

# TRADE OF VEHICLE BODY REPAIR

PHASE 2

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**Module 4**

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**UNIT: 2**

**Glazing**



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## Introduction

Since the introduction of legislation on the compulsory wearing of seatbelts for front seat passengers in the early 1980s both the type and style of glass fitted into windscreens have changed. Prior to 1980 toughened glass which shatters into tiny relatively harmless pieces when broken and which can dangerously obscure a drivers vision was used by many vehicle manufacturers. This glass was indirectly glazed onto the body and secured using a self tensioning rubber weather strip fitted to the aperture. With the seatbelt legislation in force however safety standards were improved bringing an increased use of laminated glass which is the type that remains in place when broken and therefore allows the driver to continue the journey.

This resulted in a change in glazing methods with laminated glass being increasingly secured by the process of direct glazing. This is a method if fitting a glass unit to a vehicle by chemically bonding it to the prepared aperture using specialized compound sealants. This method provides two definite design benefits. It gives an aerodynamic profile and also increases the strength of the windscreen thus making it safer and more weather resistant. As well as being easier to fit on the production line the majority of direct glazing is now done by robots. A direct glazed windscreen can also be replaced to its original specification without affecting the structural integrity of the vehicle.

# Unit Objective:

## *Glazing*

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

- Safely remove and refit a direct glazed windscreen
- Safely remove and refit an indirect glazed glazing system
- Identify laminated and toughened glazing systems
- Choose appropriate tools for the removal of direct and indirect glazing systems
- Inspect and carry out leak testing on fitted windscreen

### ***Key Learning Points:***

- Properties of laminated glass
- Characteristics of toughened glass
- Direct glazing bonding techniques
- Indirect glazing weather-strip removal and refitting techniques
- Leak detection methods
- Sealing of glazing components

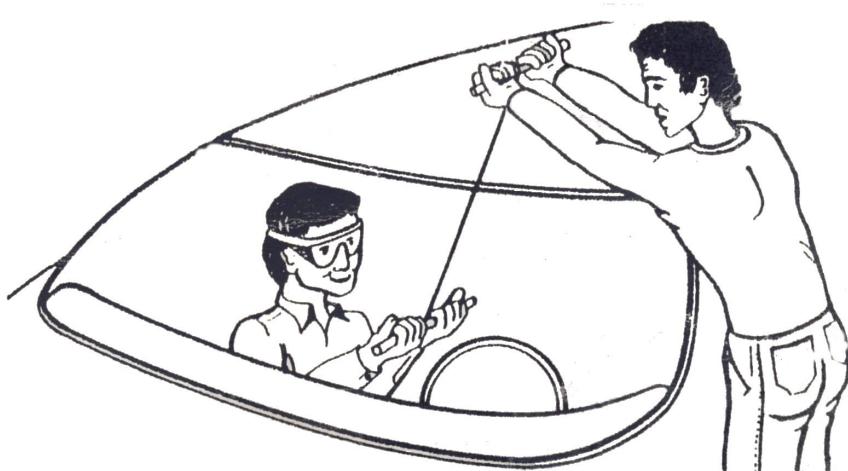
# 1.0 Windscreen Removal

## Windscreen – Numerical Order of Removal

1. Wiper arms and blades
2. Scuttle panel grille
3. Outer side trims and retainer clips
4. Upper outer moulding
5. Glass support brackets
6. 'A' post upper trims
7. Interior lamp
8. Rear view mirror
9. Sun visors
10. Remove screen using cutting wire, see method

### Cutting Wire Method

- Protect paintwork
- From inside the vehicle push one end of cutting wire through screen sealer approximately 10cm down from either top corner. Tie off outside wire end to a 'T' handle and inside wire end to a wire spike tool. Aided by a second person carefully cut around the screen to remove.



**Figure 1:** Cutting Wire Method

## 2.0 Appropriate Tools for the Removal of Direct and Indirect Glazing Systems



Piano/Cheese Wire



Air Removal Tool



Cord Removal Kit



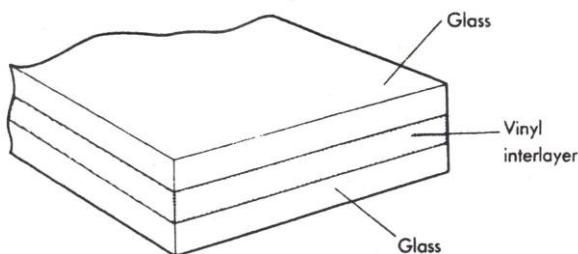
Suction Pads

## 3.0 Safe Removal and Refit an Indirect Glazed Glazing System

### 3.1 Characteristics of Toughened and Laminated Glass

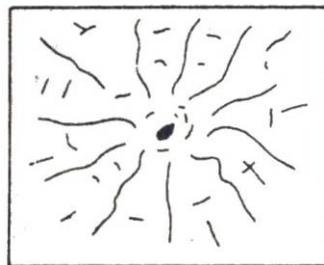
#### Indirect glazed windscreen removal and replacement

The two basic types of safety glass used in the car windscreen are laminated and toughened. Laminated glass is of a sandwich construction and consists of two pieces of thin glass one on either side of and firmly united to a piece of transparent reinforcing known as the interlayer (figure 2). Although such a glass may crack forming a spider web pattern it holds together and the panel remains in one piece except under conditions of the most violent impact. Toughened glass is produced by process of heating a solid piece of glass and then rapidly cooling it so that its liability to fracture is greatly reduced and its strength increased to about six times that of untreated glass. If fracture should take place the resulting fragments consist of very small comparatively harmless particles (Figure 3).

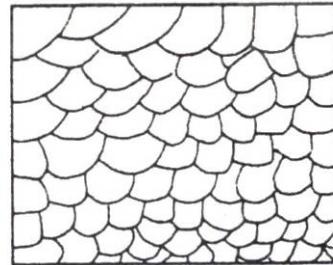


**Figure 2:** Laminated Glass

In major accident damage removal and replacement of the windscreen is an essential feature of the repair. Many windscreens and rear windows are held in place by a rubber weather strip which is usually of single piece construction. Both glass and any outside trim mouldings if used are recessed into the weather strip. It also has a recess which fits over the body flanges all round the opening for the glass. It is this portion of the weather strip that holds the entire assembly in place.

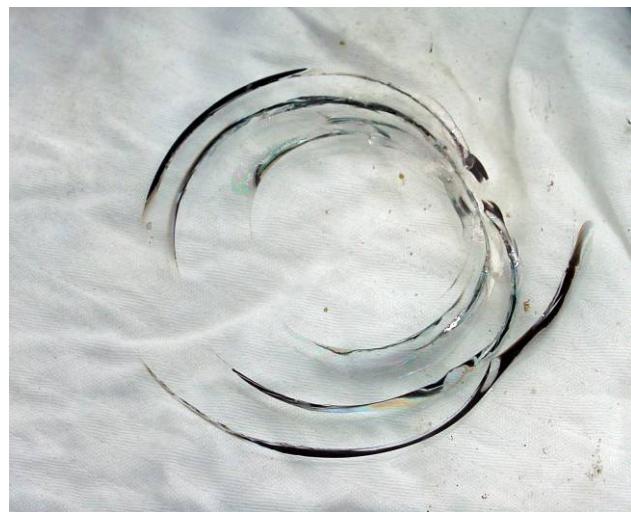


Typical fracture of  
laminated glass



Example of toughened glass  
after fracture

**Figure 3:** Characteristic Breaking Pattern of Laminated and  
Toughened Glass

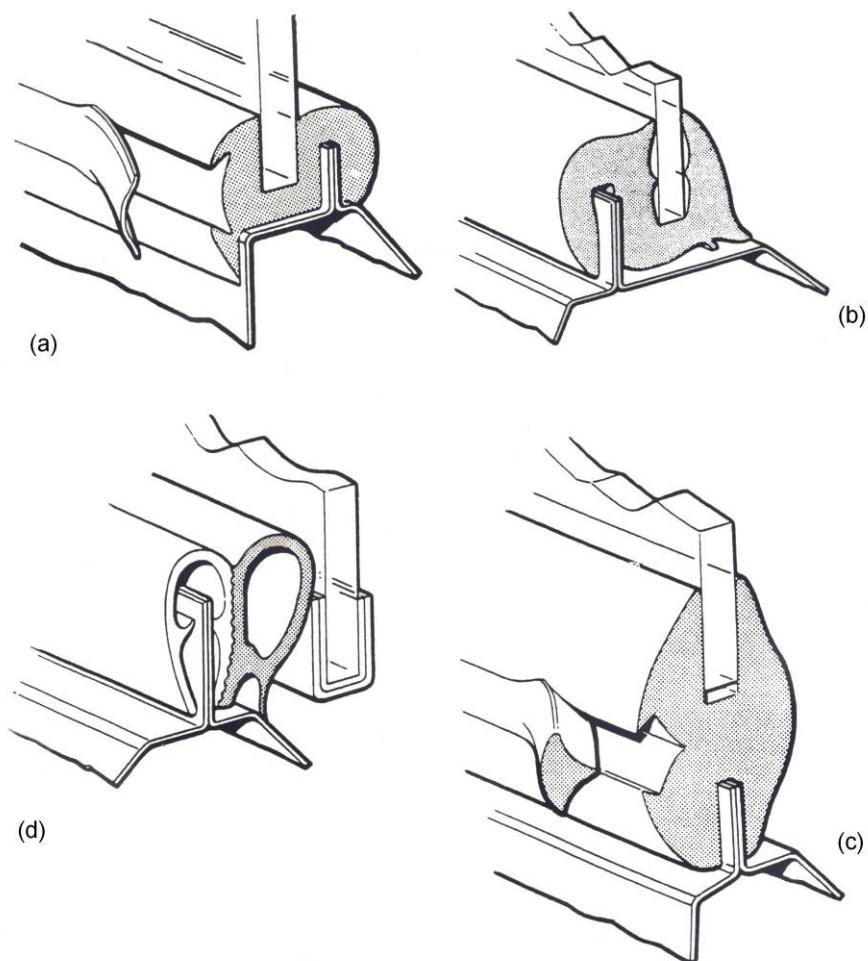


Laminated Glass when Broken



Toughened Glass when Broken

Indirect types of glazing systems can be identified for each specific model by referring to the body section of the relevant manufacturer's repair manual. The rubber weather seals used are mastic sealed, dry glazed, self sealing or push fit (figure 4). The self sealing types are held in place by a removable centre filler strip and can be mastic sealed or dry glazed (Figure 4c). All the systems are used with either a rubber weather strip moulding with a sealing compound (Figure 4a) or a rubber weather strip moulding without a sealing compound (Figure 4b). The rubber weather strip has two rebates one for glass and one to seat over the metal flange of the body aperture. It is the contact area of the aperture that requires careful attention whenever the glazing is disturbed or removed. In all cases it is essential that the aperture is correctly painted prior to refitting any of the weather seals.



**Figure 4:** Indirect Glazing System

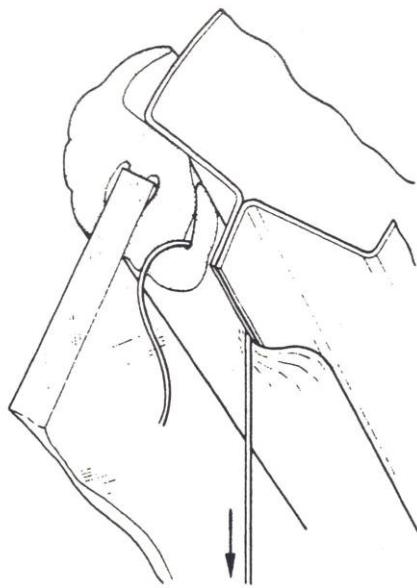
- (a) Mastic sealed
- (b) Dry glazed
- (c) Self-sealing
- (d) Push fit

### 3.2 Weather Strip Removal and Refitting Techniques

In order to remove a windscreen which is fitted with self tensioning weather strip the following procedure must be carried out. First cover the bonnet to protect the paintwork. Then working from the inside of the car, remove any instrument panel mouldings or trim which may interfere with the removal of the windscreen. Also working from the outside of the vehicle, remove any windscreen chrome mouldings which may be fitted into the weather strip. Again working from the inside and starting from one of the top corners pry the rubber weather strip off the body flange with a screwdriver. At the same time press firmly against the glass with your hand adjacent to the portion of the rubber lip being removed or bump the glass with the palm of the hand; this should force the entire assembly over the body flange. The windscreen can then be removed from the body opening.

To replace the windscreen first clean the glass channel in the rubber weather strip to be sure that all traces of sealer and any broken glass are removed. Place a bead of new sealing compound all round the weather strip in the glass channel. Work the glass into the glass channel of the weather strip and be sure it is properly seated all the way round. Lay the windscreen on a bench suitably covered to prevent scratching so that the curved ends are pointing upwards and in this position the pull cords used to seat the rubber lip over the body flange can be inserted into the metal channel on the weather strip (Figure 5). One or two cords may be used. Where two cords are normally used they can be pulled in opposite directions which will make the fitting of the windscreen easier. Commence with one cord from the bottom right hand side of the windscreen, leaving about one foot spare for pulling. Start the second cord from the bottom left hand corner and proceed to the right following round up to the top left hand corner. Apply sealer all round the metal lip on the body aperture. Place the entire unit in the windscreen opening with the cord ends hanging inside the vehicle. An assistant can help by pressing against the glass from the outside while each cord is pulled out of the groove. As the cord is pulled out the rubber lip is seated firmly over the body flange. A rubber mallet can be used to tap the unit around the outside so as to seat the entire windscreen assembly firmly in place. Any surplus sealer can be cleaned off with white spirit.

The procedure for removing a windscreen fitted with self sealing weather strip is first to locate the joint in the filler strip which runs right through the centre of the weather strip. The strip is then carefully eased up and pulled out slowly around entire assembly.



**Figure 5:** Using Pull Cords to Fit Windscreens

This relieves the tension on the glass which can then be lifted out of the weather strip by easing one corner first. To replace this type of windscreen the metal lip on the body aperture is sealed with a sealer the appropriate channel in the weather strip is then placed over this lip and seated all the way round

the body aperture. The windscreen is fitted into the glass channel on the weather strip with the aid of a special tool which enables the glass channel lip to be lifted thus allowing the glass to slip easily into position. A small brush is needed to apply a solution of soap and water to the filler channel. This assists the filler strip installation. A specially designed tool is used to insert the filler strip into its channel.



### Indirect Glazing Removal/Replace Kit



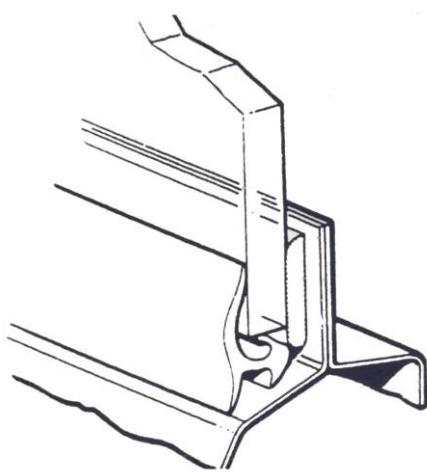
## 4.0 Safe Removal and Refit of a Direct Glazed Windscreen

### 4.1 Direct Glazing Bonding Techniques

The method of direct glazing of windscreens also known as bonding is very popular with motor manufacturers. This process involves the bonding of glass into the aperture. Some of the advantages claimed for direct glazing are as follows:

1. Increased rigidity and strength caused by integration of the glass into the body of the vehicle reducing the need for supporting members and improving visibility with enlarged glass areas.
2. Weight reduction.
3. Improved aerodynamics by deletion of rubber surrounds aiding fuel economy.
4. A better seal against the weather eliminating the need for resealing and rusting.
5. Increased protection against car and contents thefts.

Various bonding materials are used in direct glazing. Some require heating to induce a chemical reaction to create adhesion whilst others will cure at room temperature. Polyurethane and silicone materials are usually supplied as a pumpable tape. They are cold cured and the material is dispensed on to the glass through a specially formed nozzle out on the end of a cartridge. This can be done with the aid of a hand operated or compressed air cartridge gun. These materials are highly viscous in their uncured state enabling a high degree of maneuverability within the glass aperture to ensure a good seal.



**Figure 6:** Direct Glazing with Moisture-cured Polyurethane

The sealant itself is either one or two component polyurethane. The latter contains an accelerator compatible with the adhesive this is applied evenly to the perimeter of the windscreen (figure 6). Once this is achieved the glass is placed into the aperture using glass suckers and aligned before securing.

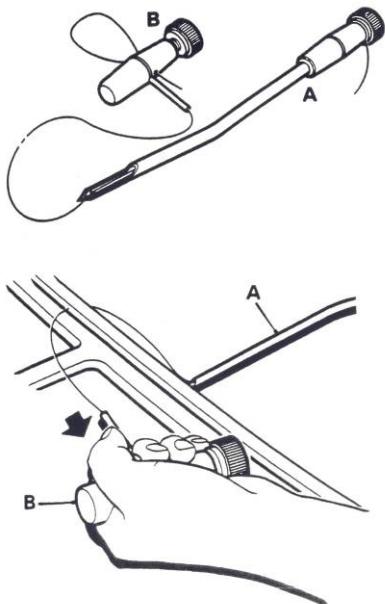
When a one component polyurethane is used the car can be driven away in four to six hours: if a two component polyurethane is used it takes only 30 minutes to cure, allowing the vehicle to be back on the road within an hour of the repair starting.

To remove the glass from the vehicle the bonding material has to be cut. This can be achieved by using piano wire, a special cutter or a hot knife, as follows:

### Piano wire

Before using this method of removal there are certain safety precautions that should be observed. Gloves should be worn to

protect the hands and safety glasses or goggles should be used for eye protection in the event of the wire or glass breaking. When the finishers or mouldings have been removed to expose the bonded area of the glass the wire has to be fed through the bonding. This is done by piercing a hole through the bonding and feeding the wire through with the aid of pliers. Handles can be fixed to the ends of the wire to allow a pulling action (Figure 7).



**Figure 7:** Removing Direct Glazing using a Piano Wire



## Pneumatic or electric cutter (oscillating)

This is an air or electric powered tool to which special shaped blades to suit specific vehicle models are fitted. The tool removes windscreens that have been bonded with polyurethane adhesives.



**Electric Windscreen Cutter**

## Hot knife

The hot knife can be used by one person cutting from the outside of the vehicle. It can cut round the average bonded windscreens and clean off the excess remaining adhesive while minimizing the risk of damaging the car bodywork. Before use, all trim around the windscreens both inside and outside should be removed. The cutting medium is provided by a heated blade which is placed under the edge of the glass and pulled around the perimeter melting the bonding to release the windscreens. It is used in conjunction with an air supply which constantly blows on to the cutting area of the blade. This prevents the heat dissipating along the blade and gives a constant temperature as well as eliminating smoke and fumes emitted from the cutting operation. Overheating can result in toxic fumes being given off and a charcoal filter mask should be worn as a safety precaution.

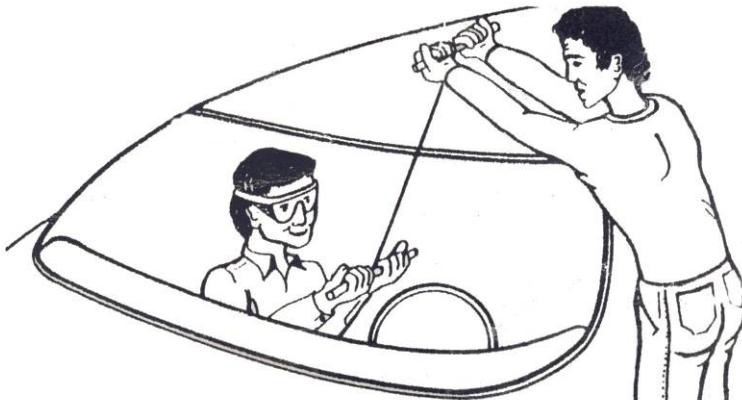
Before glazing can be replaced the bonding surfaces must be prepared correctly. The residue of the original sealer left in the aperture has to be trimmed to ensure there is a smooth layer for the new sealer to adhere to and to allow the glass to seat in the correct position. Various sealants for windscreens replacements are available.

The surfaces are then prepared with the materials included in the individual manufacturers glass replacement kit that is sealer application gun with bonding material, suction cups and leak test equipment and following the instructions provided. There is little variation in the sequence of operations which is typically as follows:

## 4.2 Instructions

### Please read carefully

1. Cut out the damaged windscreen using a power tool, piano wire or braided cutting wire. Braided cutting wire is particularly effective on the toughest polyurethane sealants and will not easily kink or break. Carefully examine the residue of sealant left on the body aperture. If the damaged windscreen was bonded with a non polyurethane sealant (e.g. cold butyl kit, hot electro bond kit, silicone etc) all the old sealant MUST be removed. If you are in any doubt as to the type of sealant that was used we would strongly advise the removal of ALL the old sealant.



2. Using a sharp knife trim and level off sealer remaining in the vehicle windscreen aperture. Remove loose sealer. Areas where bare metal is exposed must be treated with etch primer.
3. If the original windscreen is to be refitted level off the remnants of the old sealer. Take care not to damage the black ceramic edging.
4. Apply the cleaning solvent provided in the repair kit to the windscreen aperture and the inboard edges of the screen then wipe both aperture and screen with a clean cloth.



**When working with solvents and primers use PVC gloves or apply barrier cream to hands.**

5. Take the spacer blocks from the repair kit, remove the adhesive backing and fit them in the original position on the windscreens aperture. Ensure that the differently shaped blocks are located correctly.
6. Fit the suction cups to the outer face of the windscreens and place the screen in the vehicle. Centralize the screen in the body aperture. Take strips of masking tape and attach them across the join between the body and the screen. These strips afford a guide when finally fitting the screen after sealant has been applied. Cut the masking tape strips at the glass edges and remove the screen.
7. Shake the tin containing the glass primer for at least 30 seconds. Then using the felt swab apply the primer evenly along the screen perimeter. When dry wipe with a clean cloth. Repeat the above process this time by cutting the applicator head and using it to apply a coat of primer 17mm wide (0.7in.) to the windscreens aperture. Assuming you have chosen to remove all the existing sealant the body aperture and windscreens perimeter MUST be cleaned and allowed to dry for approximately 3 minutes. Both surfaces MUST then be primed and allowed to dry for a further 3 minutes before sealant application. (Never use a butyl primer with polyurethane sealant).
8. Immerse a cartridge of sealer in water at a temperature of 60°C for approximately 30 minutes. Pierce the sealer cartridge in the centre of its threaded end and fit the pre-cut nozzle. Remove the lid from the other end, shake out any crystals present and install the cartridge in the applicator gun.

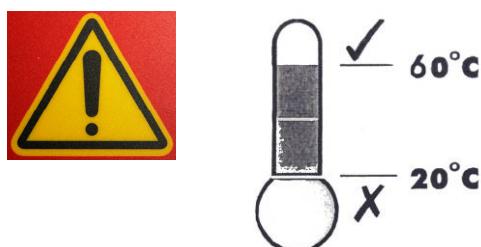


Figure 8

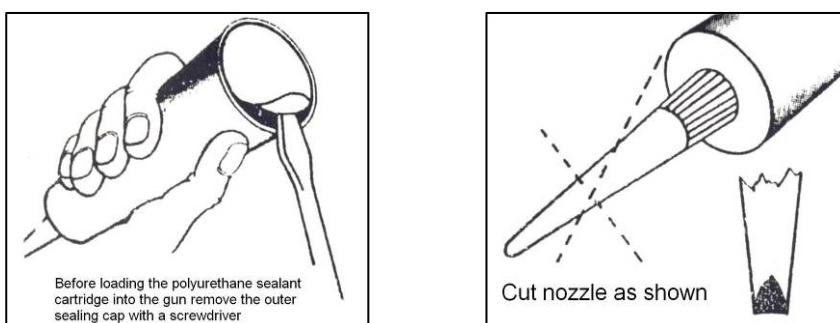


Figure 9: Installing the Polyurethane Cartridge into the Gun



Sealer and Sealer Gun

9. Apply the sealer in a smooth continuous bead around the edge of the windscreen. The sealer bead should be 12mm (0.5in.) high and 7mm (0.25in.) wide at its base. The sealant may be applied to the body aperture or windscreen as preferred. Should you wish to apply the sealant to the windscreen you will require suction cups to lift the windscreen into position.

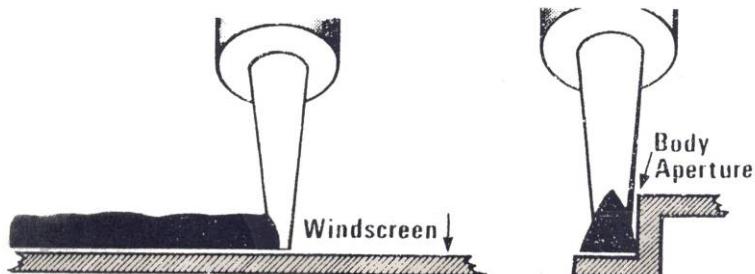


Figure 10: Applying Sealant



Figure 11: Applying Sealant to Windscreen

10. Lift the screen using the suction cups and offer it up to the vehicle top edge leading. Carefully align the masking tape strips then lower the screen into position. Remove the suction cups.



11. Testing for leaks using either leak testing equipment or spraying with water may be carried out immediately.

**Caution:** If a leak or leaks are detected apply sealer to the area and retest. Do not remove the screen and attempt to spread the sealer already applied.

12. If leaks are not present fit the windscreen finishers. Heat the windscreen finishers to 45°C and commencing at one end of the screen lower corners and press into position around its entire perimeter. Remove the fascias protective covering. Trim the lower spacer blocks. Fit retaining clips as necessary.
13. Fit the windscreen wiper finisher panel and air intake mouldings and the wiper arms and blades.

**Caution:** Do not slam the vehicles doors with the windows fully closed until the screen is fully cured.

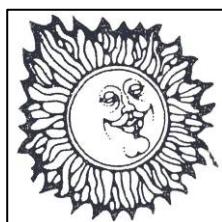


The integrity of the vehicles safety features can be impaired if incorrect windscreen replacement bonding materials and fitting instructions are used. The manufacturer's instructions should be adhered to.

## 5.0 Cure and Drive-Away-Time

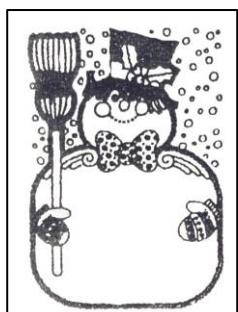
**AUTOBOND ZR 400** is the fastest one part moisture curing polyurethane sealant on the world market. The sealant cures at the rate of 6mm per 24 hours provided the temperature is at least 20°C with 65% relative humidity. Because less sealant is used with the “short cut out methods”, cure and drive-away time is reduced. We therefore recommend the following:

### Summer



In the summer time the vehicle can be returned to normal service one hour after front windscreen replacement. We recommend a 2 hour drive-away- time for rear windscreens and side lights.

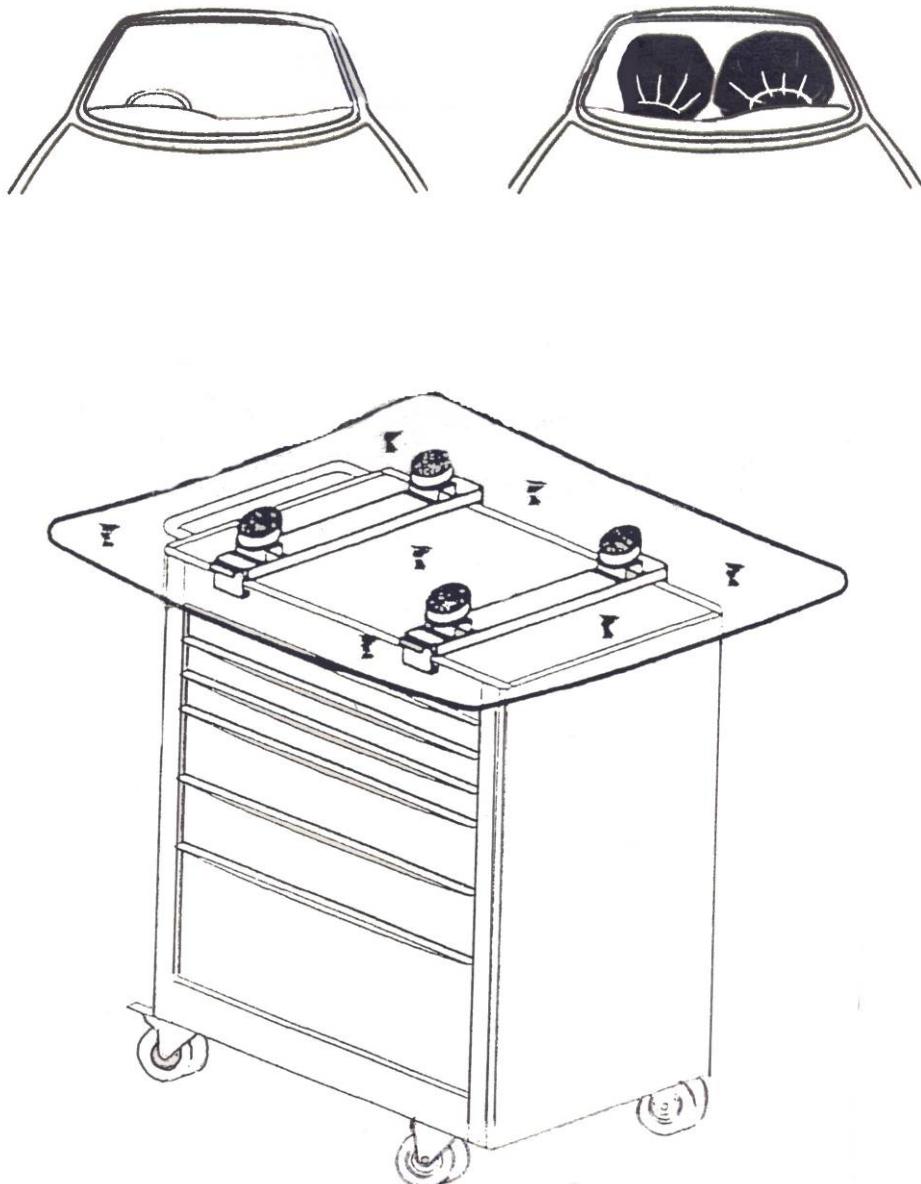
### Winter



In winter conditions the vehicle can be returned to normal service after front windscreen replacement. We recommend a 4 hour drive-away time for rear windscreens and side lights. Cure time and performance of all polyurethane sealants is affected should the temperature drop to below +5°C. In these conditions it is advisable to keep the vehicle indoors for longer and/or use the vehicle heater and blower to accelerate cure time. If in any doubt please contact our Technical Department who will be pleased to offer practical advice and further assistance if required.

## 6.0 Airbag

See instruction on product for drive-away time for windscreen replacement on vehicles with airbags.



**Figure 12:** Glass Trolley

# 7.0 Inspect and Carry out Leak Testing on Fitted Windscreen

## 7.1 *Leak detection methods*

The general principles for searching for the actual location of where water leaks could potentially occur on the vehicle are not specific to any particular model and can apply to all vehicles.

First start by obtaining as much information as possible from the customer as to when, where and how the leak occurs and also whether the water appears to be clean or dirty. If these facts are not known, considerable time could be spent checking the wrong areas of the vehicle.

### Tools and equipment

The following tools and equipment are recommended:

- Garden spray (hand pump pressure type).
- Wet/dry vacuum cleaner.
- Torch.
- Seal lippling tool
- Trim panel removing tool
- Small wooden or plastic wedges
- Dry compressed air supply
- Hot air blower
- Sealant applicator
- Ultrasonic leak detector

### Locating the leak

Locating the source of the water leak involves a logical approach together with a combination of skill and experience. For the purpose of locating the leak the vehicle should be considered in three specific areas: the front interior space, the rear passenger space and the boot space. From the information provided by the customer the body repairer should be able to determine which area is the right one on which to concentrate. Having identified the area of the leak, the repairer must find the actual point where the water is entering the vehicle. An ordinary garden spray of type which can be pressurized and adjusted to deliver water in the form of a very fine spray or a small powerful jet has been found to be very

effective in helping to locate most leaks. Using a mirror and torch will help to see into any dark corners.

## Testing

The sequence of testing is particularly important. Always start at the lowest point and work upwards. The reason for this is to avoid masking a leak in one place while testing in another. If for example testing was to commence around the windscreen water cascading down could leak into the car via the heater plenum or a bulkhead grommet. However it could be wrongly assumed that the windscreen seal was at fault.

The visible examination of door aperture seals, grommets and weather strips for damage, deterioration or misalignment as well as the actual shut of the door against the seals are important parts of identifying an area where water can pass through.

### Leak detection using ultrasonic equipment

When the vehicle is in motion the body shape may produce eddy currents and turbulence which can force air and water through the smallest orifice. When the vehicle is stationary it can be difficult to reproduce these conditions to a realistic level.

The ultrasonic equipment works on the principle of a transmitter creating ultrasonic waves which penetrate the smallest orifice in the vehicle body and are then picked up by a receiver fitted with a suitable probe which can in turn pinpoint the exact leak point. The transmitter is placed in a base plate which automatically switches it on via a reed switch in the base of the transmitting body. Ultrasonic waves will then penetrate out through the unsealed area, including the front windscreen, wiper spindle and washer jet fitment, roof seams bulkhead seams and grommets, A-post area, door seals, front wheel arch seams and heater air intakes to the receiver.

An important feature of this equipment is the incorporation of a sensitivity control which enables the operator to check a wide range of fitments. For example a boot seal is a very light touch seal whereas a urethane screen fitment is at the other end of the scale setting of the equipment and would need a high setting to determine a leak.

To ensure satisfactory leak location and testing it is recommended not to use a leak detector on a wet vehicle which should be blown prior to the test. As with any equipment it is important to read the instructions to enable the equipment to be used to its full potential.

## Sealing

Having located the point of the water it is then necessary to carry out satisfactory rectification. Door aperture seals and weather strips should be renewed if damaged or suffering from deterioration. Alternatively the seals can be adjusted by carefully setting the mounting flange after making sure the fit of the door is correct.

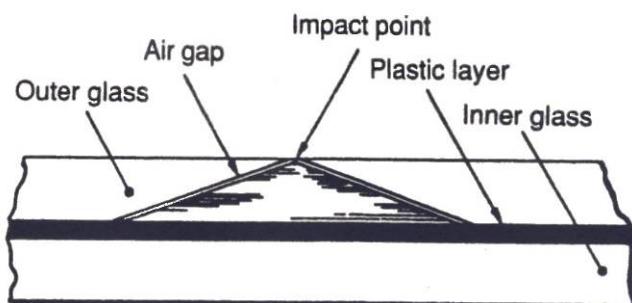
Leaks through body seams should be sealed from the outside wherever possible to ensure water is excluded from the seam. First dry out with compressed air or a hot air blower.

When leaks occur between the glass and the body, avoid removing the glass if possible. Use recommended sealers to seal between the glass and the weather strip or the body.

If the vehicle is wet then it should be blown dry prior to sealing. It is difficult to seal a wet vehicle because if a fault is found it cannot be rectified quickly before moving to another area.

### 7.2 Windscreen repair: Glass Weld Pro-Vac

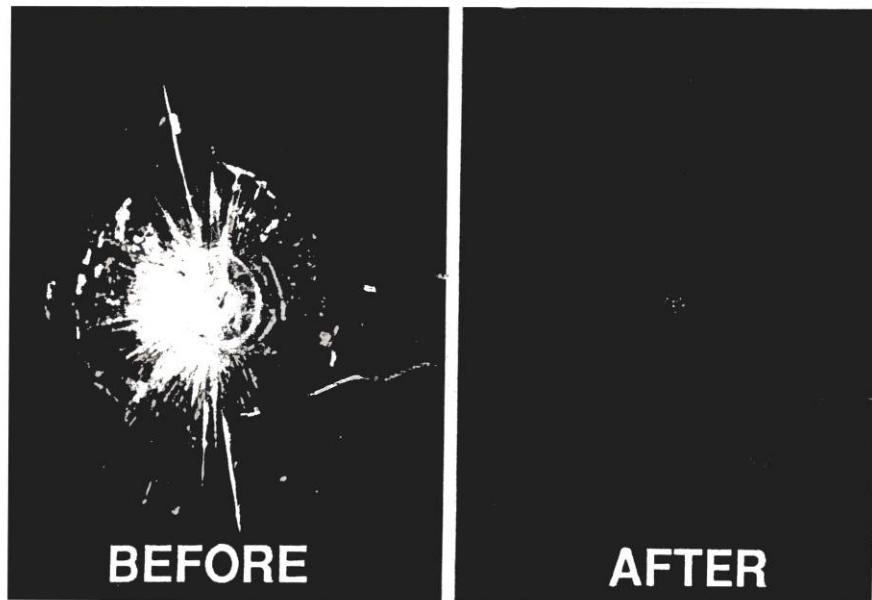
This system of repair involves extracting all the air from the damaged glass and replacing the void with a resin which when cured with ultraviolet light, is optically clear and is stronger than the glass that has been replaced. The system is widely accepted and repair to Glass Weld standard would not cause the vehicle to fail the statutory Department of Transport test for windscreens: 80 per cent of stone damaged windscreens can be repaired by this method.



**Figure 13:** Damaged Windscreen (Laminated Safety Glass)

When glass breaks an air gap opens up. Sometimes crushed glass may also be present inside the glass on either side of the air gap. These three things result in the visibility of the damaged area being

affected. The damage will eventually spread further as the temperature changes and the vehicle flexes in normal use.



**Figure 14:** Before and After Repair



Before Repair



After Repair

## **7.3 Repairing Chips in Laminated Glass**

**The System Works, as follows:**

- All foreign materials and crushed glass are carefully removed from the centre of the damaged area to open up an airway into the break. Certain types of damage may need to be precision drilled.
- The patent Pro-Vac injector is filled with the appropriate resin, depending on local temperature and humidity, before being mounted on the screen. The injector is then threaded through the stand until the outer seal makes airtight contact with the screen.
- The Pro-Vac injector is capable of creating a total vacuum within the damaged area, which is essential for top quality repairs. Using alternative vacuum and pressure cycles, all of the air in the break is withdrawn and the void is filled with resin. Once the damage is optically clear, curing can commence.
- Using a special ultraviolet lamp, the resin is cured. Once the curing process is complete the repair area is not only optically clear but also structurally sound, in fact is stronger than the glass it replaces.

**Red crack fill = Can repair cracks 5cm long**

**Green polymer 2 = Can repair chips 5mm diameter**

**Instructions:**

- 2 or 3 drops into injector
- 2 bar pressure for 5 mins
- Vacuum for 5 mins
- 2 bar for 10 mins longer if no heat. (heat can be used to speed up repair)
- Release pressure before removing
- Apply patch and turn on ultra violet lamp



Wurth Glass Repair Kit

## Summary

Safety is of utmost importance when glazing because of breaking glass and the possibility of flying piano wire both of these could cause serious injury in the form of cuts and glass getting into eyes, so always wear P.P.E Equipment. Do not take any chances!

Glazing is a vital aspect of vehicle body repair and the correct replace repair procedures are very important because in the event of an accident if a person is not wearing a safety belt the glazing may restrain them in the vehicle, this is not the ideal situation but it may save a life.

## Self Assessment

### *Questions – Module 4. Unit 2*

1. What safety precautions must you take when glazing?

2. What is meant by pinch protection in glazing?

3. What material is used to manufacture front windscreens?

4. What is piano wire used for?

5. What are the characteristics of toughened glazing (broken)?

6. What are the characteristics of laminated glazing (broken)?

7. Is the drive away time different for a vehicle with airbags as opposed to one without?

8. What must you use to fit an indirect windscreen?

9. At what temperature approximately must sealer be when applying it to a vehicle?

10. Approximately what height of bead must be applied to a body aperture?

## ***Answers to Questions 1-10. Module 4. Unit 2***

**1.**

Always wear glasses, gloves, respirator mask, P.P.E

**2.**

Prevent glazing from closing if obstructed.

**3.**

Laminated glass

**4.**

To remove cut-out direct glazing.

**5.**

Breaks into small pieces

6.

Breaks in cracks that run from point of impact.

7.

Yes

8.

Pull cord

9.

Approx 20° - 60°

10.

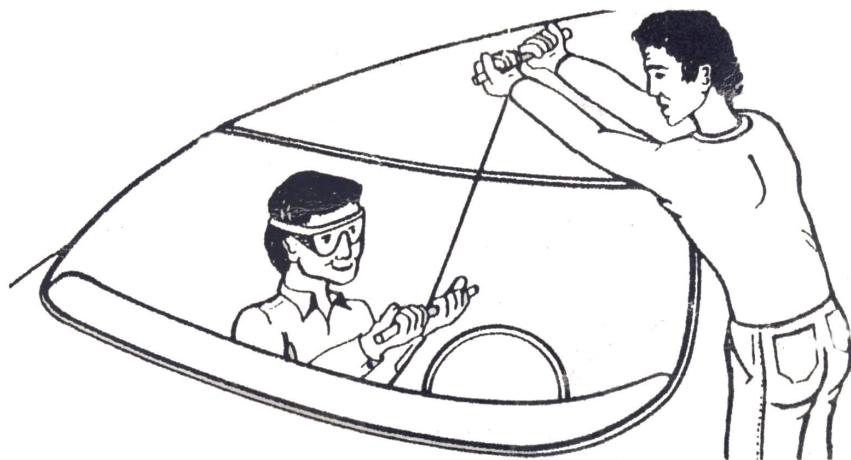
Approx 14mm high

## Suggested Exercise

1. Remove and refit an indirect glazed glass panel. Carry out a leak detection test on the fitted glass.
2. Remove and refit a direct glazed laminated windscreens. Execute an ultra-sonic leak detection test on fitted windscreens.
3. Remove weather strip and mylar strip. Press back internal weather strip lip over window aperture flange. Remove window glass and weather strip. Refit glazing and weather strip by using cord. Insert mylar strip into weather strip. Check for leaks by using water from a hose and seal if necessary.

## Safety

- Always wear appropriate safety mask
- Always wear safety glasses
- Always wear safety gloves
- See P.P.E Equipment



# Training Resources

- Classroom/workshop
- Motor vehicle
- Powered adhesive cut out knife
- Cut out wire and handles
- Suction cups
- Caulking gun
- Adhesive primers
- Cleaners and windscreen
- Bonding material
- Weather strip moulding release tool
- Glass stand
- Cord or wire for fitting weather-strips
- Ultrasound leak detector
- 3/8" drive socket set
- Spanner set
- Various pliers
- Screwdrivers



An tSeirbhís Oideachais Leanúnaigh agus Scileanna  
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