of the component material and the welding rod. Both must be in the same molten state at the point of fusion. Dressing and finishing is the same for speed welded material.

Figure 12: Pendulum Welding

Fusing

This technique may be used to repair small components such as mounting lugs on heater casings, or on thin-walled parts such as screen-washer bottles. The repair is carried out by tackling and spreading the existing material using a soldering iron. Soldering irons are available with a wide range of tips including broad shoes to help in the spreading of the base material.

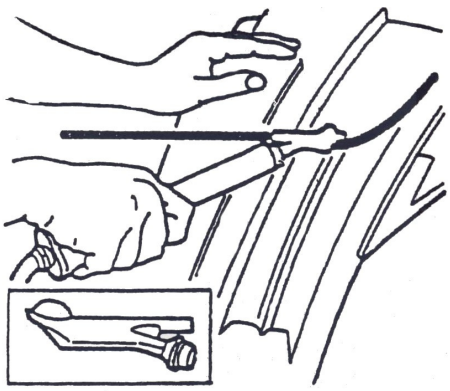


Figure 13: Speed Tip

Used for long breaks or fractures, welds faster and automatically feeds the rod once fused to the material.

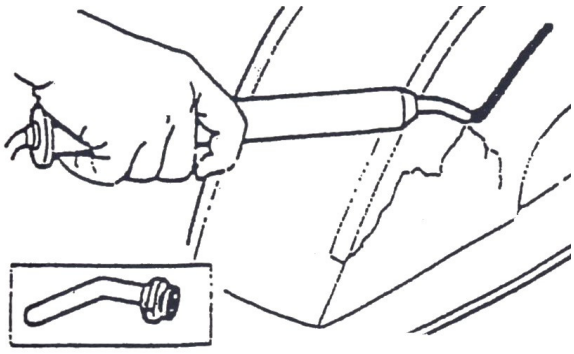
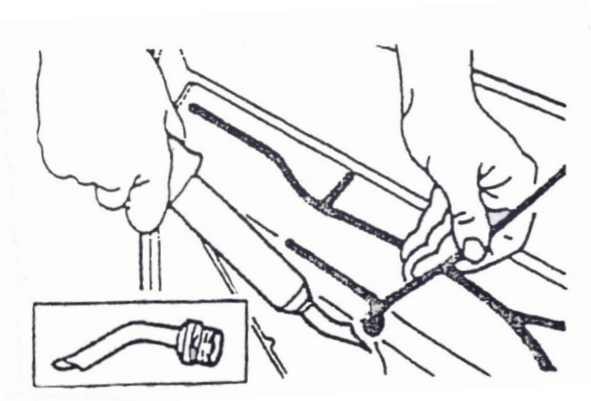


Figure 14: Tacking Tip.

For tack welding long breaks or fractures to hold material in correct alignment prior to welding.

Figure 15: Round Tip

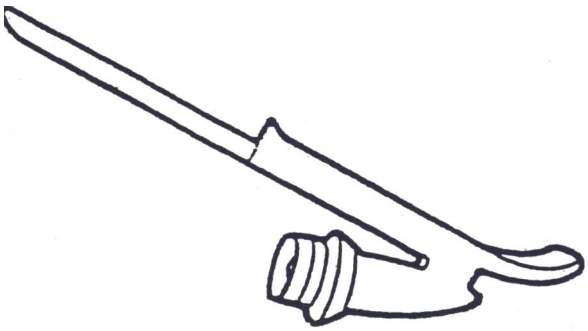
For welding small fractures and areas where different curvatures are encountered.



Speed Ribbon Tip

This type uses a ribbon 1/2in wide instead of a round section welding rod. It is ideal for welding fractures with an awkward shape which may cause difficulties with a conventional rod, for example, on lower front panels where the mounting bolt holes have been torn out of shape.

Figure 16: Speed Ribbon Tip



8.0 Faults in plastic

The following table shows the type of problems which may be encountered when carrying out plastic welding operations:

Problems	Cause
Uneven welding base	Uneven pressure when 'feeding in' the welding rod Welding rod stretched Uneven heating of rod
Inadequate bonding	Incorrect preparation Poor welding technique Incorrect welding speed Incorrect welding speed Incorrect welding rod for job Incorrect welding temperature selected
Carbonisation of repaired area (charming)	Welding temperature too high Uneven welding speed Workplace temperature too low
Warping	Shrinking of work-piece Overheating Incorrect preparation of work-piece Parts fixed under tension or pre-load
Deformation	Overheating of welded joint Welding speed too low Welding rod too thin
Poor weld preparation	Poor preparation Inadequate gap Welding rod too thick Welding speed too fast
Porous weld	Porous welding rod welding rod too large welding rod stretched welding speed too fast

9.0 The plastic weld gun

If the damage passes behind a decorative of protective trim this must be removed from the damage component to provide complete access to the repair area. Trims are usually fixed with an adhesive that softens with heat treatment. Attempting to remove a trim that is cold can damage it beyond repair. Moving the hot air tool over the trim surface aids even heat absorption to soften the adhesive. It also prevents localised heat build-up. When the adhesive is soft the trim should pull away nearly allowing re-use after the repair. Precautions apply when heating or burning off protective under body coatings, use breathing apparatus. This process is also useful for removing stripes, stickers, etc…

9.1 Repairing plastic using the bonding process

Adhesive Bonding Process

An alternative to welding or fusing on thermoplastic components is the use of adhesives. It should be noted that this method is the only one that may be used on repairs to thermosetting materials. The precaution procedure used is broadly the same as that for welded repairs. Firstly, clean the area to be repaired using a suitable solvent degreaser, then shape any splits and tears to a "V" section using a sanding disc. Sand the underside of the repaired area to aid adhesion. If a two-pack adhesive is to be used, mix the material to the correct ratio on a non-porous mixing plate. Apply the adhesive to the damaged area, together with glass-fibre matting if necessary

to the underside of the repaired area to enhance strength in the case of structural components. Coat the matting with adhesive. Where the work-piece is made from Acronitrile Butadiene Styrene (ABS) it is advisable to use acetone as the bonding medium. Apply the acetone to the damaged edges and allow the resulting chemical reaction to bond them together.

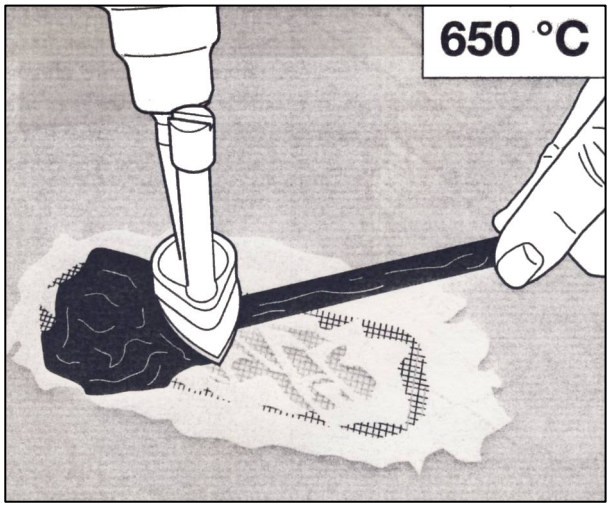


Figure 17: Adhesive Bonding

10.0 Sanding Techniques

Sand smooths any unevenness to leave a paintable surface. After sanding preparing the repaired area, subsequent refinishing is carried out according to the vehicle manufacturer's or paint supplier's paint system.

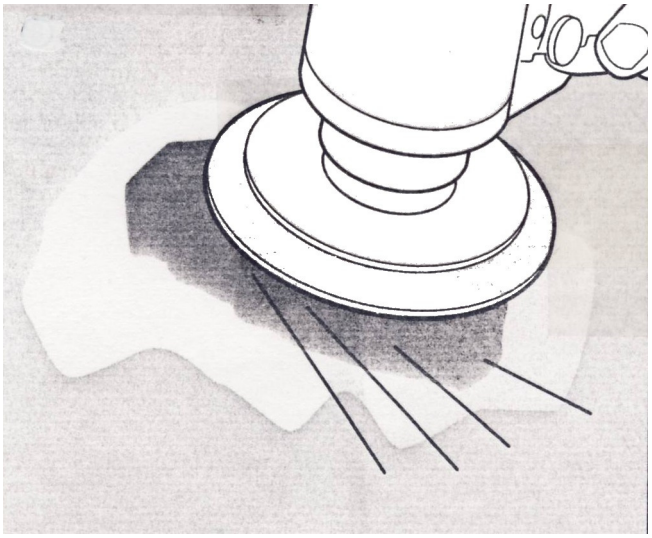


Figure 18: Sanding Techniques

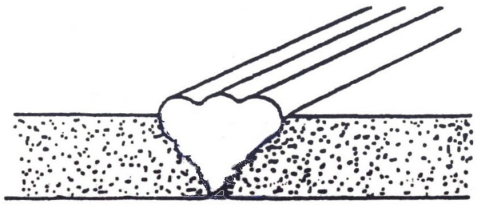


Figure 19: Before Sanding

A successful weld forms a slightly raised smooth, even bead across the component surface. Welds must be flatted only when they are cold, warm welds will clog the sanding disc. Remember that plastic is a soft material that yields easily to abrasives, for this reason use a 120 grit disc first then progress to 180 and finally 320 to produce a smooth finish. Always use new clean, sharp papers. Allow a 7cm to 10cm margin around the weld area for dressing to provide a key for painting.

Figure 20: After Sanding

The weld should be flatted with a 120 grit abrasive disc followed by 180 and 320 grit to obtain a smooth finish. Further smoothness can be obtained using a fine abrasive paper. Prepare up to 10cm each side of the weld but beware of over flatting.

Summary

The Case for Plastic Repairs

When checking the financial feasibility of a plastic repair is whether or not the cost of doing so is lower than that of renewing the component. Although this is the case in many instances the part is very often renewed unnecessarily.

The reasons for this unnecessary action are usually lack of technical knowledge concerning the repair, an unwillingness to accept new ideas, the perception that it is not commercially viable or the need to move stocks of new parts.

In experience, repair is a viable alternative to renewal and can involve minimal capital outlay and training. This is of particular relevance in view of the non-biodegradability of plastics together the twin aspects of environmental legislation and the need for recycling. In short the need to recycle plastics has never been stronger.

Self-Assessment

Questions - Module 1. Unit 6

1. Explain the term GRP

2. Can polyester be welded?

3. Give the identification initials for polyurethane.

4. Give the identification initials for polypropylene.

5. How are plastic cracks prepared for welding?

6. How is a crack prevented from further lengthening?

7. What is thermosetting plastic?

8. What is thermoplastic plastic?

9. If a crack is more than 12 inches long is it cost effective to weld it?

10. Where would you put stitches when repairing a cracked bumper?

Answers to Questions 1-10. Module 1. Unit 6.

1.

Glass Reinforced Plastic

2.

No

3.

PU

4.

PP

5.

Rotary burring tool

6.

By drilling a 3mm hole in each end of the crack.

7.

A non weldable plastic

8.

A weldable plastic

9.

No

10.

Put the stitches on the back where they are hidden.

Suggested Exercises

- Select, assemble and operate safely the plastic welding hot gun. Set the correct temperature on the weld gun. Weld and repair plastic body component to specifications.
- Repair plastic bumper using bonding agent.

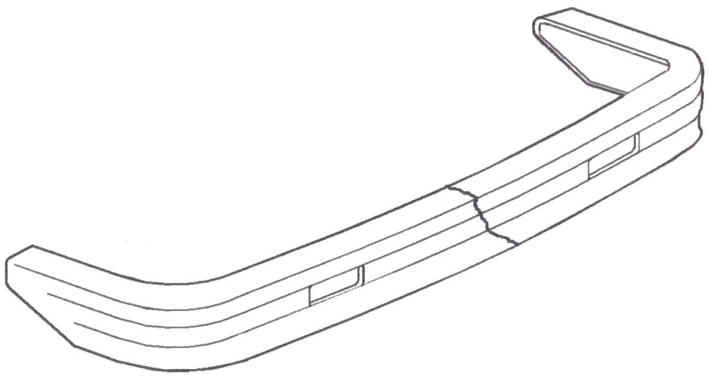
Suggested Exercise.

Instructions

Identify plastic, select suitable welding rod, assemble gun and set temperature. Prepare plastic component for welding, weld plastic bumper cover, repair body component ready for spraying. Remove broken sections, chamfer edges, apply adhesion promoter and bond components using reinforcements. Sand off excess material and repair body component ready for spraying.

Tools and materials

- Safety equipment
- Plastic welding hot gun
- Welding rods
- Identification kit
- Rill bits
- Vacuum sander and discs
- Files
- Various types of sandpaper
- Router
- Clamps
- Bonding kit
- Plastic components



Dimensions	Gen. tol.	Scale	Material
mm		nts	
PLASTIC WELDING-REPAIR			
SOLAS	Phase 2. Mod 1. Practice		

Training Resources

- Classroom/workshop
- Plastic welding hot gun
- Nozzles and tips
- Various plastic welding rods
- Module handouts
- Identification kit
- Drill and burring bits
- Vacuum sander and various types of sanding discs and paper
- Clamps
- Personal protection equipment

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

27-33 Upper Baggot Street
Dublin 4