FORD FIG0

Service Manual

2010-2014

FORD FIGO B517

GROUP 5

Body and Paint

SECTION TITLE PAGE

SECTION 501-00 Body System - General Information

VEHICLE APPLICATION: 2010.25 Figo

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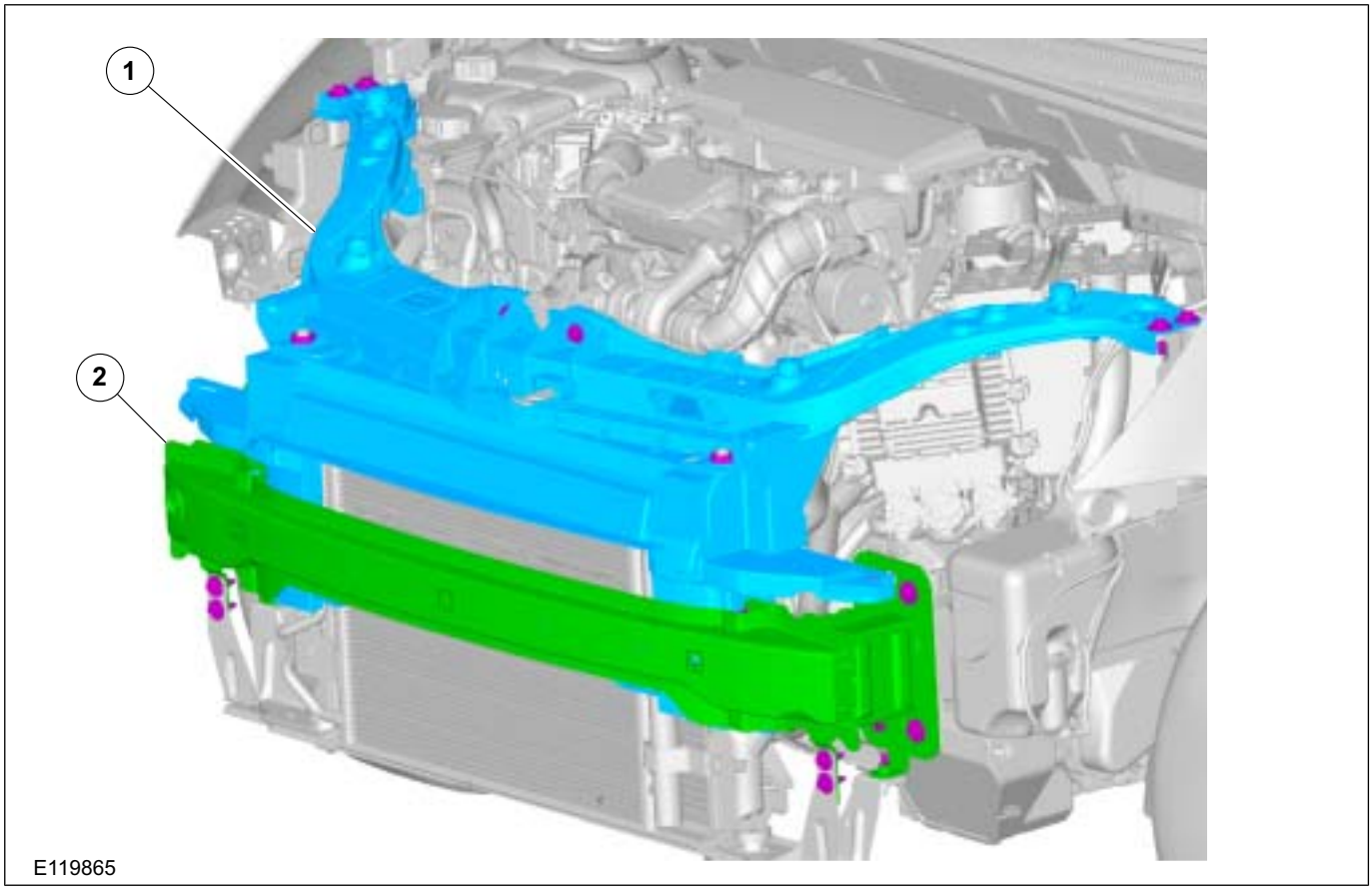
DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

Body

Front end design features

The newly designed front end structure of this model consists mainly of the plastic front end module and the sheet steel crash element.



Item	Description
1	Plastic front end module
2	Sheet steel crash element (crossmember)

This design allows repairs to be performed easily and economically, as the complete front end module can be detached together with the flanged-on assemblies.

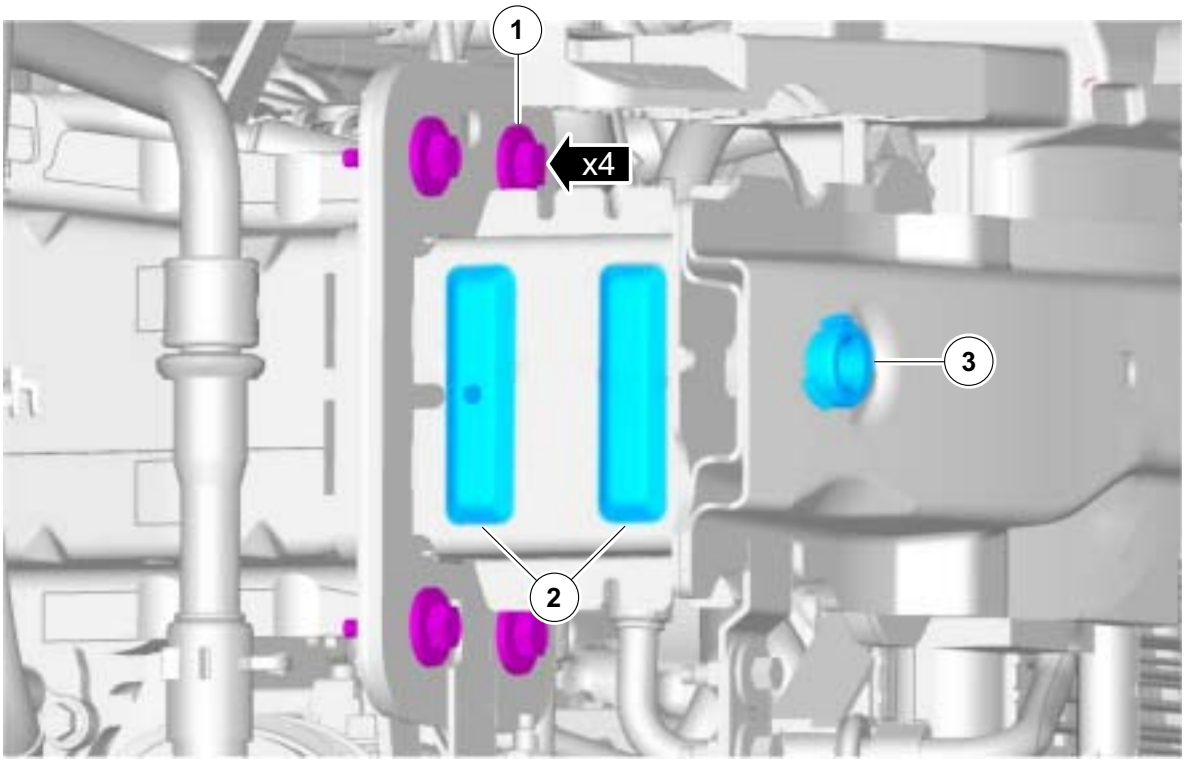
In areas subjected to more severe loads the plastic front end module is additionally reinforced with high-resistance foam.

Plastic front end module

The plastic front end module acts among other things as a mounting for various components like the radiator, radiator fan and hood lock.

DESCRIPTION AND OPERATION

Sheet steel crash element



E119866

Item	Description
1	Securing bolts
2	Designated yield points
3	Towing eye mounting

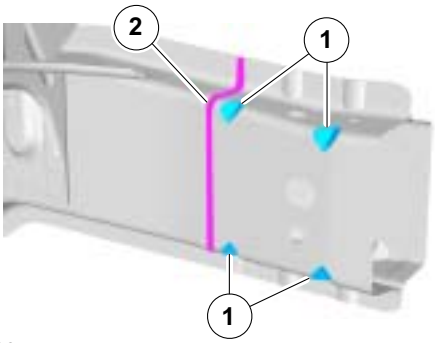
The sheet steel crash element consists of a crossmember to which two crash boxes are welded.

The crash element absorbs the majority of the impact energy in a crash.

Flange plates on the longitudinal members allow the bolted crash element to be easily replaced.

Towing eye mounting

Front longitudinal member



E119867

Item	Description
1	Designated yield points
2	Laser weld seam

As well as the sheet steel crash element, the front longitudinal members also contribute to the passive safety of the vehicle.

DESCRIPTION AND OPERATION

Two additional designated yield points in the front part of the longitudinal members absorb further crash energy.

2-part frame construction in the deformation area - increased ease of repair.

Laser butt weld seam directly behind the crash area - optional sectional replacement.

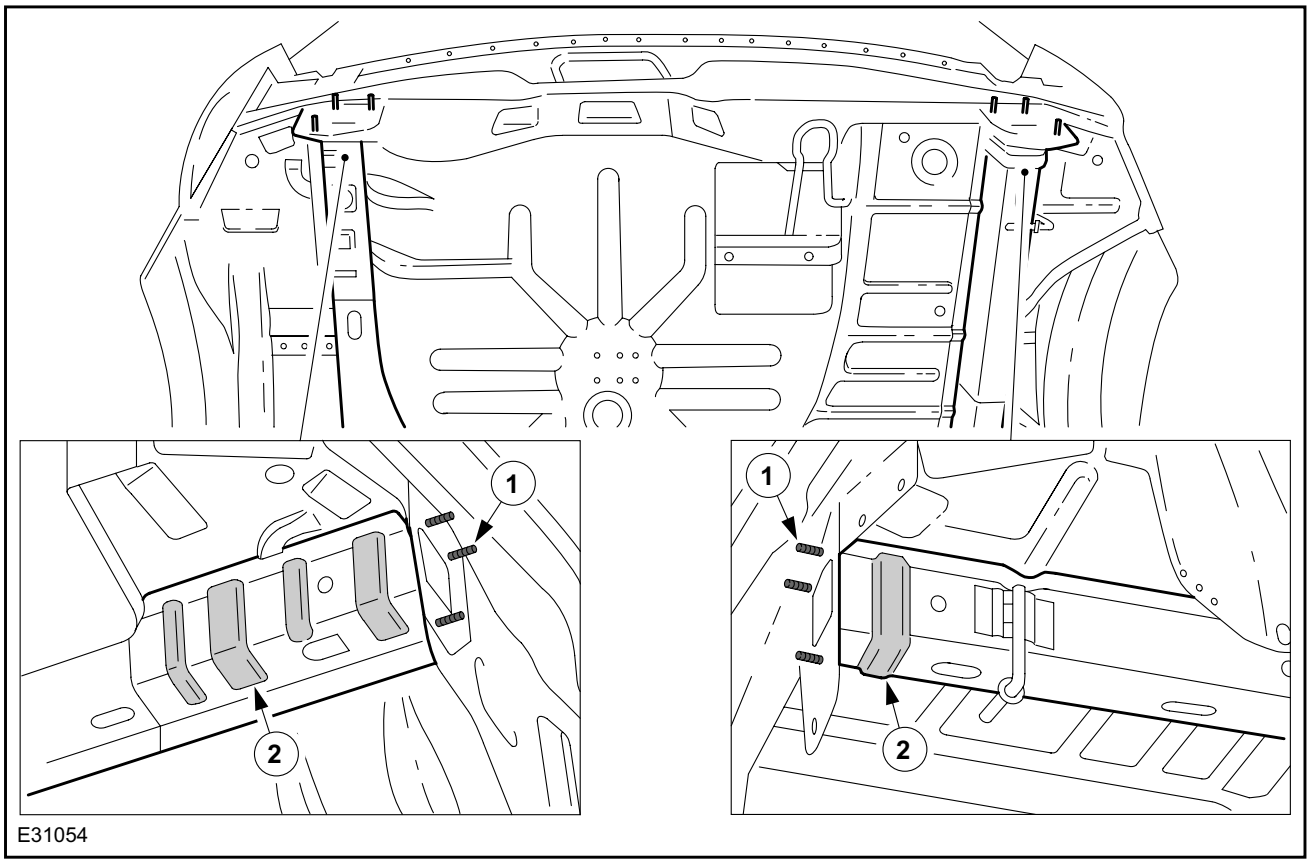
In the front area of the longitudinal members (deformation area) there are no inward reinforcements - increased ease of repair.

Front bumper

The plastic bumper is positioned relative to the fenders with two plastic lugs on each side of the vehicle and bolted in place.

The fog lamps are integrated in the bumper, and the ventilation grille and the front apron are clipped onto the bumper.

Rear end design features



Item	Description
1	Studs
2	Designated yield points

Rear longitudinal member

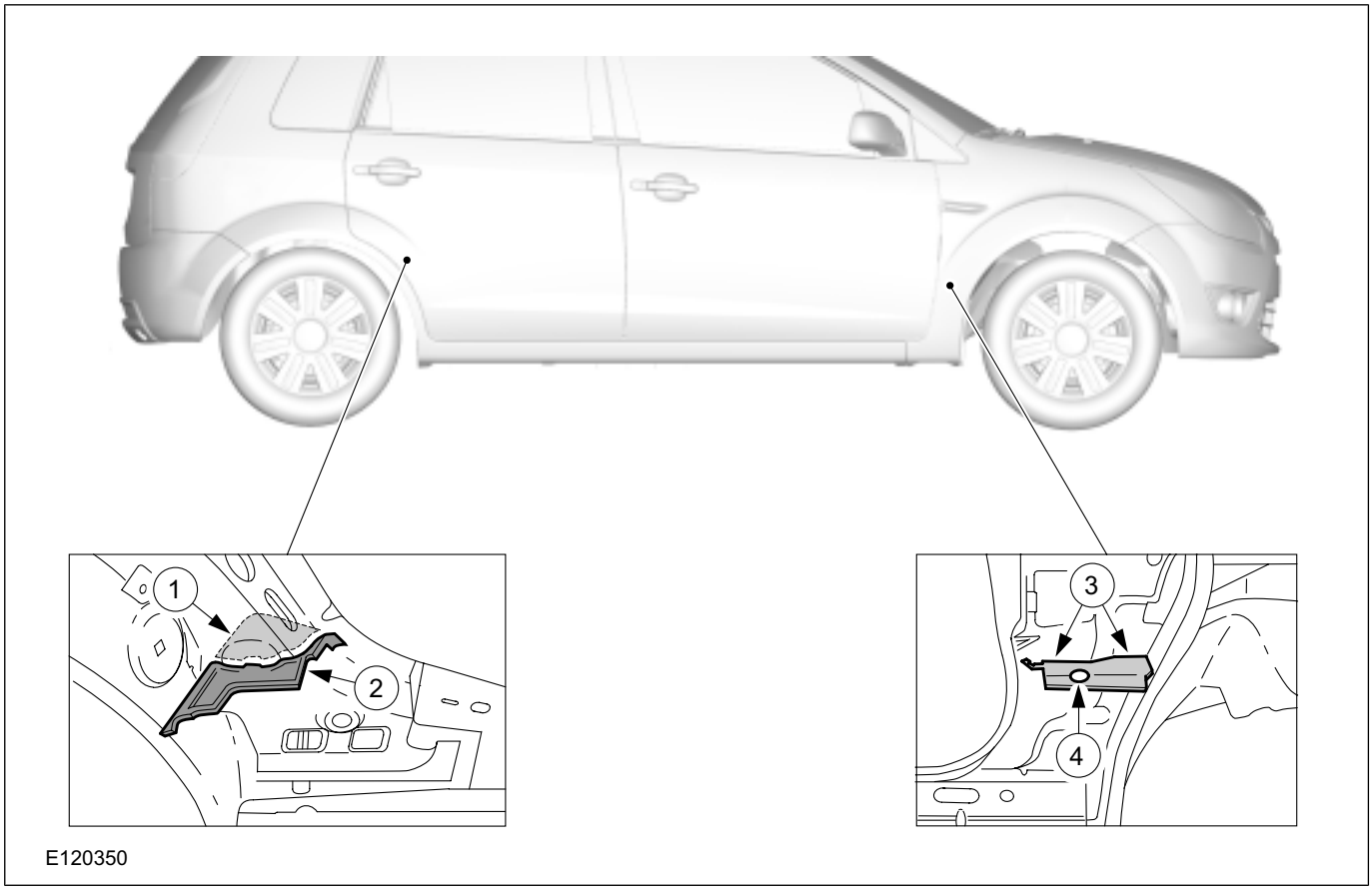
In more serious rear impacts the ends of the rear longitudinal members are also deformed in addition to the crossmember. Designated yield points in this area allow the residual energy to be dissipated in a controlled manner and prevent follow-on damage on the body structure. Sectional replacements are possible in the area of the designated yield points.

NVH elements

As already featured on some models of Ford, this model also features three elements on each side of the vehicle to reduce the transmission of airborne noise to the body.

If any body repairs are carried out in these areas then the NVH elements must also be reinstalled or renewed.

DESCRIPTION AND OPERATION



Item	Description
1	NVH element - C-pillar/inner wheel arch
2	NVH element - C-pillar/outer wheel arch
3	Clip connections
4	NVH element - A-pillar with leadthrough for the sun roof water drain hose

A-pillar area

Separation of wet and dry areas.

Leadthrough for the sun roof water drain hose.

C-pillar/wheel arch area

2-part element.

Mounting provided by a clip connection in the intermediate panel of the wheel arch.

Divides up the resonant space of the sill panel and the C-pillar.

Attached parts

Doors

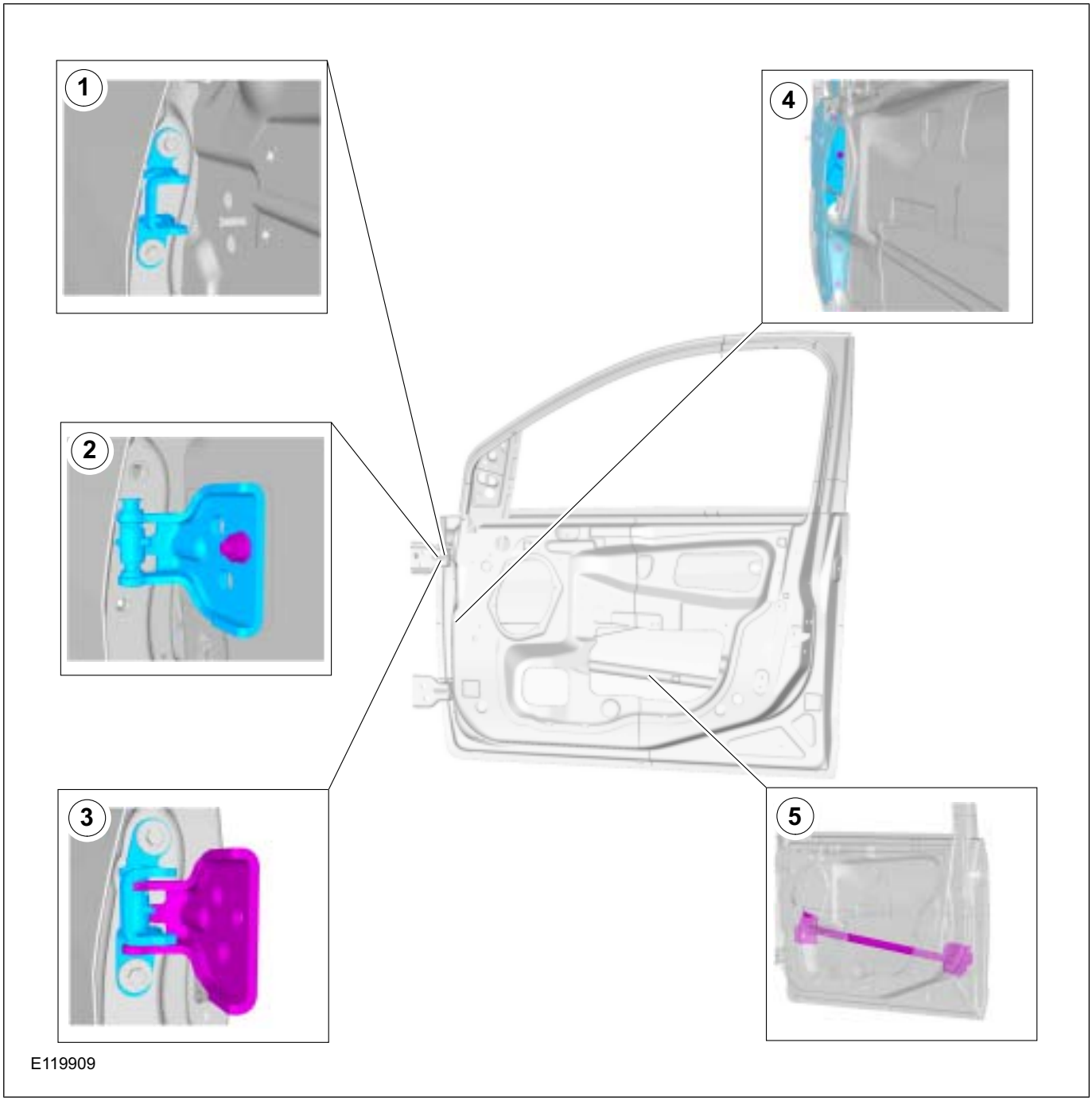
The dividable door hinges are attached with two bolts each to the body and the door. Adjustment options are provided via the oversized bores in the halves of the hinge, allowing adjustments to be performed without removing trim panels.

The central electrical power supply to the doors is provided on the front doors via a round bayonet connector and on the rear doors via a rectangular clip connector.

The doors are only hung by the hinge halves on pivot pins and can be simply unhinged when open. The doors are locked in the closed position via a mechanical locking mechanism which is integrated into the hinge half on the body side.

Sealing for the doors is provided in the form of a surrounding rubber seal on the body side.

DESCRIPTION AND OPERATION

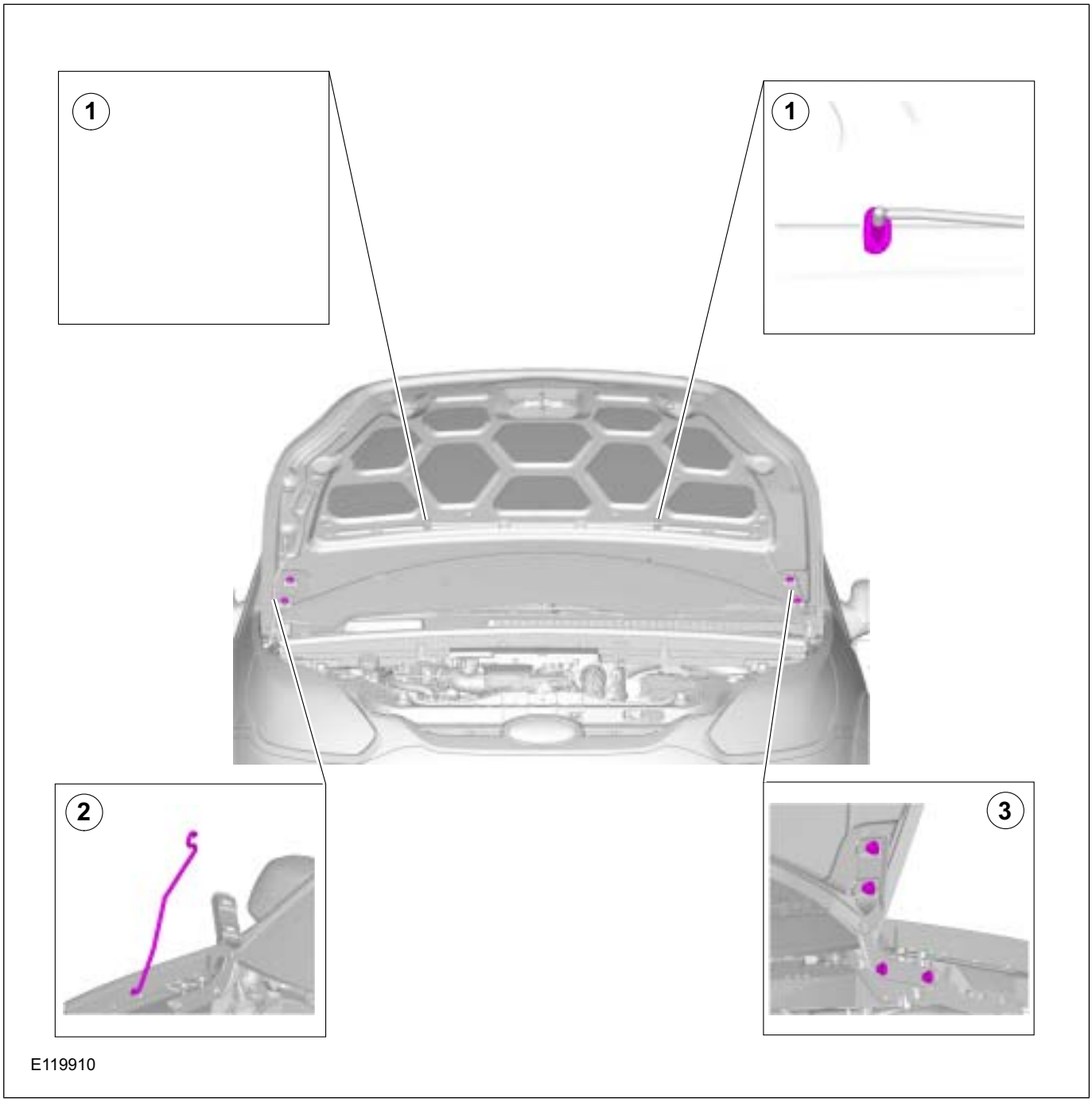


Item	Description
1	Hinge half, door side
2	Hinge half, body side

Item	Description
3	Mechanical locking mechanism with the door closed
4	Door hinge mounting plate
5	Front door reinforcement

DESCRIPTION AND OPERATION

Hood



Due to the reinforcement of the panel areas (grey areas), there are limited options for performing dent removal techniques without damaging the paintwork.

Surrounding seals and sealing bead in the clinched flange area.

Windshield washer nozzles (1) integrated into the hood.

Mechanical hood prop (2) on the right-hand side of the vehicle.

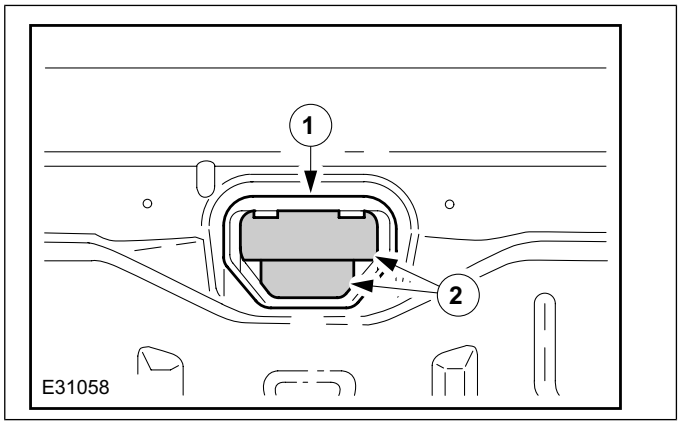
Hinge on the body side and hood side (3), each secured with 2 bolts. Adjustment options are provided via oversized bores,

The hood lock can be released via a cable from the passenger compartment.

Some variants of diesel vehicles are equipped with a hood insulation.

DESCRIPTION AND OPERATION

Forced ventilation



Item	Description
1	Plastic mounting element
2	Moving plates

In the rear part of this model there are three clipped-in elements for forced ventilation of the passenger compartment and luggage compartment.

- Two elements in the lower part of the left/right-hand side panel.
- One central element in the area of the rear panel.

Fascia/crash padding

The fascia/crash padding is secured to a cross-car beam bolted between the two A-pillars. Components like the passenger airbag, steering column etc. are directly attached to this component.

SECTION 501-02 Front End Body Panels

VEHICLE APPLICATION: 2010.25 Figo

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SPECIFICATIONS

Torque Specifications

Item	Nm	lb-ft	lb-in
Hood hinge to hood retaining nuts	23	17	-
Hood hinge retaining bolts	23	17	-
Windshield wiper arm retaining nuts	20	15	-
Fender splash shield retaining screws	5	-	44
Fender retaining bolts	7	-	62
Washer reservoir to radiator grille opening panel retaining bolt	3	-	27
Front bumper retaining bolts	25	18	-
Radiator grille opening panel retaining bolts	25	18	-
Hood release cable fitment to body	9	-	-

REMOVAL AND INSTALLATION

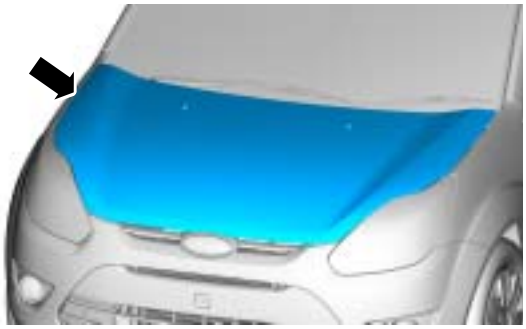
Fender(44 252 0)

Removal

1. **NOTE: For right side fender removal only.**

   Remove the hood.

   For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

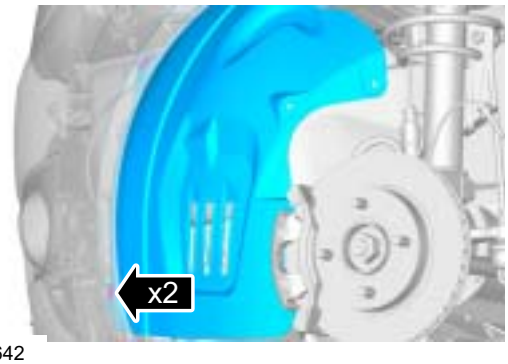


E120988

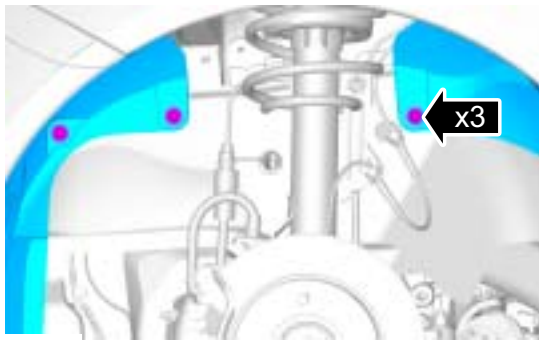
2. **Remove the front wheels.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

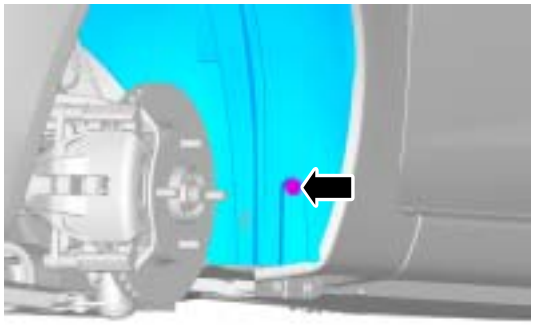
3. **Remove the fender splash shield.**



E119642

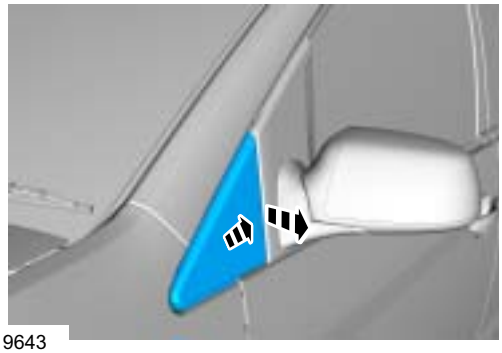


E119641



E119640

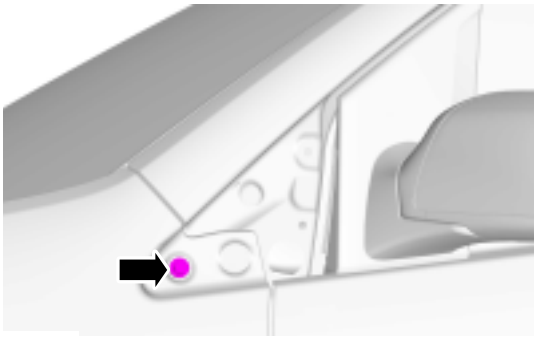
4. **Remove the fender side cover moulding.**



E119643

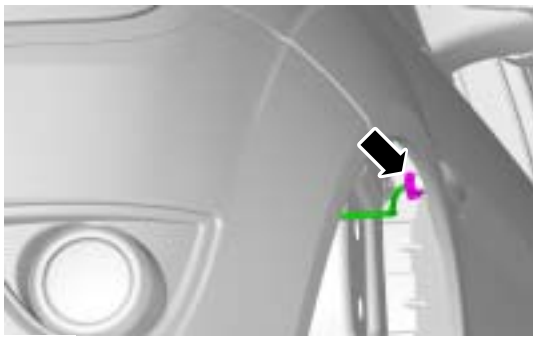
REMOVAL AND INSTALLATION

5. Remove the fender retaining upper bolt.



E119644

6. Disconnect the turn signal electrical connector.



E119645

7. Remove the headlamp assembly.

8. Remove the fender inner retaining bolt.

E119646

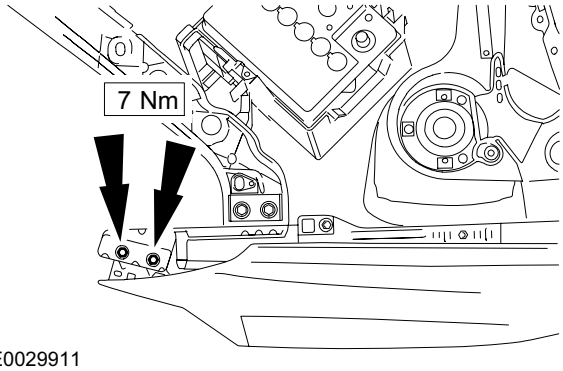
9. Remove the front bumper cover.

   For additional information, refer to: Front Bumper Cover (501-19 Bumpers, Removal and Installation).

10. Remove the fender lower retaining bolts.

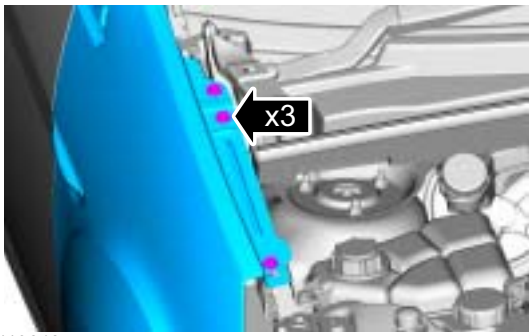
E119647

11. Remove the fender front retaining bolts.



E0029911

12. Remove the fender.



E119648

Installation

1. To install, reverse the removal procedure.

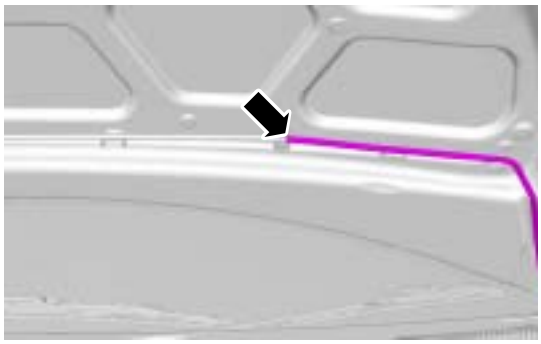
REMOVAL AND INSTALLATION

Hood

Removal

1. Open the hood.
2. Remove the battery negative cable.

   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
3. Remove the wiper washer fluid hose.



E119632

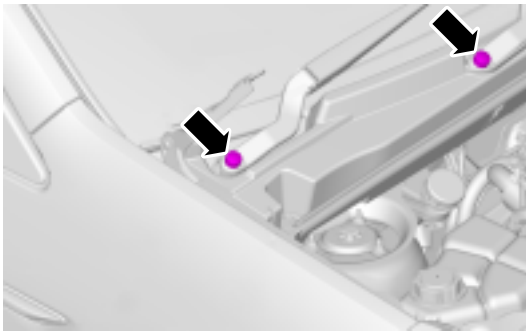
4. NOTE: Mark the position of the hood hinge in relation to the hood on both sides to aid installation.

   Remove the hood.

   1. Remove the nuts on both sides.

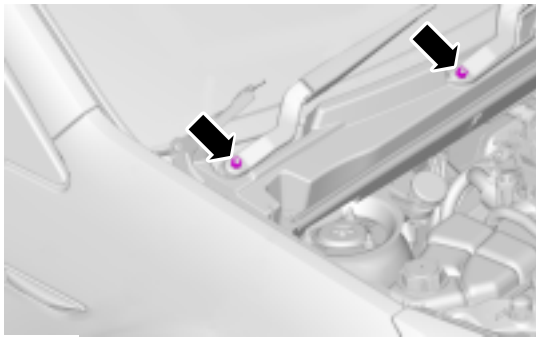
E119633

5. Remove the wiper arm covers on both sides.



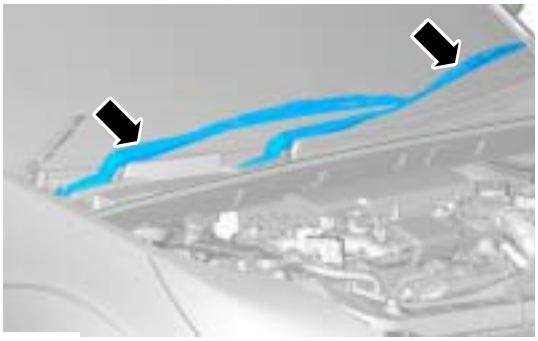
E119634

6. Remove the wiper arm nuts on both sides.



E119635

7. Remove the wiper arms on both sides.



E119636

8. Remove the cowl panel grill.

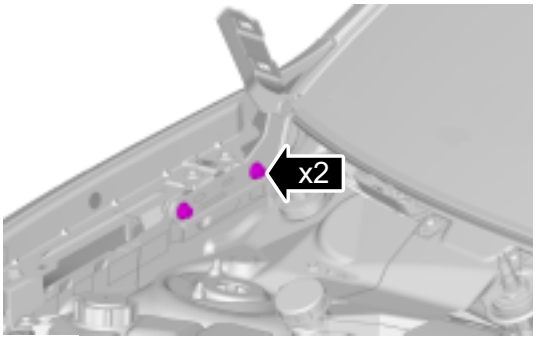
REMOVAL AND INSTALLATION

1. Remove the clips on both sides.

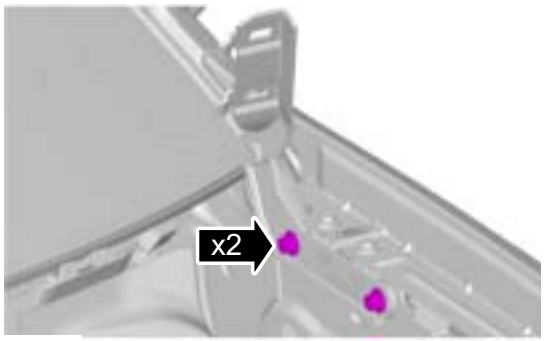
E119637

9. Remove the hood hinges on both sides.

1. Remove the bolts on both sides.



E119638



E119639

Installation

1. NOTE: Align the hood and hood hinge bolts to the previously marked positions.

To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Radiator Grille Opening Panel

Removal

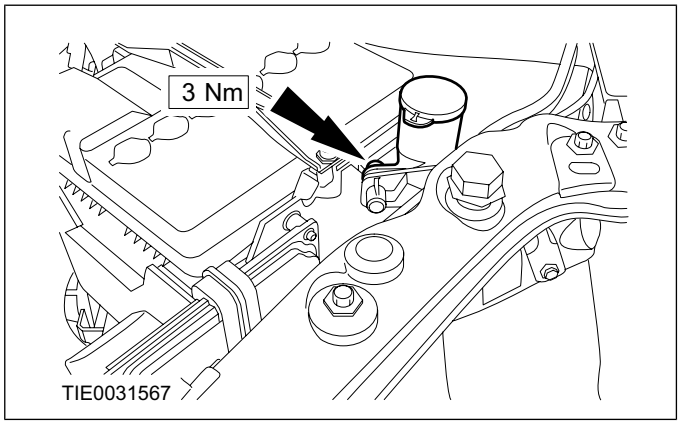
1. **Remove the front bumper cover.**

   For additional information, refer to: Front Bumper Cover (501-19 Bumpers, Removal and Installation).

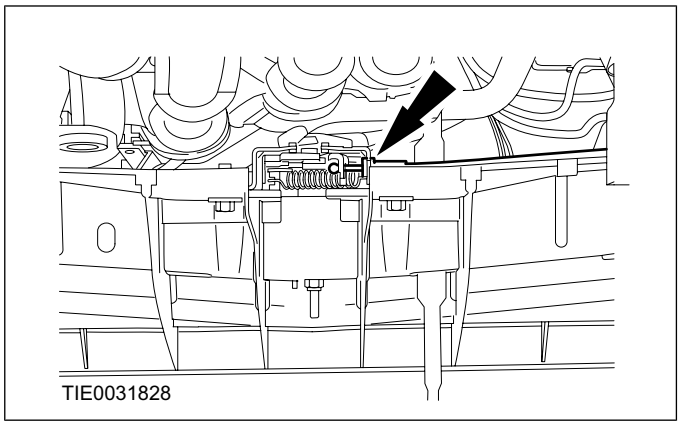
2. **Remove the headlamp assembly.**

   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

3. **Detach the windshield washer reservoir from the radiator grille opening panel.**

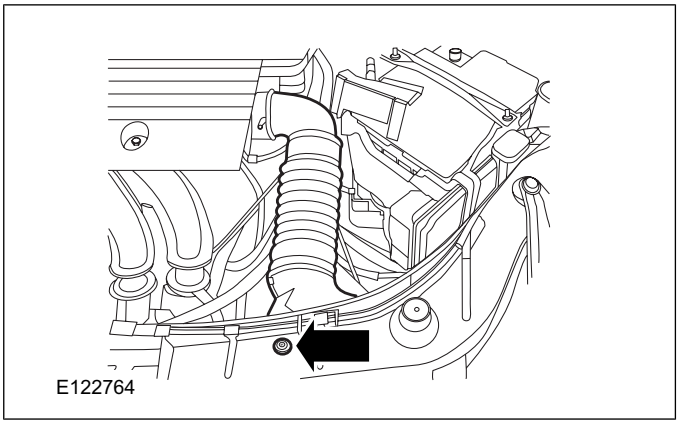


4. **Release the hood latch release cable.**

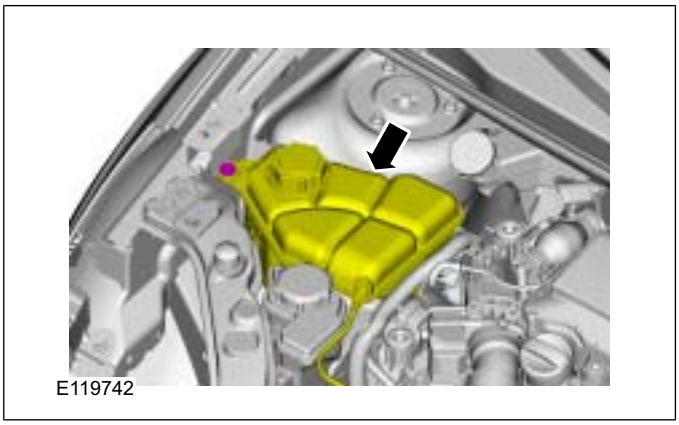


5. **NOTE: Vehicles with 1.4L/1.6L Duratec engines only.**

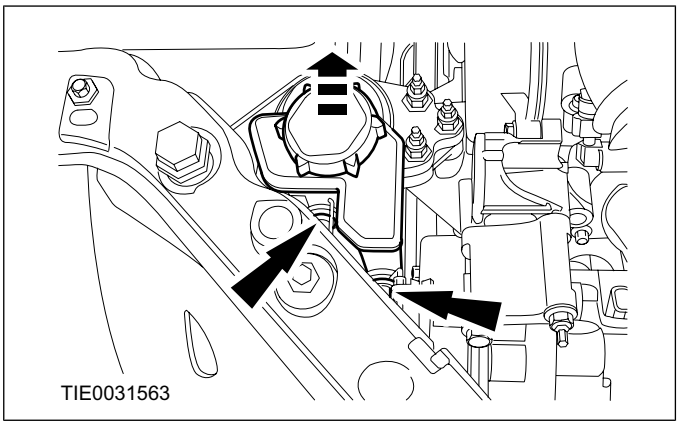
   Detach the air intake hose from the radiator grille opening panel.



6. **Detach the coolant tank and keep it aside.**

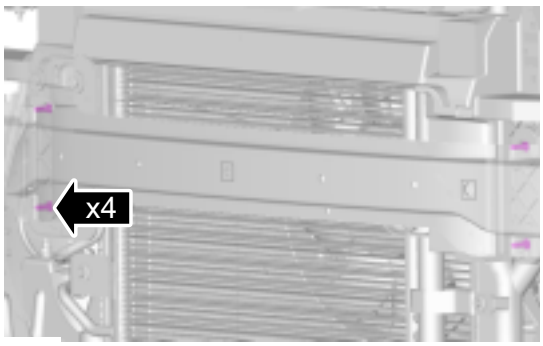


7. **Detach the power steering pump (PSP) reservoir from the radiator grille opening panel.**



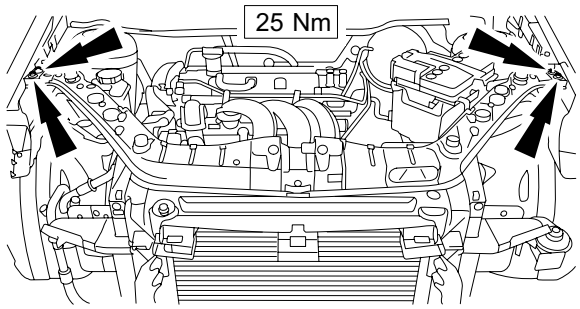
REMOVAL AND INSTALLATION

8. **Remove the radiator grill opening panel retaining bolts attaching it to the front reinforcement assembly.**



E119659

9. **Remove the radiator grill opening panel retaining bolts.**



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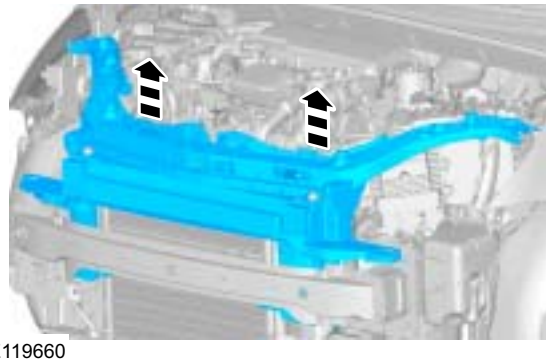
10. **Remove the radiator grille opening panel.**


E119660

Installation

1. **CAUTION: The radiator grille opening panel must be installed centrally between the fenders, the hood and headlamps must engage freely to prevent damage.**

   To install, reverse the removal procedure.

SECTION 501-03 Body Closures

VEHICLE APPLICATION: 2010.25 Figo

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SPECIFICATIONS

Torque Specifications

Item	Nm	lb-ft	lb-in
Door check strap to door retaining bolts	6	-	53
Door check strap to door pillar retaining bolts	23	17	-
Door striker plate retaining bolts	14	10	-
Door hinge retaining bolts	25	18	-
Front and rear door bezel screw tightening	2	-	-
Front and rear trim board lower screw tightening	2	-	-
Outer handle screw tightening	2	-	-
Liftgate striker plate retaining bolts	11	8	-
Liftgate hinge retaining nuts	18	13	-
Liftgate hinge retaining bolts	11	8	-
Hood hinge retaining bolts	23	17	-
Check arm screw tightening (Front & Rear)	23	17	-
Liftgate damper pivot	23	17	-
Tailgate latch screw tightening	23	17	-
Latch assy to front and rear door	8	-	-
Mechanical fuel door lever fitment	6	-	-

SECTION 501-05 Interior Trim and Ornamentation

VEHICLE APPLICATION: 2010.25 Figo

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SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Safety belt lower anchor retaining bolts	40	30	-
Safety belt upper anchor retaining bolts	40	30	-

REMOVAL AND INSTALLATION

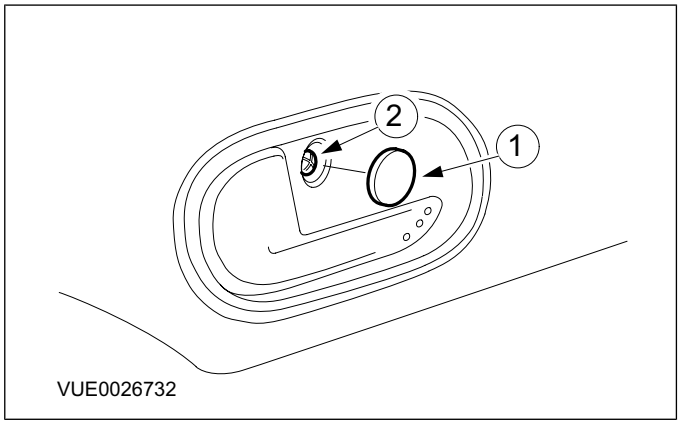
Front Door Trim Panel(43 705 0)

Removal

All vehicles

1. Detach the rear door latch remote control handle bezel.

1. Remove the screw cover.
2. Remove the retaining screw.



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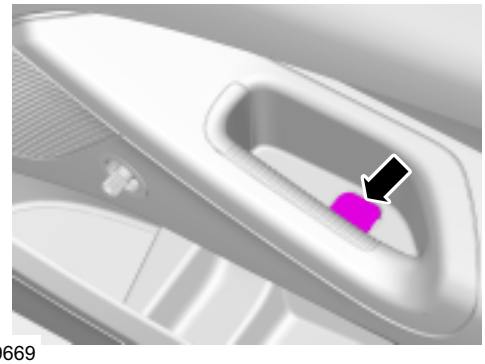
Vehicles with manual windows

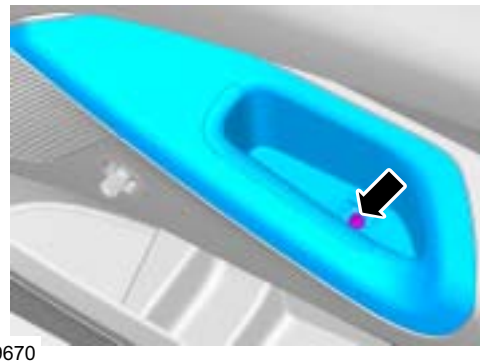
2. Remove the window regulator handle.


E119663

3. Remove the door pull handle screw cover.

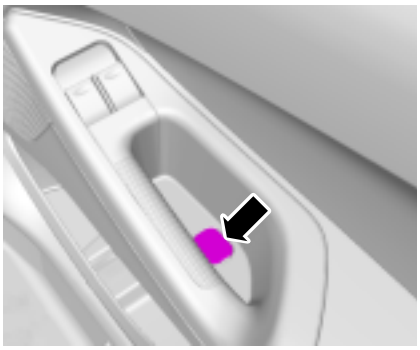

E119669

4. Remove the screw.

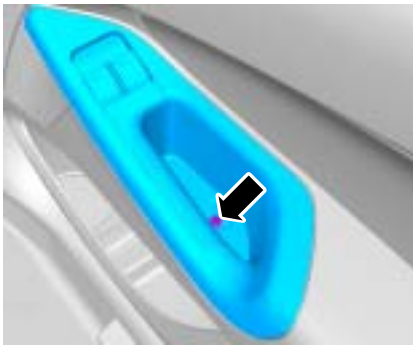

E119670

Vehicles with power windows

5. Remove the door pull handle screw cover.


E119661

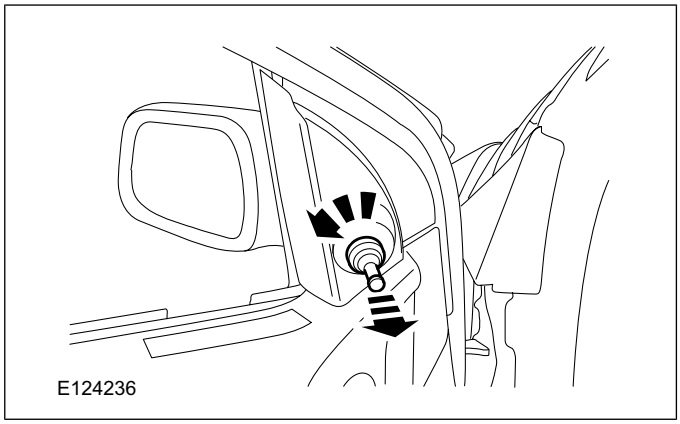
6. Remove the screw.


E119662

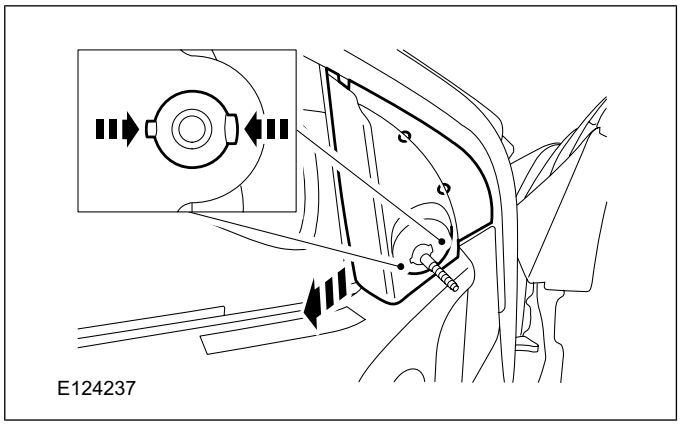
REMOVAL AND INSTALLATION

Vehicles with manual mirrors

7. **Remove the exterior mirror adjustment lever cover.**

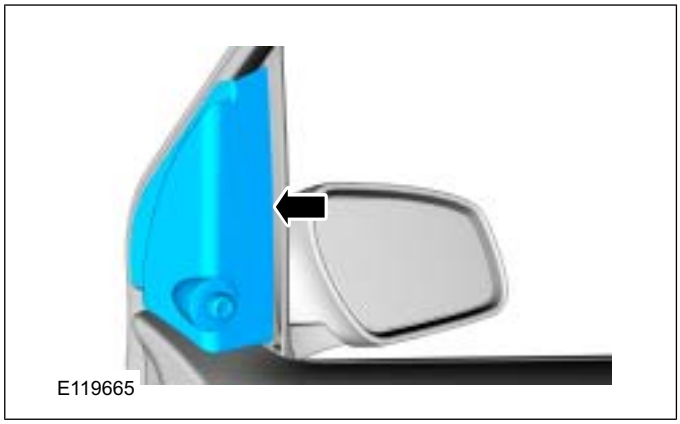


8. **Remove the exterior mirror trim panel.**

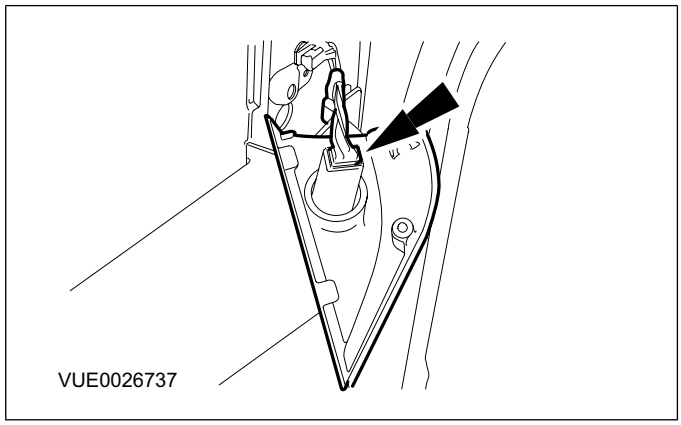


Vehicles with power mirrors

9. **Detach the exterior mirror trim panel.**

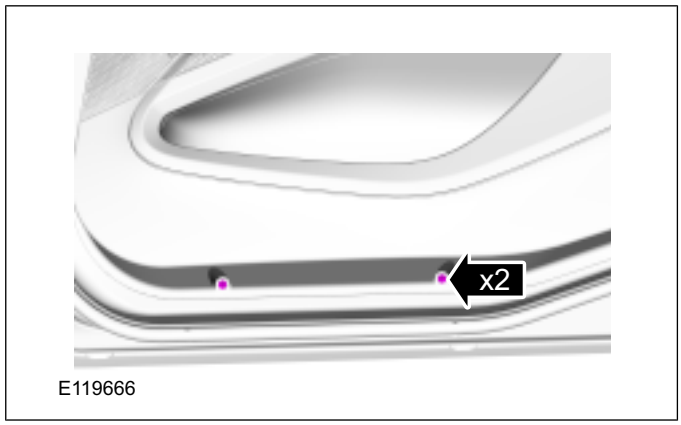


10. **Disconnect the exterior mirror control switch electrical connector.**



All vehicles

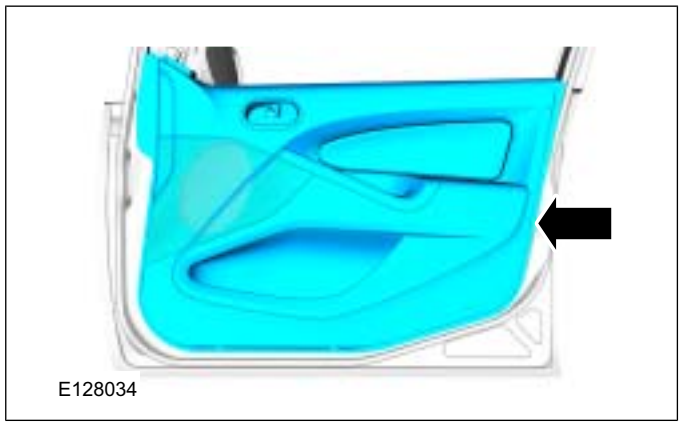
11. **Remove the door trim retaining screws.**



12. **Detach the door trim panel.**

    Pull the door trim panel out at the bottom to detach the retaining clips.

    Lift up the door trim panel to release from the door.

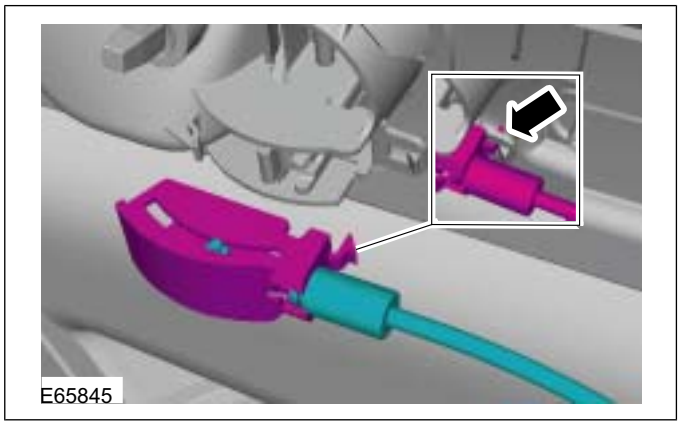


All vehicles

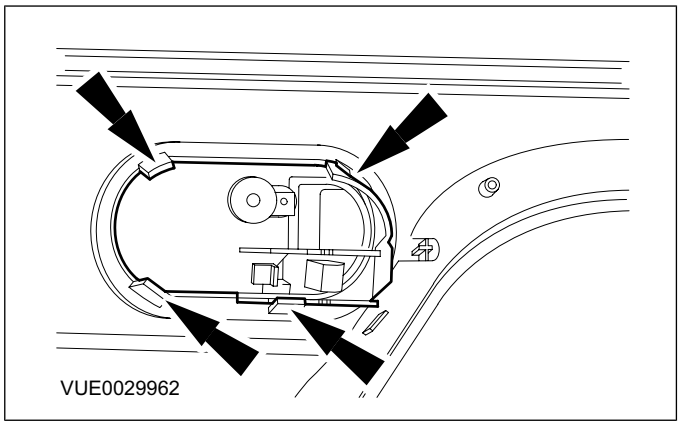
13. **Disconnect the front door latch remote control cable from the front door latch**

REMOVAL AND INSTALLATION

remote control handle and remove the front door trim panel.

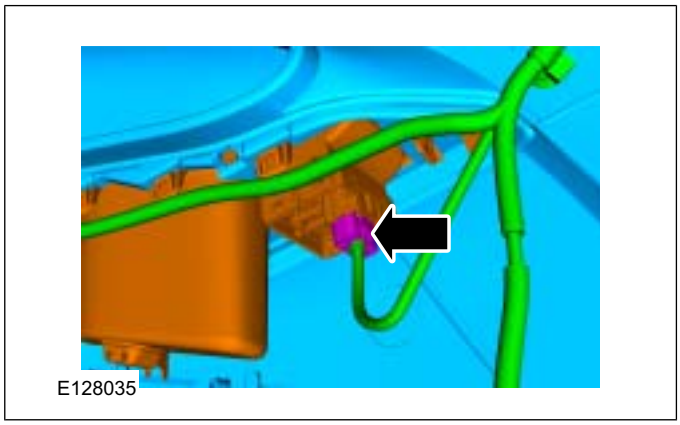


14. **Release the locking tangs and remove the front door latch remote control handle from the front door trim panel.**



Vehicles with power windows

15. **Disconnect the window control switch electrical connector.**



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

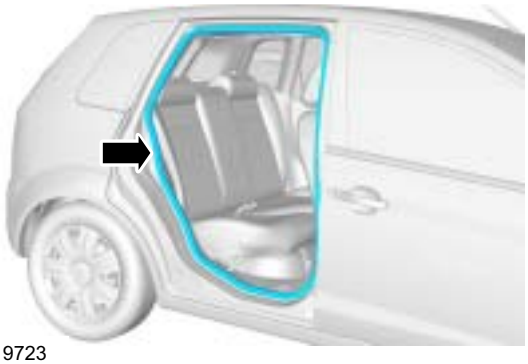
Front Scuff Plate Trim Panel

Removal

1. Remove the front door opening weatherstrips.


E119720

2. Remove the rear door opening weatherstrips.


E119723

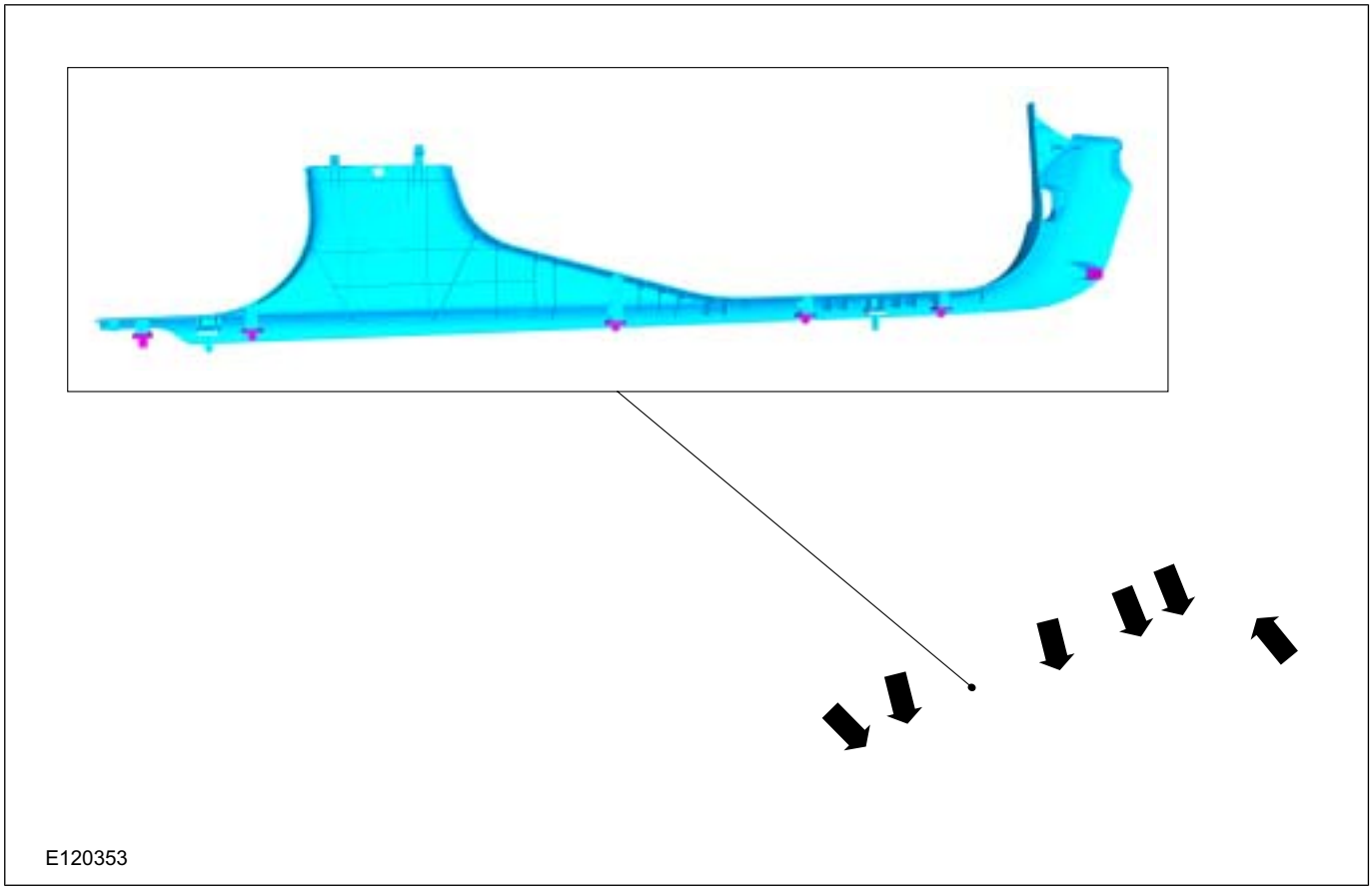
3. Remove the B-pillar trim panels.

   Refer to: B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

4. **NOTE:** Seats and doors removed view shown for clarity.

   Pull the scuff plate towards centre of vehicle and remove it.

REMOVAL AND INSTALLATION



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

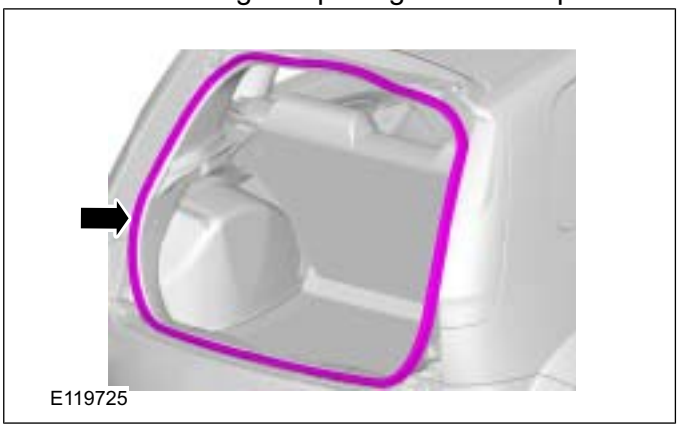
Loadspace Trim Panel

Removal

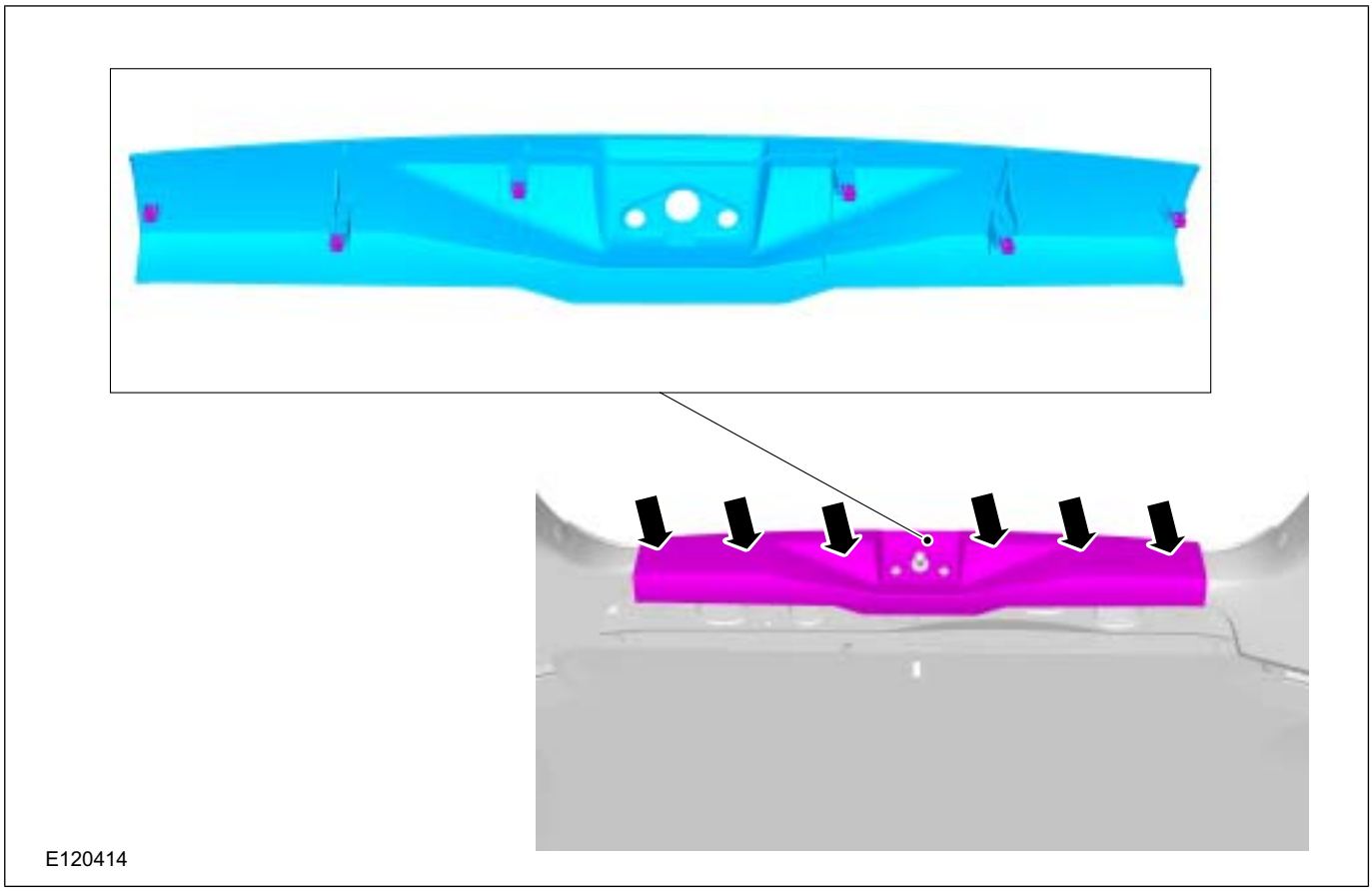
1. **NOTE:** Back door removed shown for clarity.

   NOTE: Water leak test to be done after fitment of liftgate weatherstrip and to be renewed if leak is observed.

Detach the liftgate opening weatherstrip.

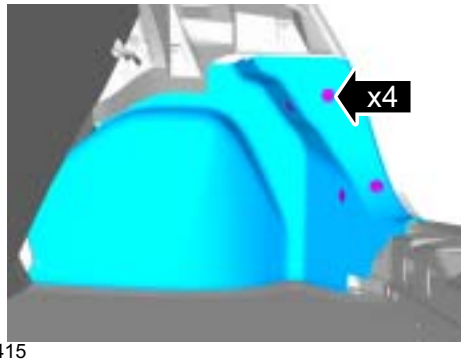


2. Pull the back door trim lower.



REMOVAL AND INSTALLATION

3. Remove the clips and detach the load space trim panel.



E120415

Installation

1. To install reverse the removal procedure.

REMOVAL AND INSTALLATION

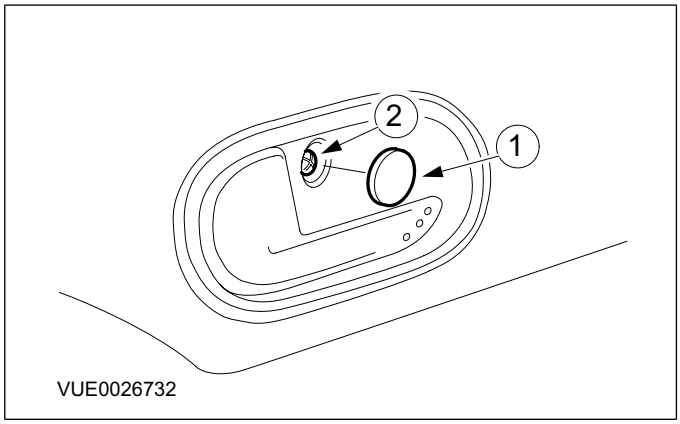
Rear Door Trim Panel(43 706 0)

Removal

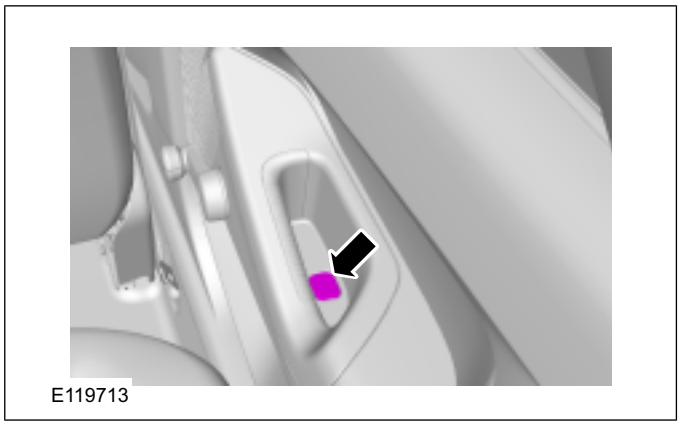
All vehicles

1. Detach the rear door latch remote control handle bezel.

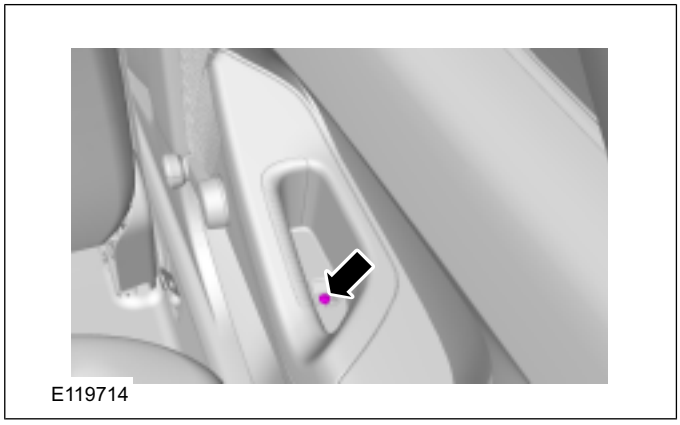
1. Remove the screw cover.
2. Remove the retaining screw.



2. Remove the screw cover.



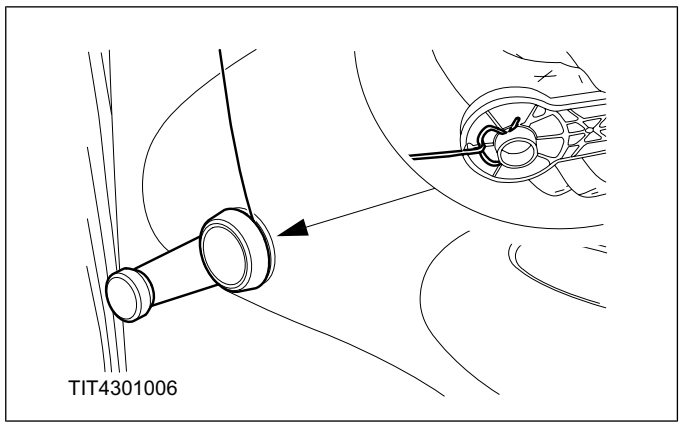
3. Remove the retaining screw.



Vehicles with manual windows

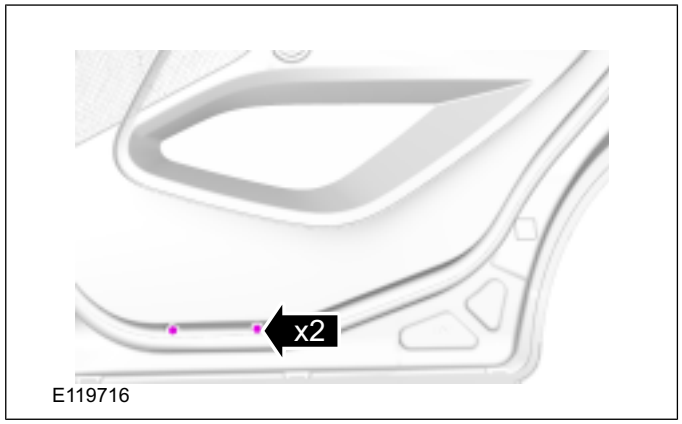
4. Remove the window regulator handle.

- Use a suitable piece of hooked wire or similar.

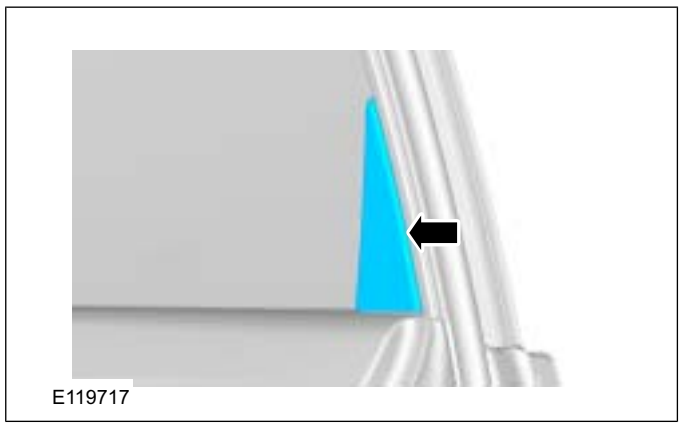


All vehicles

5. Remove the door trim panel retaining screws.



6. Remove the rear door inner trim quarter panel.

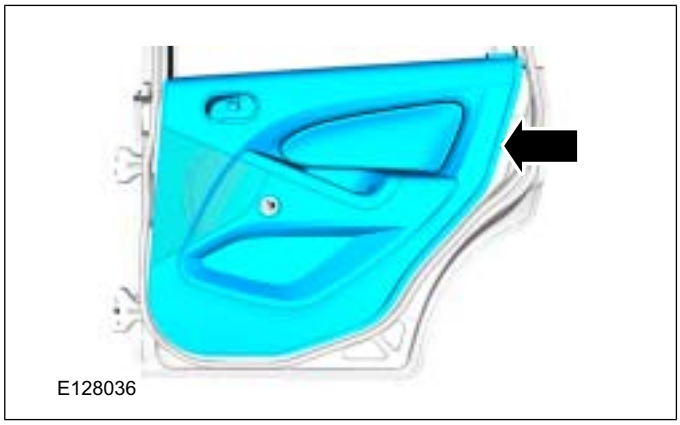


7. Detach the door trim panel

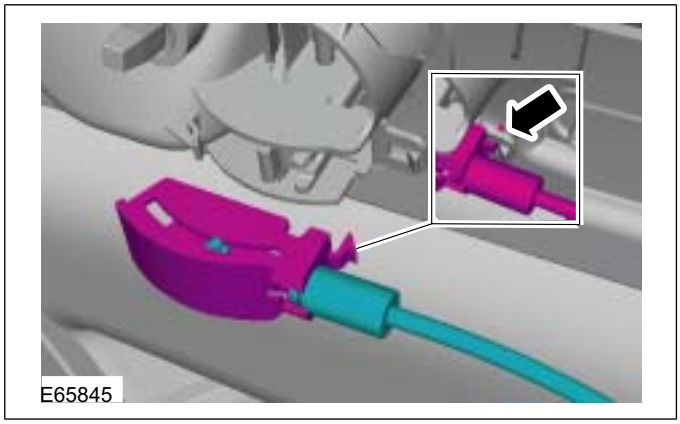
REMOVAL AND INSTALLATION

Pull the door trim panel out at the bottom to detach the retaining clips.

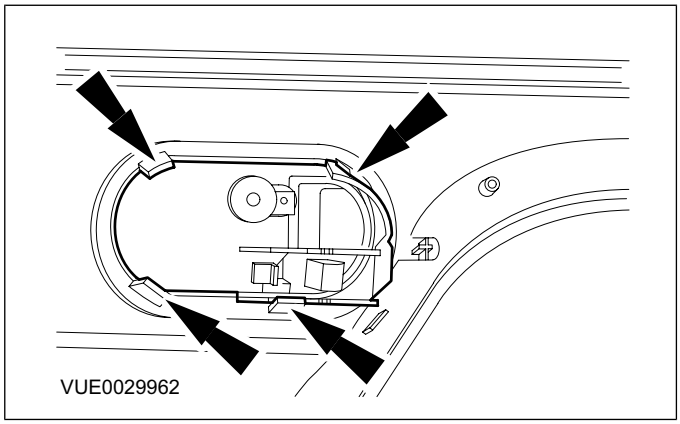
Lift up the door trim panel to release from the door.



8. **Disconnect the door latch remote control cable from the door handle and remove the door trim panel.**



9. **Release the locking tangs and remove the front door latch remote control handle from the front door trim panel.**



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Headliner(43 612 0)

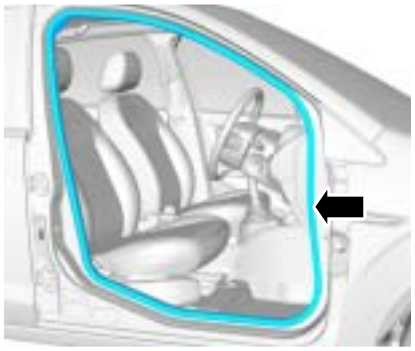
General Equipment

6 mm flat-bladed screwdriver

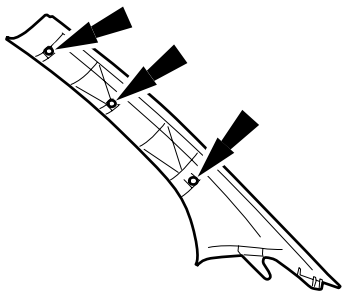
Removal

All vehicles

1. **Detach the front door opening weatherstrips.**

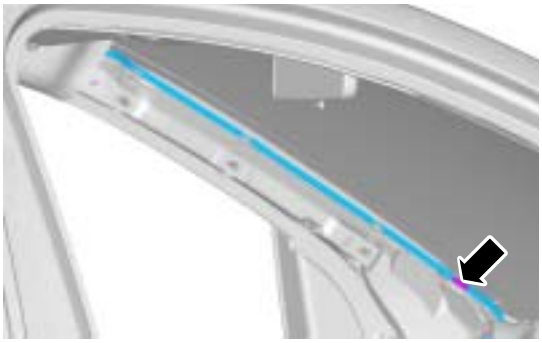

E119720

2. **Remove the A-pillar trim panels.**


VUE0027052

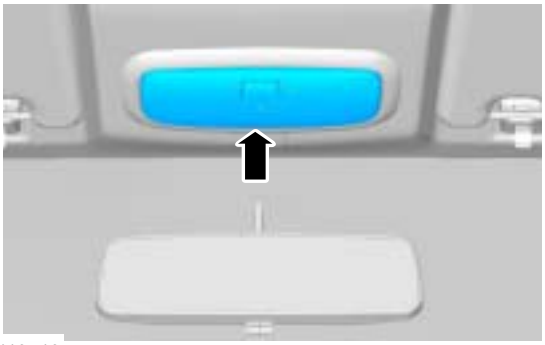
3. **NOTE: When disconnecting the rear washer tube, allow the washer fluid to drain into a suitable container.**

Detach the rear washer tube from the A-pillar.

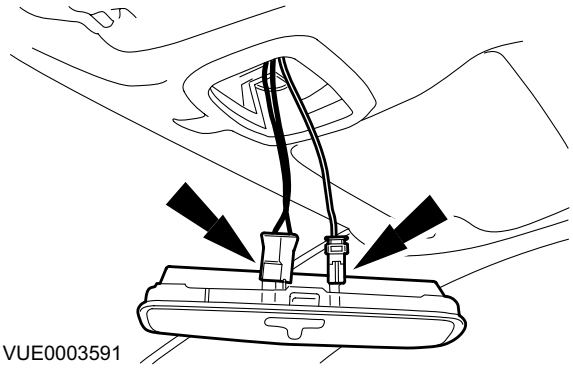

E119721

All vehicles

4. **Detach the interior lamp.**


E119719

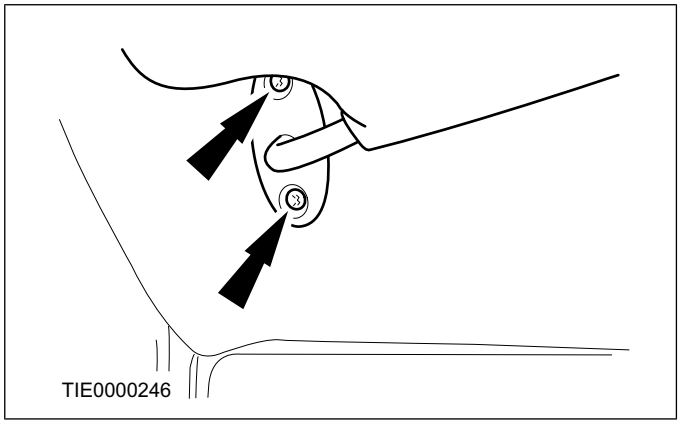
5. **Disconnect the electrical connectors and remove the interior lamp.**


VUE0003591

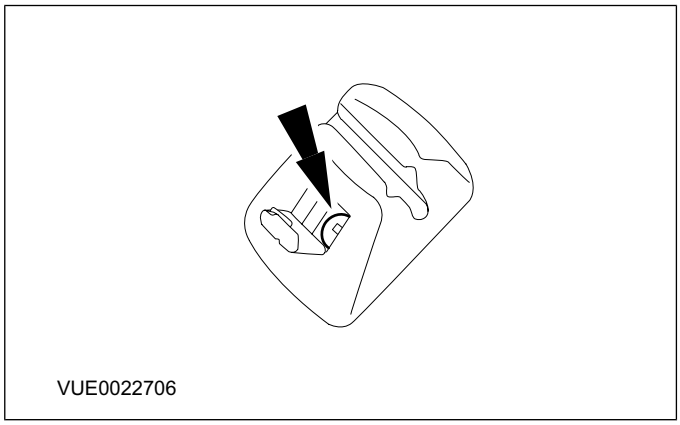
REMOVAL AND INSTALLATION

All vehicles

6. Remove the sun visors.



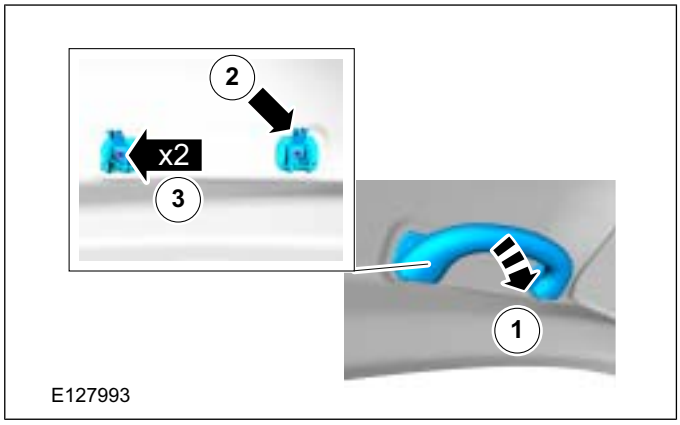
7. Remove the sun visor retaining clips.



All vehicles

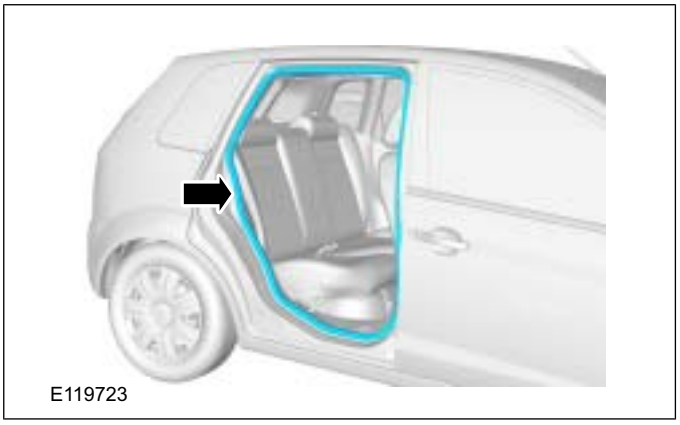
8. Remove the passenger assist handles.

1. Pull the handle downwards.
2. Open the cover.
3. Remove the screws.



All vehicles

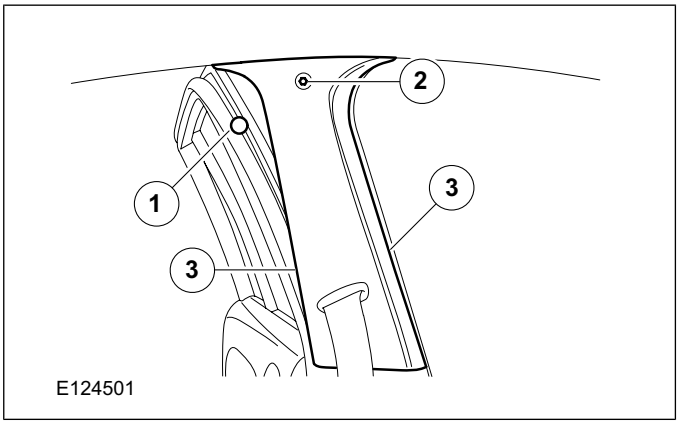
9. Detach the rear door opening weatherstrips.



10. Detach the B-pillar upper trim panels and position them to one side.

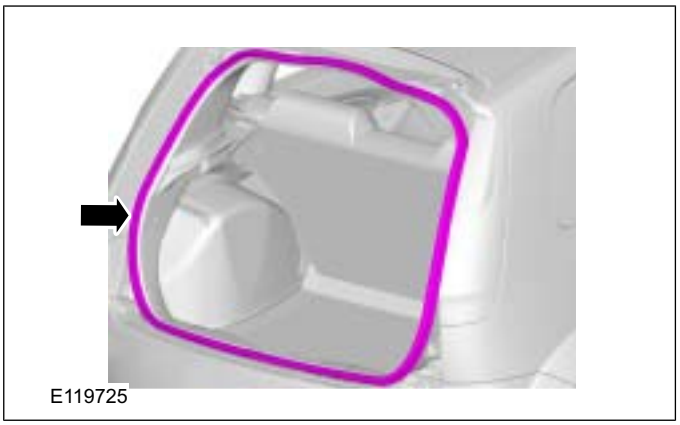
1. Remove the screw cover.
2. Remove the retaining screw.

- Unclip the upper trim panel.



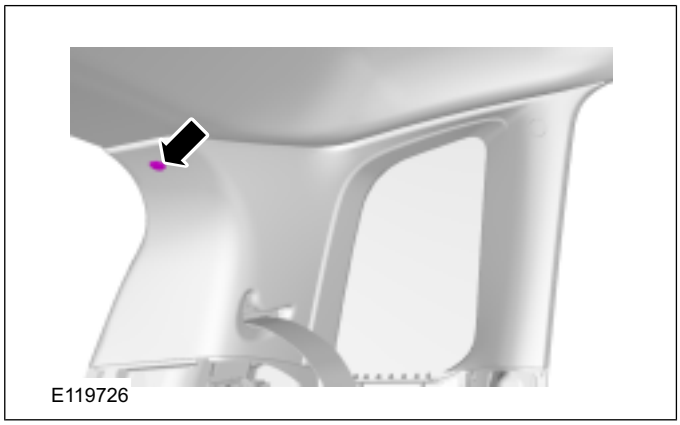
11. NOTE: Water leak test to be done after fitment of liftgate weatherstrip and to be renewed if leak is observed.

Detach the liftgate opening weatherstrip.

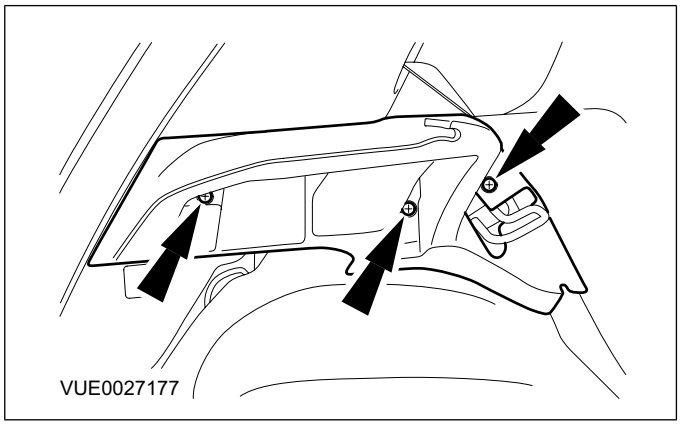


REMOVAL AND INSTALLATION

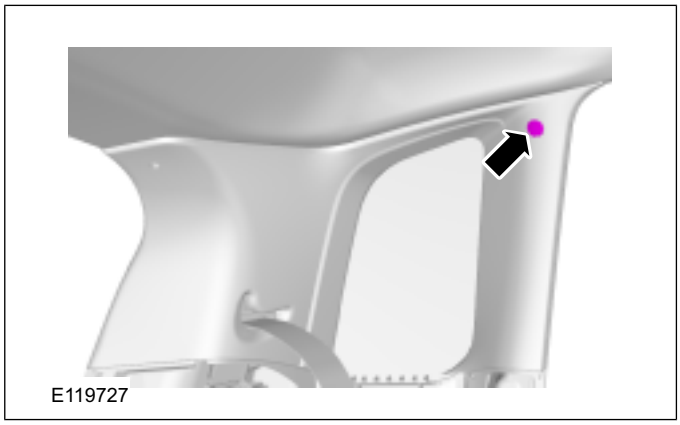
12. **Remove the C-pillar trim panel retaining clips.**



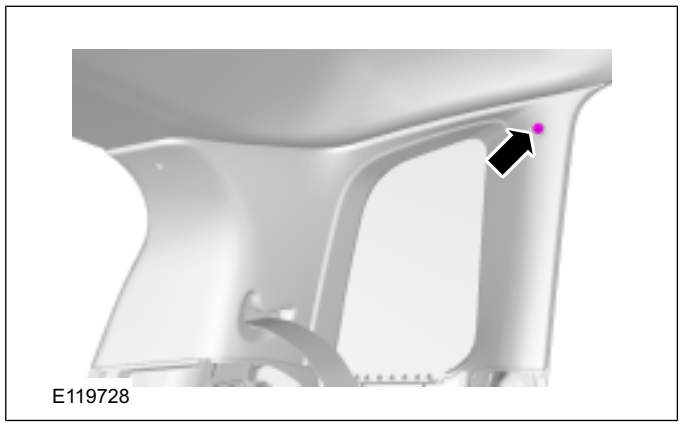
13. **Remove the rear parcel shelf.**
14. **Remove the rear parcel shelf supports.**
    - Disconnect the load space lamp electrical connector to remove the right-hand rear parcel shelf support.



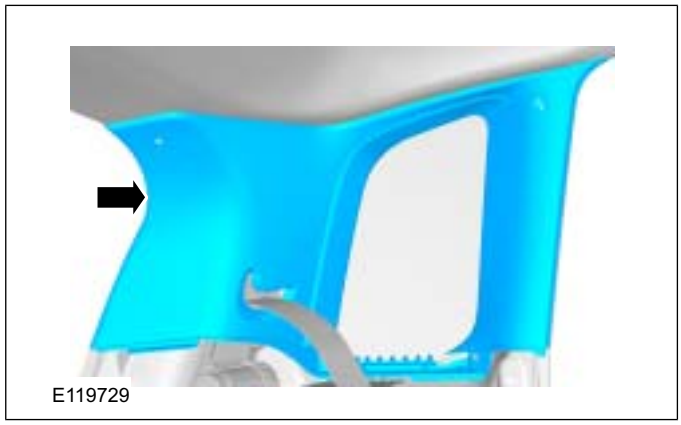
15. **Remove the C-pillar screw cover.**



16. **Remove the C-pillar retaining screw.**

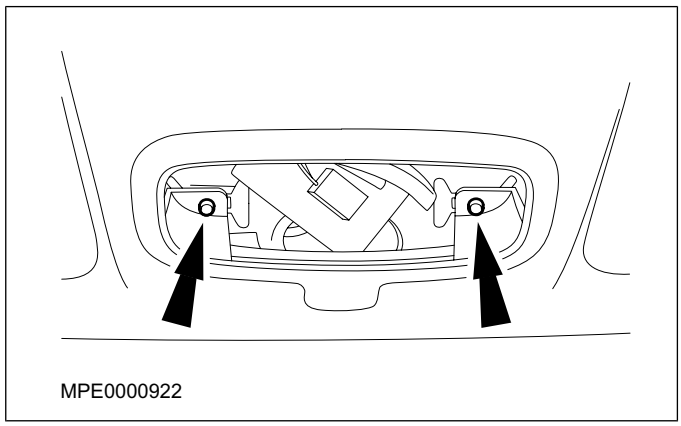


17. **Unclip and detach the C-pillar trim panels, then position them to one side.**



All vehicles

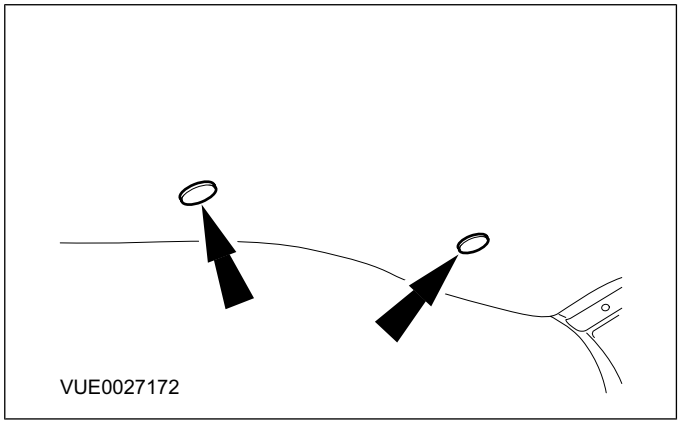
18. **Remove the interior lamp bezel.**



REMOVAL AND INSTALLATION

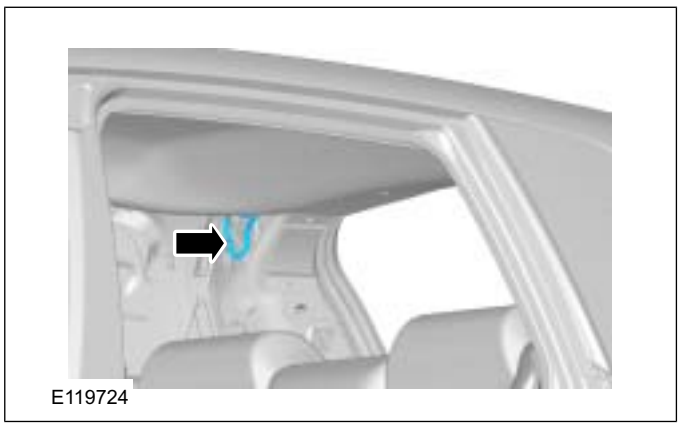
All vehicles

19. Remove the headliner rear retaining clips.

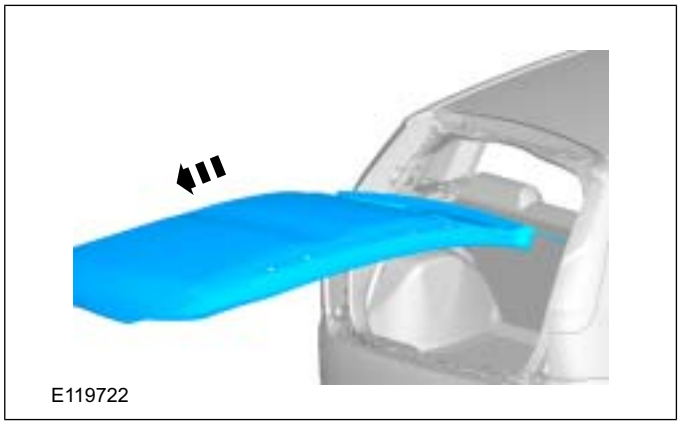


All vehicles

20. Disconnect the rear washer tube from the headliner.



21. Remove the headliner through the liftgate opening.



Installation

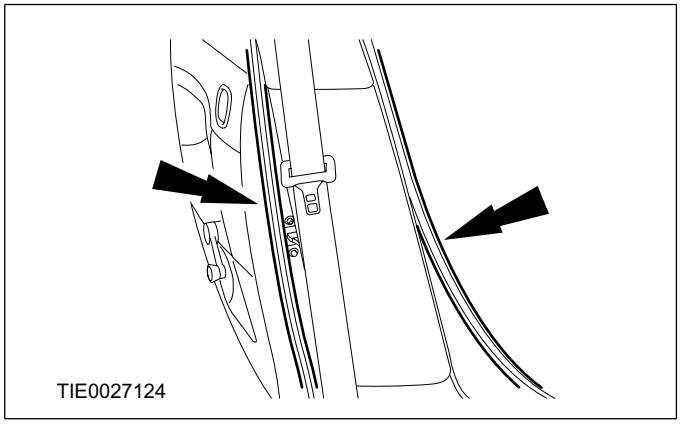
1. NOTE: Fix foams to the roof header properly.

To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

B-Pillar Trim Panel(43 617 0)

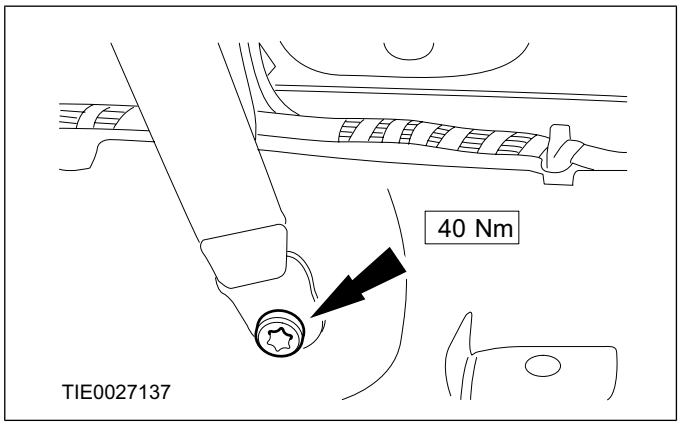
1. **Detach the door opening weatherstrips from the B-pillar.**



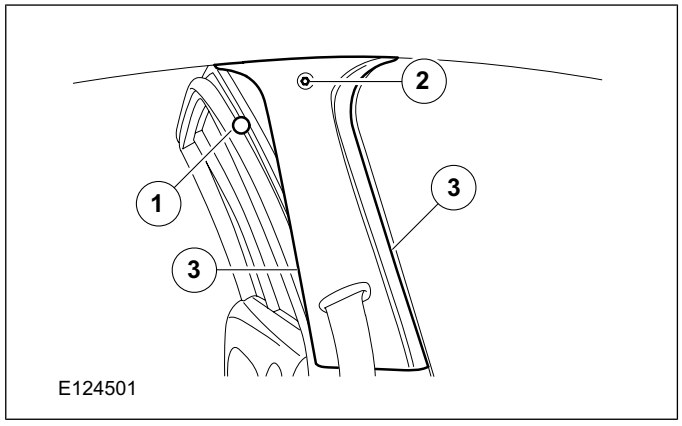
2. **NOTE: Hold the safety belt webbing when detaching the safety belt lower anchor from the floor panel.**

   Detach the safety belt lower anchor from the floor panel.

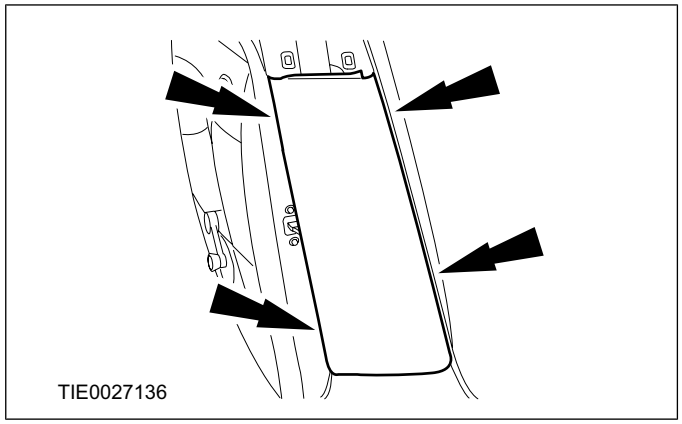
   - Remove the retaining bolt and spacer from the anchor plate.



3. **Remove the B-pillar upper trim panel.**
   1. Remove the screw cover.
   2. Remove the retaining screw.
   3. Detach the retaining clips.
   - Feed the safety belt webbing through the B-pillar upper trim panel.



4. **Remove the B-pillar lower trim panel.**
   - Detach the retaining clips.



Installation

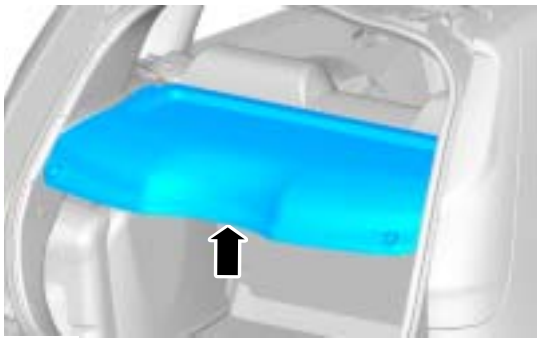
1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

C-Pillar Trim Panel(43 618 0)

Removal

1. **Remove the parcel shelf (Back door removed shown for clarity).**

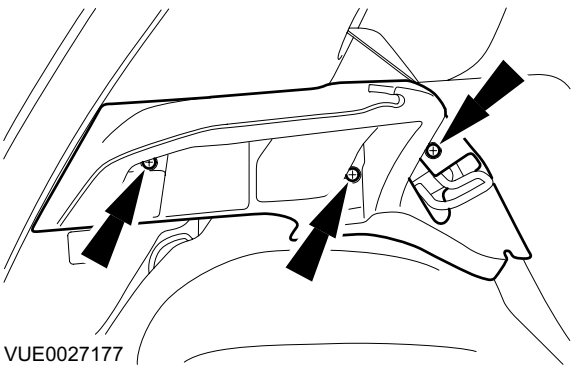

E120051

2. **NOTE: Water leak test to be done after fitment of liftgate weatherstrip and to be renewed if leak is observed.**

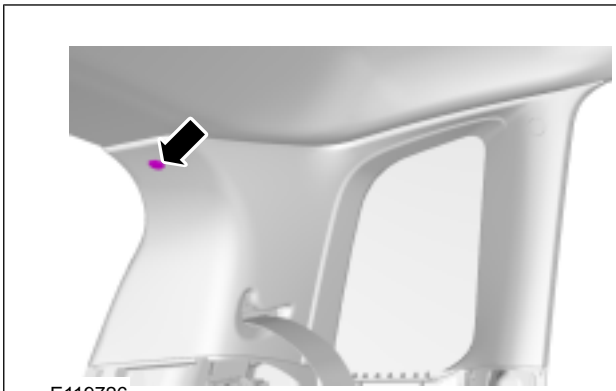
   Detach the liftgate opening weatherstrip.


E119725

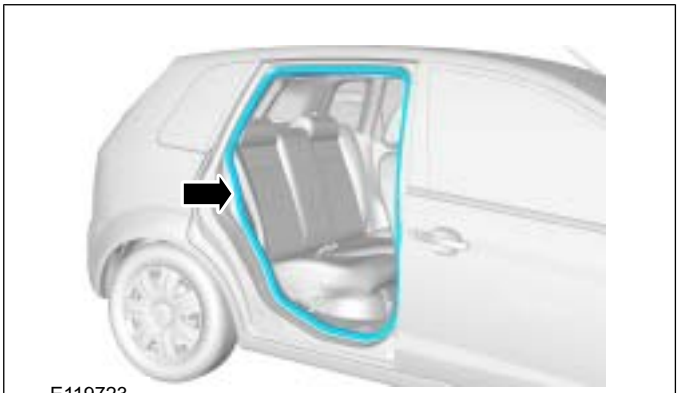
3. **Remove the parcel shelf supports.**


VUE0027177

4. **Remove the C-pillar trim panel retaining clip.**

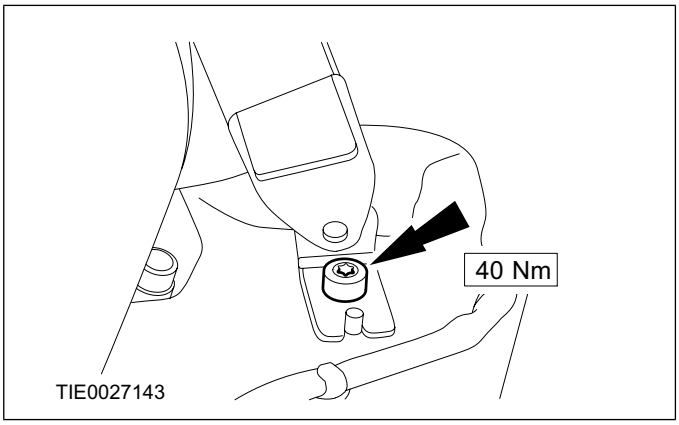

E119726

5. **Detach the rear door opening weatherstrips.**


E119723

6. **Fold the rear seat cushion.**
7. **NOTE: Hold the safety belt webbing when detaching the lower anchor from the floor panel.**

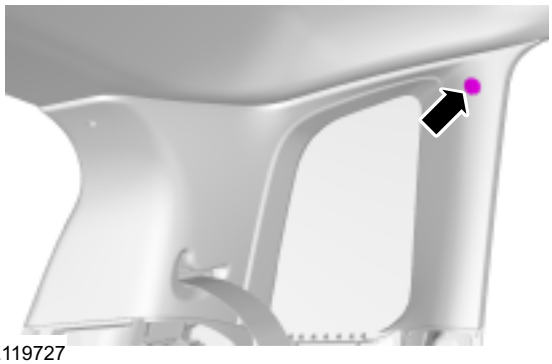
   Detach the rear safety belt lower anchor from the floor panel.



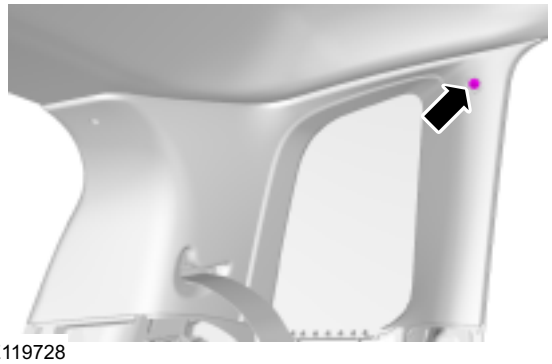
TIE0027143

REMOVAL AND INSTALLATION

8. Remove the C-pillar screw cover.


E119727

9. Remove the C-pillar retaining screw.


E119728

10. Unclip and detach the C-pillar trim panel.


E119729

Installation

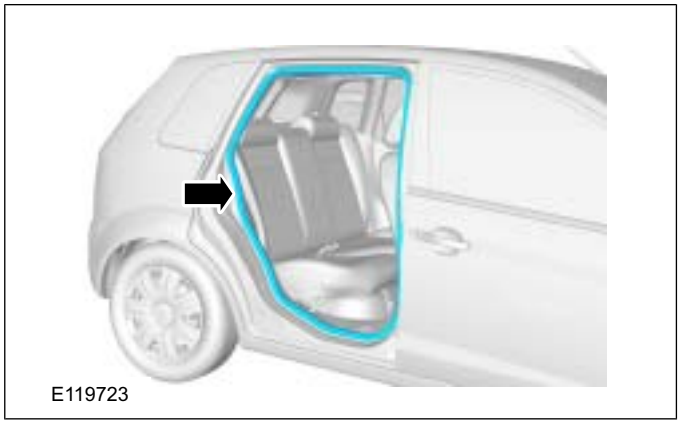
1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Rear Scuff Plate Trim Panel

Removal

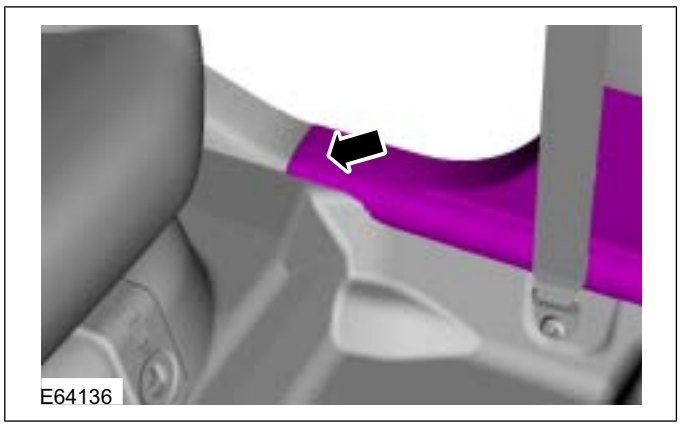
1. Remove the rear door opening weatherstrips.


E119723

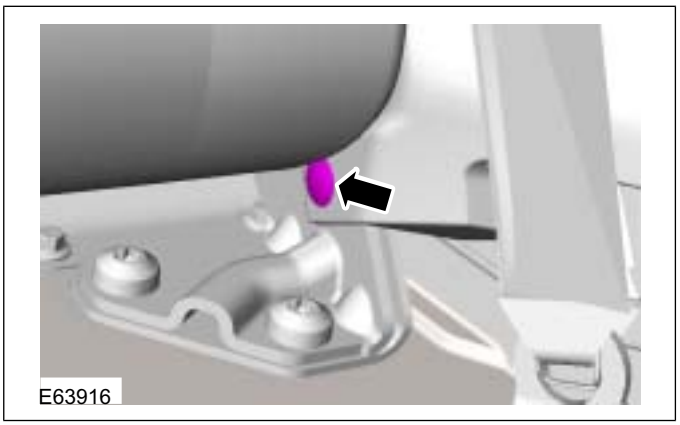
2. Remove the C-pillar trim panel.

   For additional information, refer to: C-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

3. Detach the front scuff plate trim from the rear scuff plate trim panel.

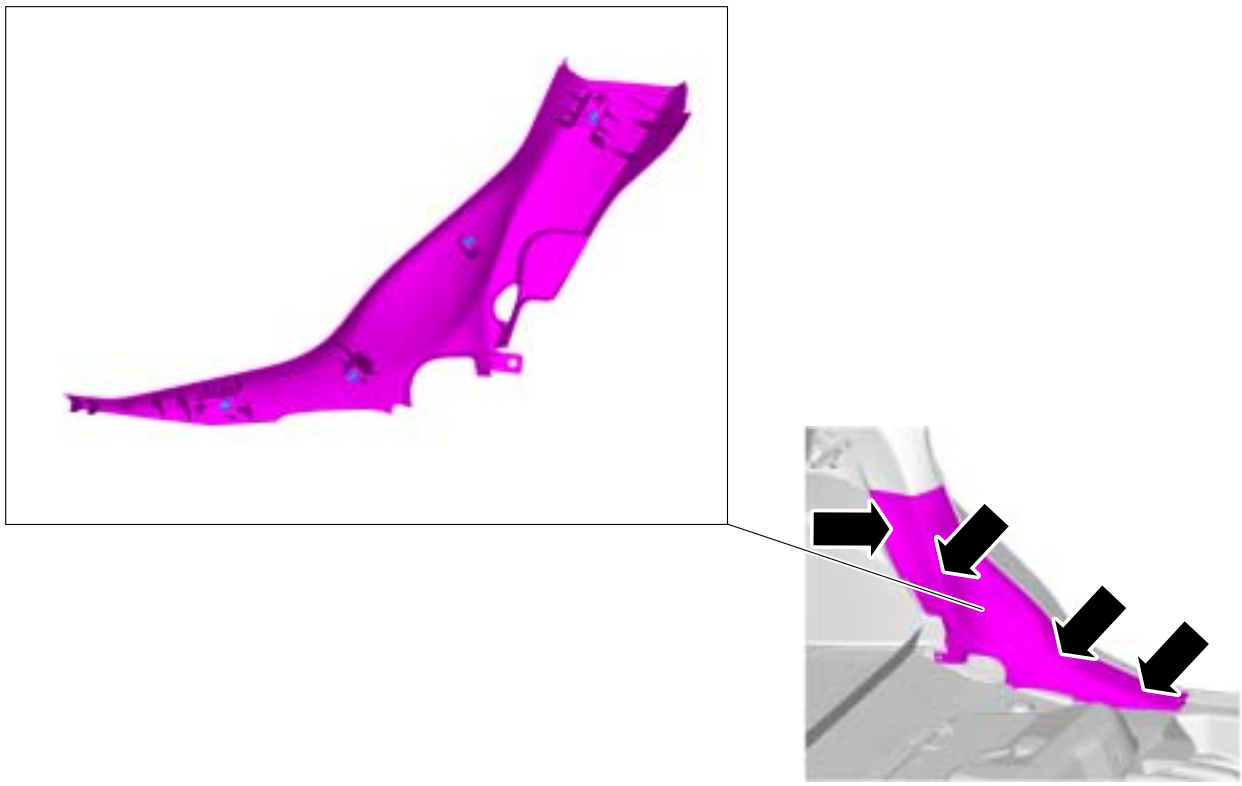

E64136

4. Tilt the rear seat cushion forward.
5. Remove the rear scuff plate trim panel retaining clip.


E63916

6. Tilt the rear seat backrest forward.
7. Remove the rear scuff plate trim panel.

REMOVAL AND INSTALLATION



Installation

1. **To install, reverse the removal procedure.**

SECTION 501-09 Rear View Mirrors

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Torque Specifications

Item	Nm	lb-ft	lb-in
External mirror retaining bolt	11	8	-

DESCRIPTION AND OPERATION

Rear View Mirrors

There are two levels of exterior rear view mirror available depending upon market options. All models have a manual day/night interior rear view mirror. Low series models have manually operated remote exterior rear view mirrors. High series models have electrically operated power mirrors controlled by a multi-function switch mounted on the drivers door panel.

Replacement mirror glasses are available for both power and manually operated exterior rear view mirrors.

The interior rear view mirror is attached to a specially treated area of the front windshield by an adhesive patch. The adhesive patch is available as a service part.

DIAGNOSIS AND TESTING

Rear View Mirrors

Refer to Wiring Diagrams Section 501-09, for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical and electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Exterior mirror(s)	• Fuse(s) • Electrical connector(s) • Switch

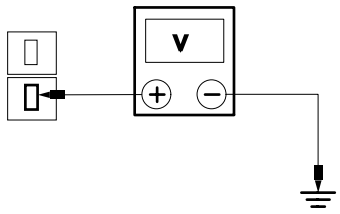
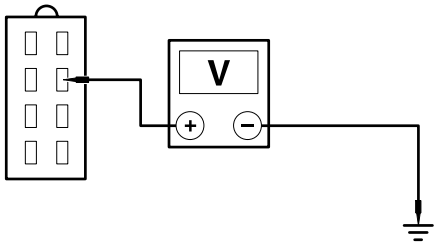
3. If an obvious cause for an observed or reported concern is found, correct the cause before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom	Possible Sources	Action
• The exterior mirrors are inoperative	• Exterior mirror control switch	• CARRY OUT the Exterior Mirror Control Switch Component Test. REFER to the component test at the end of the section.
	• Circuit(s).	• GO to Pinpoint Test A.
• A single exterior mirror is inoperative	• Exterior mirror control switch.	• CARRY OUT the Exterior Mirror Control Switch Component Test. REFER to the component test at the end of the section.
	• Exterior mirror motor(s). • Circuit(s).	• GO to Pinpoint Test B.
• A single exterior mirror does not function with switch logic	• Exterior mirror control switch.	• CARRY OUT the Exterior Mirror Control Switch Component Test. REFER to the component test at the end of the section.
	• Exterior mirror motor(s). • Circuit(s).	• GO to Pinpoint Test C.

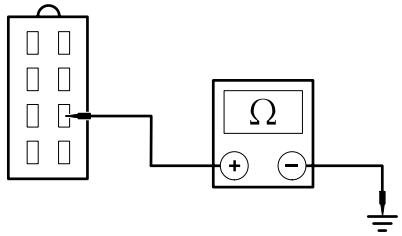
PINPOINT TEST A : THE EXTERIOR MIRRORS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK THE FUSE F6 (7.5A) (CJB)	
	1 Ignition switch in position 0.

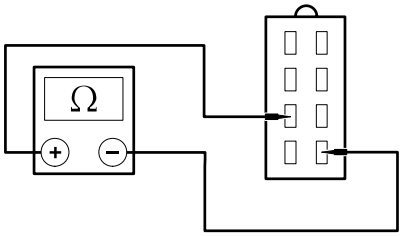
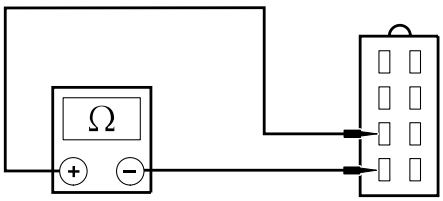
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect the Fuse F6 (7.5A) (CJB). • Is the fuse ok? → **Yes** GO to A2. → **No** INSTALL a new fuse. TEST the system for normal operation. If the fuse fails again repair circuit SBP06 (BN/RD) using the wiring diagram. INSTALL a new CJB if necessary.
A2: CHECK THE FUSE F6 (7.5A) (CJB) FOR POWER	
	1 Connect the Fuse F6 (7.5A) (CJB).
 E67858	2 Measure the voltage between Fuse F6 (7.5A) (CJB) pin 2, circuit SBP06 (BN/RD) component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A3. → **No** Repair circuit SBP06 (BN/RD) using the wiring diagram. INSTALL a new CJB if necessary. TEST the system for normal operation.
A3: CHECK THE VOLTAGE TO THE EXTERIOR MIRROR CONTROL SWITCH	
	1 Disconnect Exterior Mirror Control Switch CAPM20.
 TIE0014407	2 Measure the voltage between the exterior mirror control switch CAPM20 pin 6, circuit SBP06 (BN/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A4. → **No** REPAIR circuit SBP06 (BN/RD). TEST the system for normal operation.

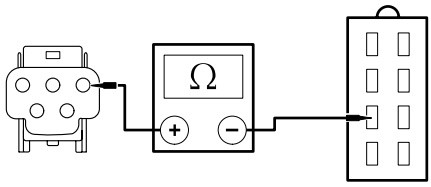
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A4: CHECK THE EXTERIOR MIRROR CONTROL SWITCH GROUND CIRCUIT FOR CONTINUITY	
 TIE0014408	1 Measure the resistance between the exterior mirror control switch CAPM20 pin 4, circuit GD356 (BK/VT), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. → **No** REPAIR circuit GD356 (BK/VT), ground connection G10 and splice SAD356 using the wiring diagram. TEST the system for normal operation.

PINPOINT TEST B : A SINGLE EXTERIOR MIRROR IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK THE EXTERIOR MIRROR MOTOR CIRCUIT FOR CONTINUITY	
	1 Disconnect Exterior Mirror Control Switch CAPM20.
 E96095	2 Measure the resistance between the exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the exterior mirror control switch CAPM20 pin 2, circuit CPM21 (YE/VT), harness side.
 E122760	3 Measure the resistance between the exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the exterior mirror control switch CAPM20 pin 1, circuit CPM17 (BU/GN), harness side. • Is the resistance less than 50 ohms? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. → **No** GO to B2.

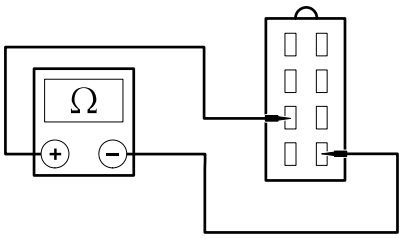
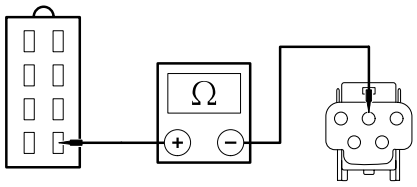
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE EXTERIOR MIRROR	
	1 Disconnect Driver Side Exterior Mirror C54 or Passenger Side Exterior Mirror C55.
 E104565	2 Measure the resistance between the: • Exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the driver side exterior mirror C54 pin 1, circuit CPM18 (GN/BN), harness side. • Exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the passenger side exterior mirror C55 pin 1, circuit CPM18 (GN/BN), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new exterior mirror. REFER to: Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM18 (GN/BN). TEST the system for normal operation.

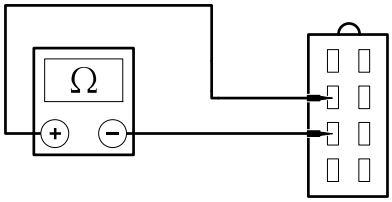
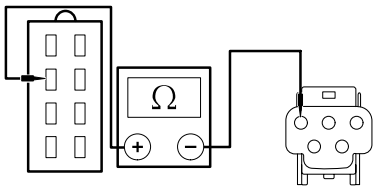
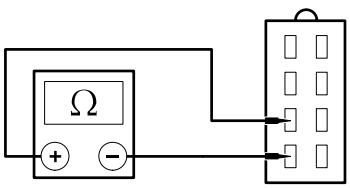
PINPOINT TEST C : A SINGLE EXTERIOR MIRROR DOES NOT FUNCTION WITH SWITCH LOGIC

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
C1: CHECK THE EXTERIOR MIRROR FUNCTIONS WITH SWITCH LOGIC	
	1 Ignition switch in position 0.
	2 Operate the exterior mirror control switch. • Does the exterior mirror function with switch logic? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. → **No** Driver side exterior mirror up/down function inoperative GO to C2. Driver side exterior mirror left/right function is inoperative GO to C4. Passenger side exterior mirror up/down function is inoperative GO to C6. Passenger side exterior mirror left/right function is inoperative GO to C8.

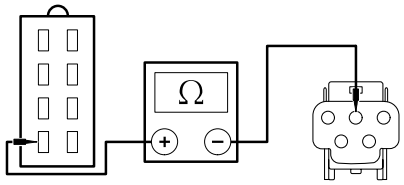
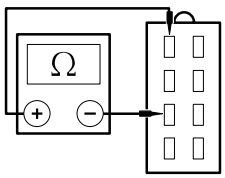
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C2: CHECK THE DRIVER SIDE EXTERIOR MIRROR UP/DOWN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Exterior Mirror Control Switch CAPM20.
 E96095	3 Measure the resistance between the exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the exterior mirror control switch CAPM20 pin 2, circuit CPM21 (YE/VT), harness side. • Is the resistance less than 50 ohms? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. REFER to the component test at the end of the section. → **No** GO to C3.
C3: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE DRIVER SIDE EXTERIOR MIRROR	
	1 Disconnect Driver Side Exterior Mirror C54.
 E104570	2 Measure the resistance between the exterior mirror control switch CAPM20 pin 2, circuit CPM21 (YE/VT), harness side and the driver side exterior mirror C54 pin 2, circuit CPM21 (YE/VT), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new driver side exterior mirror. REFER to: Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM21 (YE/VT). TEST the system for normal operation.
C4: CHECK THE DRIVER SIDE EXTERIOR MIRROR LEFT/RIGHT CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Exterior Mirror Control Switch CAPM20.

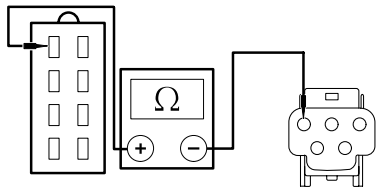
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E96096	3 Measure the resistance between the exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the exterior mirror control switch pin 5, circuit CPM20 (BN/WH), harness side. • Is the resistance less than 50 ohms? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. → **No** GO to C5.
C5: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE DRIVER SIDE EXTERIOR MIRROR	
	1 Disconnect Driver Side Exterior Mirror C54.
 E104566	2 Measure the resistance between the exterior mirror control switch CAPM20 pin 5, circuit CPM20 (BN/WH), harness side and the driver side exterior mirror C54 pin 3, circuit CPM20 (BN/WH), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new driver side exterior mirror. REFER to: Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM20 (BN/WH). TEST the system for normal operation.
C6: CHECK THE PASSENGER SIDE EXTERIOR MIRROR UP/DOWN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Exterior Mirror Control Switch CAPM20.
 E96097	3 Measure the resistance between the exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the exterior mirror control switch CAPM20 pin 1, circuit CPM17 (BU/GN), harness side. • Is the resistance less than 50 ohms? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. → **No** GO to C7.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C7: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE PASSENGER SIDE EXTERIOR MIRROR	
	1 Disconnect Passenger Side Exterior Mirror C55.
 E104567	2 Measure the resistance between the exterior mirror control switch CAPM20 pin 1, circuit CPM17 (BU/GN), harness side and the passenger side exterior mirror C55 pin 2, circuit CPM17 (BU/GN), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new passenger side exterior mirror. REFER to: Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM17 (BU/GN). TEST the system for normal operation.
C8: CHECK THE PASSENGER SIDE EXTERIOR MIRROR LEFT/RIGHT CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Exterior Mirror Control Switch CAPM20.
 E104568	3 Measure the resistance between the exterior mirror control switch CAPM20 pin 3, circuit CPM18 (GN/BN), harness side and the exterior mirror control switch CAPM20 pin 7, circuit CPM16 (BN/BU), harness side. • Is the resistance less than 50 ohms? → **Yes** CARRY OUT the Exterior Mirror Control Switch Component Test. → **No** GO to C9.
C9: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE PASSENGER SIDE EXTERIOR MIRROR	
	1 Disconnect Passenger Side Exterior Mirror C55.

DIAGNOSIS AND TESTING

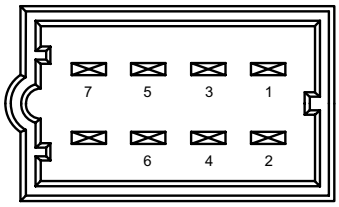
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E104569	2 Measure the resistance between the exterior mirror control switch CAPM20 pin 7, circuit CPM16 (BN/BU), harness side, and the passenger side exterior mirror C55 pin 3, circuit CPM16 (BN/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new passenger side exterior mirror. REFER to: Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM16 (BN/BU). TEST the system for normal operation.

Power mirror adjust switch component testing procedure

Circuit to test	Connect self–powered test light or ohmmeter to terminals	Move switch to these positions	A good switch will indicate
Power mirror, left side	6 and 3	Rest	Open circuit
Power mirror, left side	6 and 3	Up	Open circuit
Power mirror, left side	6 and 3	Down	Closed circuit
Up/down	6 and 1	Rest	Open circuit
Up/down	6 and 1	Up	Closed circuit
Up/down	6 and 1	Down	Open circuit
Power mirror, right side	6 and 3	Rest	Open circuit
Power mirror, right side	6 and 3	Up	Open circuit
Power mirror, right side	6 and 3	Down	Closed circuit
Up/down	6 and 2	Rest	Open circuit
Up/down	6 and 2	Up	Closed circuit
Up/down	6 and 2	Down	Open circuit
Power mirror, left side	6 and 3	Rest	Open circuit
Power mirror, left side	6 and 3	Left	Closed circuit
Power mirror, left side	6 and 3	Right	Open circuit
Left/right	6 and 7	Rest	Open circuit
Left/right	6 and 7	Left	Open circuit
Left/right	6 and 7	Right	Closed circuit
Power mirror, right side	6 and 5	Rest	Open circuit
Power mirror, right side	6 and 5	Left	Open circuit

DIAGNOSIS AND TESTING

Circuit to test	Connect self–powered test light or ohmmeter to terminals	Move switch to these positions	A good switch will indicate
Power mirror, right side	6 and 5	Right	Closed circuit
Left/right	6 and 3	Rest	Open circuit
Left/right	6 and 3	Left	Closed circuit
Left/right	6 and 3	Right	Open circuit
Up/down	4 and 3	Rest	Open circuit
Up/down	4 and 3	Up	Closed circuit
Up/down	4 and 3	Down	Open circuit
Left/right	4 and 3	Rest	Open circuit
Left/right	4 and 3	Left	Open circuit
Left/right	4 and 3	Right	Closed circuit



E124614

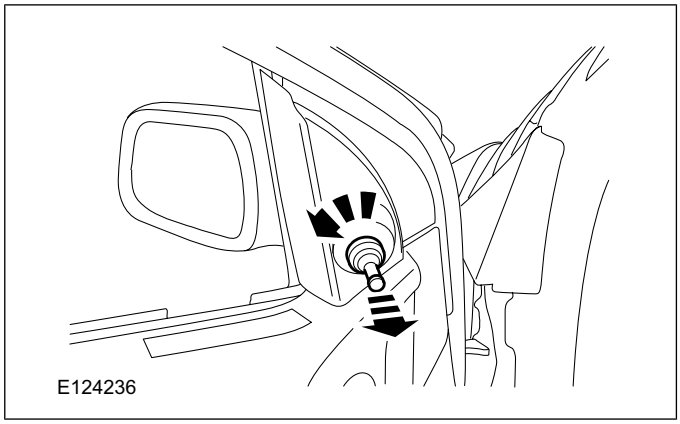
REMOVAL AND INSTALLATION

Exterior Mirror(43 364 0)

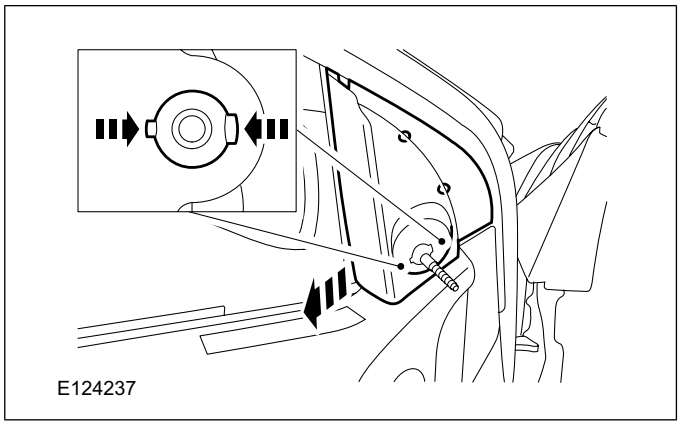
Removal

Vehicles with manual mirrors

1. **Remove the exterior mirror adjustment lever cover.**

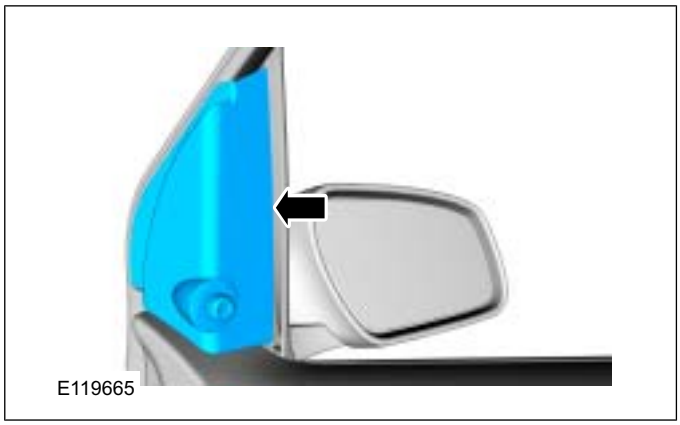


2. **Remove the exterior mirror trim panel.**

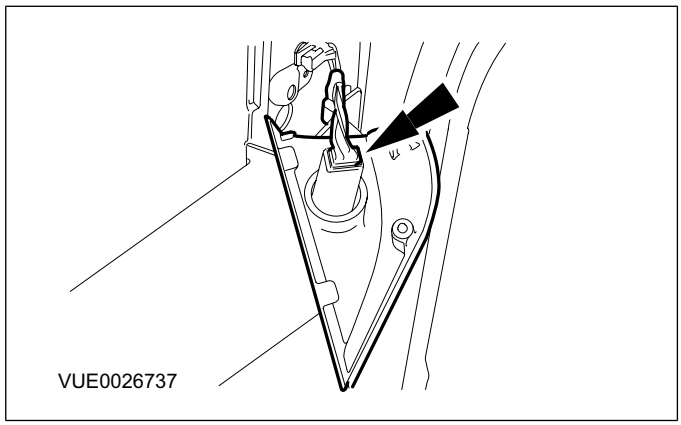


Vehicles with power mirrors

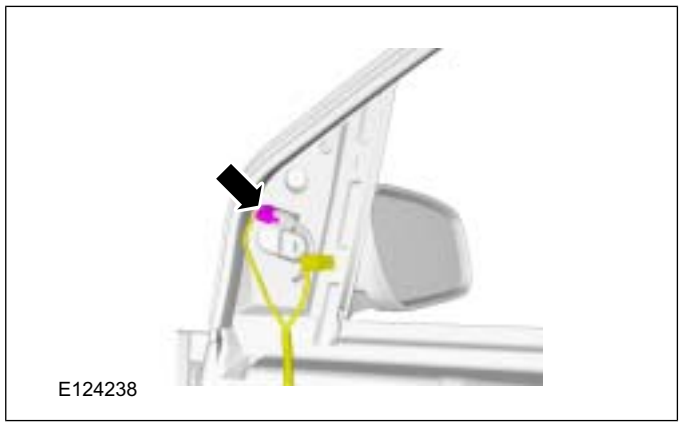
3. **Detach the exterior mirror trim panel.**



4. **Disconnect the exterior mirror control switch electrical connector.**

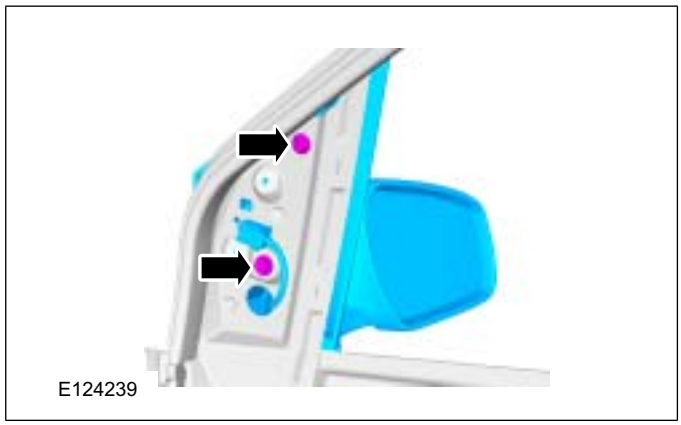


5. **Disconnect the exterior mirror electrical connector.**



All vehicles

6. **Remove the exterior mirror (power mirror shown).**
   1. Remove the exterior mirror retaining screw.
   2. Remove the exterior mirror retaining bolt.



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.

SECTION 501-10 Seating

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Torque Specifications

Item	Nm	lb-ft	lb-in
Front seat retaining bolts	35	-	-
Front seat belt buckle	47	-	-
Front seat cushion retaining bolts	23	17	-
Front seat backrest retaining bolts	48	35	-
Rear seat backrest latch retaining bolts	27	20	-
Rear seat cushion retaining bolts	25	18	-
Rear seat backrest retaining bolts	25	18	-
Rear center safety belt lower anchor and buckle assembly retaining bolt	55	41	-

DESCRIPTION AND OPERATION

Seats

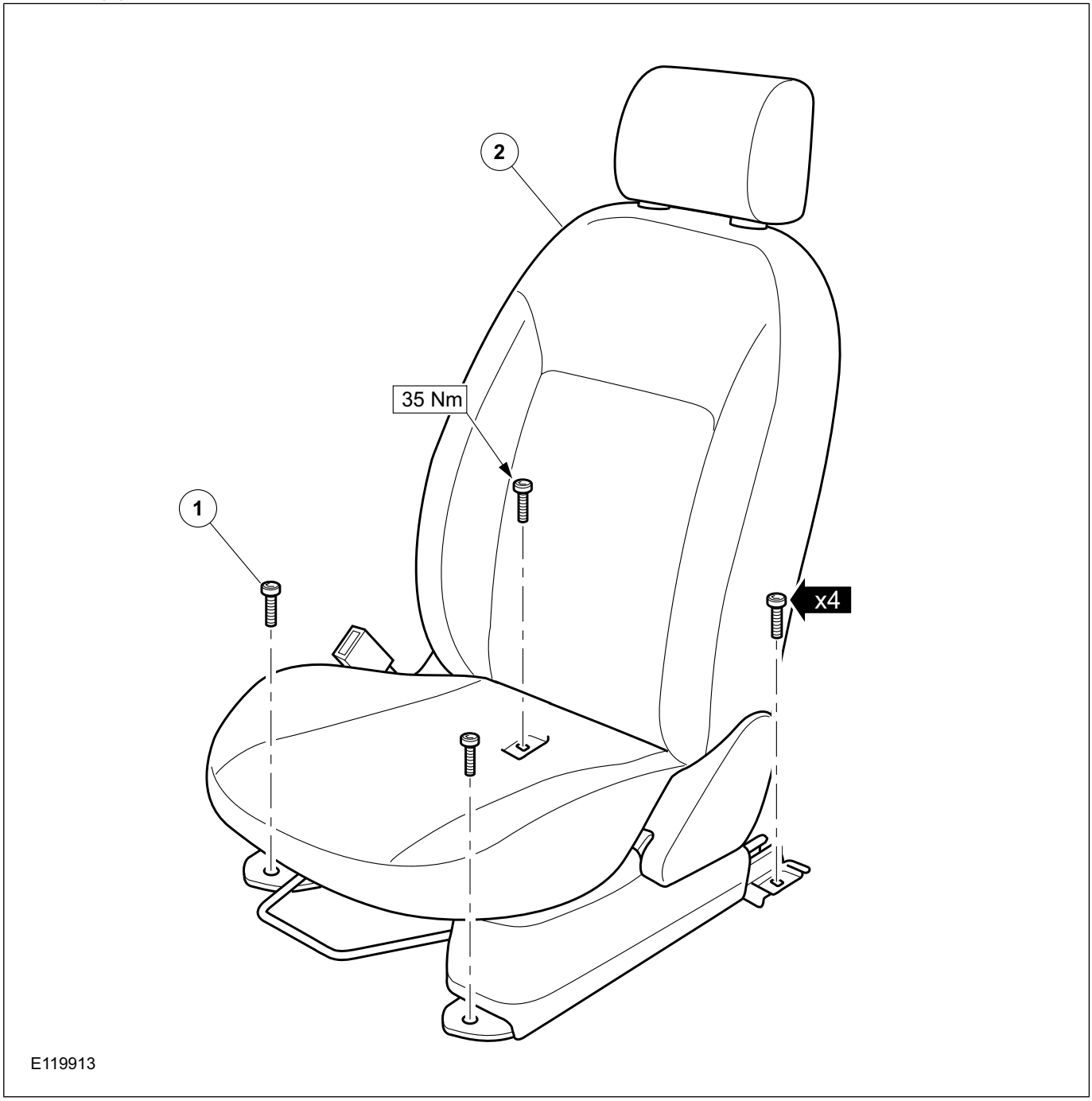
Front seats have cut and sew covers over foam padding supported by sprung wire on a steel frame. The cushion and backrest are contoured for lateral support with tie downs in the seat back to improve rear seat knee clearance. Both front seats can be fully reclined and are fitted with two way adjustable head restraints with foam pads. A flow-through gap between the head restraint and the front seat backrest has been incorporated to allow cool air to reach rear seat occupants. Seat tracks allow forwards and rearwards travel. All front seats incorporate an outer trim panel, inner trim panels are fitted depending on vehicle specifications.

The rear seats are contoured with foam padding supported on a sprung wire frame. The rear seat backrest has two integral head restraints.

REMOVAL AND INSTALLATION

Front Seat

1. **Remove the components in the order indicated in the following illustration(s) and table(s).**



Item	Description
1	Front seat retaining bolts
2	Front seat

2. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Front Seat Backrest Cover(40 108 0)

General Equipment

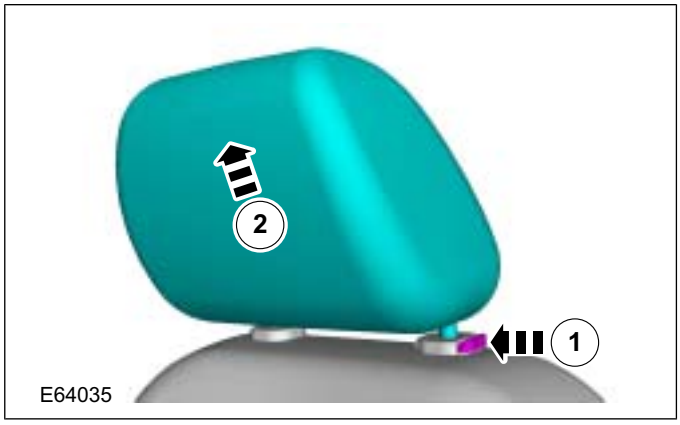
Hog ring pliers

Removal

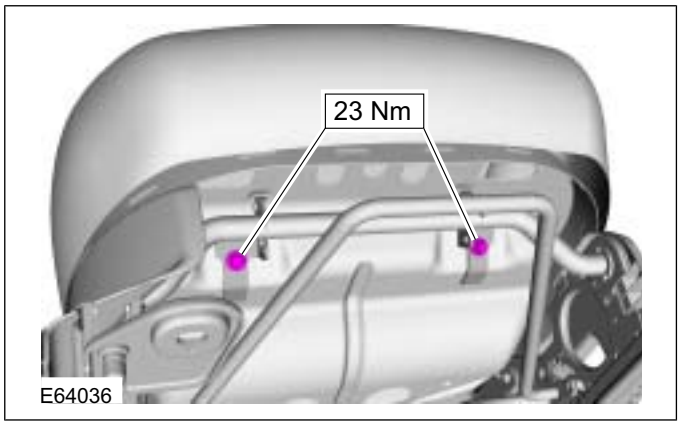
1. **Remove the front seat.**

   For additional information, refer to: Front Seat (501-10 Seating, Removal and Installation).

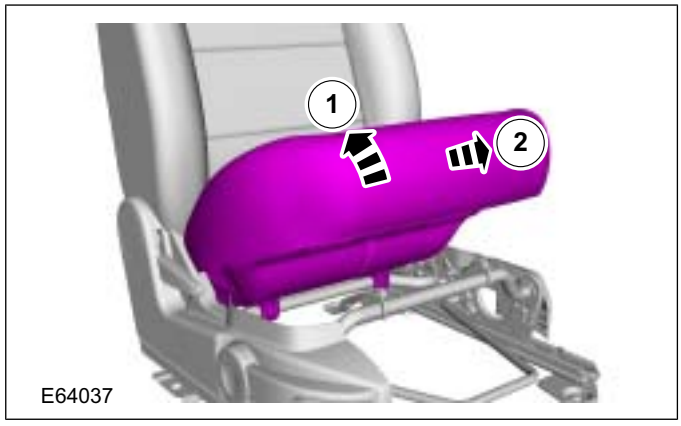
2. **Remove the head restraint.**
   1. Press in the head restraint locking clip.
   2. Pull the head restraint out of the front seat backrest.



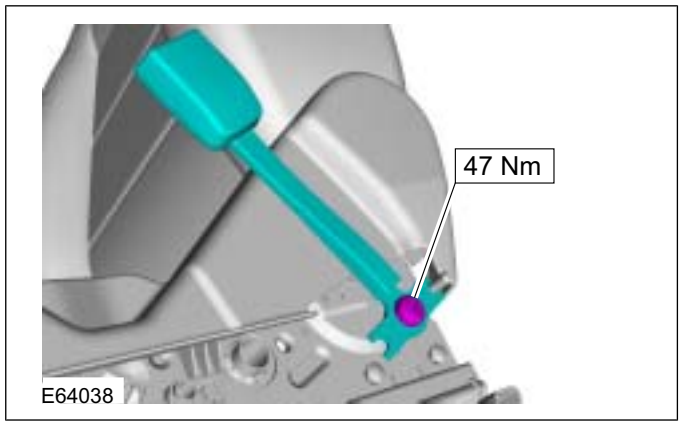
3. **Remove the front seat cushion retaining bolts.**



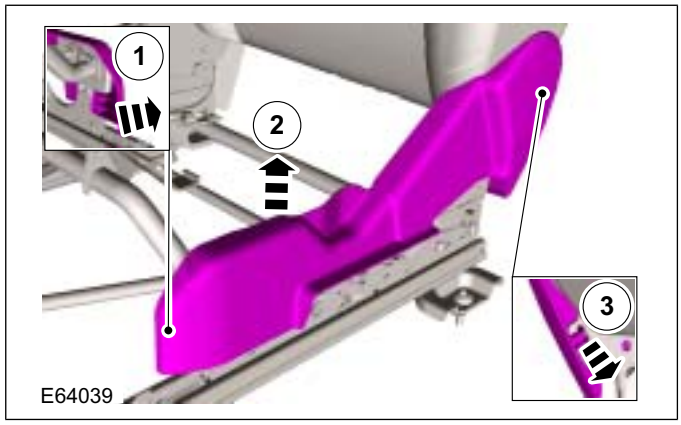
4. **Remove the front seat cushion.**
   1. Lift the front seat cushion upwards.
   2. Pull the front seat cushion forward to detach the cushion retaining hooks



5. **Remove the front seat belt buckle.**

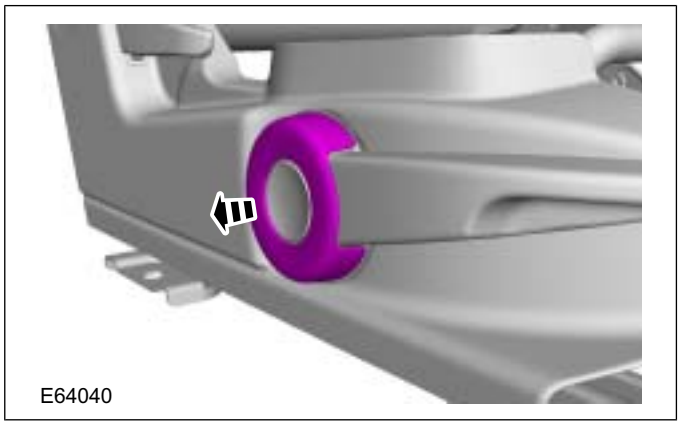


6. **Remove the front seat base inner trim panel.**
   1. Detach the trim panel front retaining clip.
   2. Lift the trim panel to release the upper retaining clip.
   3. Detach the trim panel rear retaining clip.



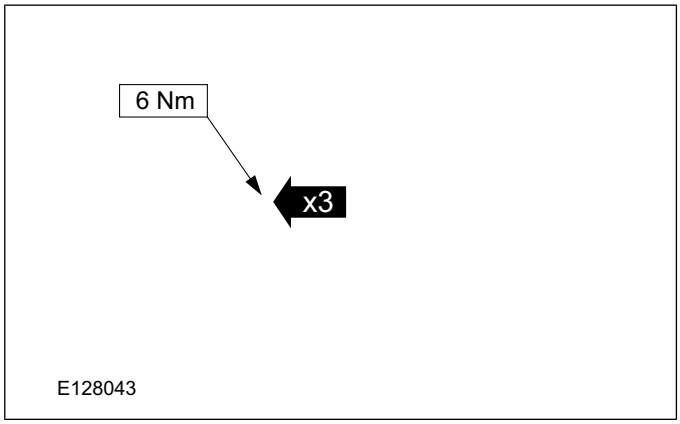
REMOVAL AND INSTALLATION

7. Remove the front seat height adjustment lever trim cover.



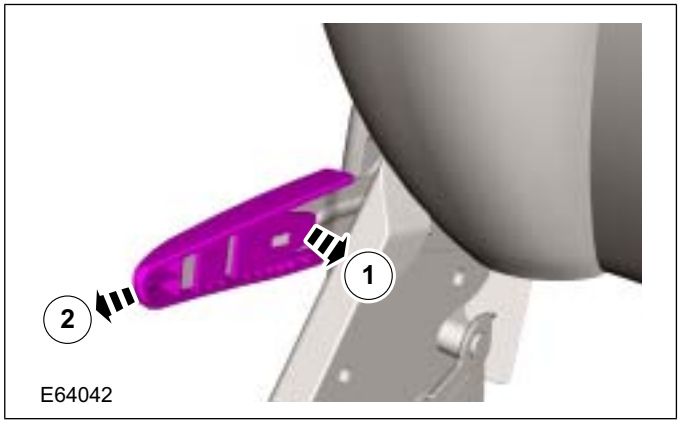
8. Remove the front seat height adjustment lever.

- Remove the front seat height adjustment lever retaining bolts.



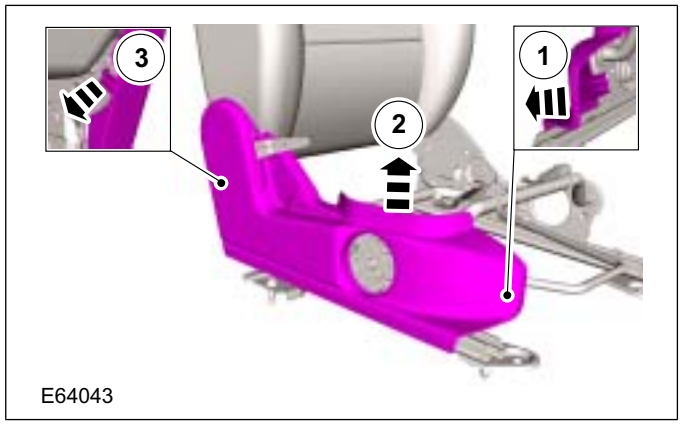
9. Remove the front seat backrest tilt lever trim cover.

1. Release the tilt lever trim cover retaining clip.
2. Pull the tilt lever trim cover off of the tilt lever.



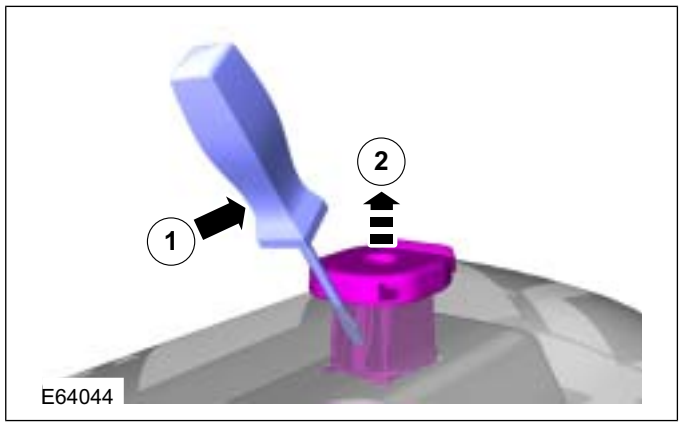
10. Remove the front seat base outer trim panel.

1. Detach the trim panel front retaining clip.
2. Lift the trim panel to release the upper retaining clip.
3. Detach the trim panel rear retaining clip.



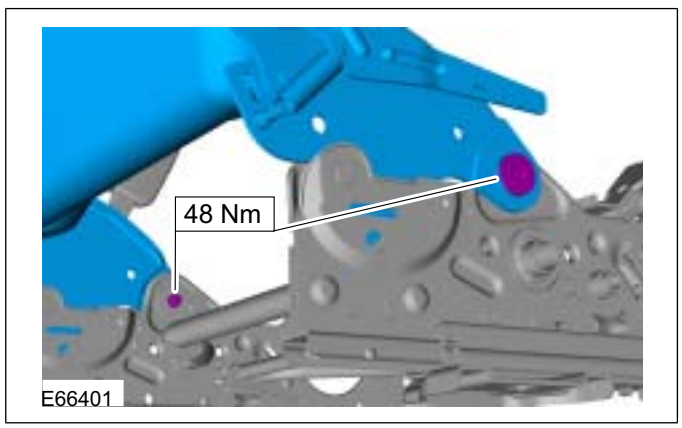
11. Remove the front seat head restraint guide tubes.

1. Using a flat blade screwdriver, press in the head restraint tube locking clip.
2. Lift the head restraint tube out of the front seatback.



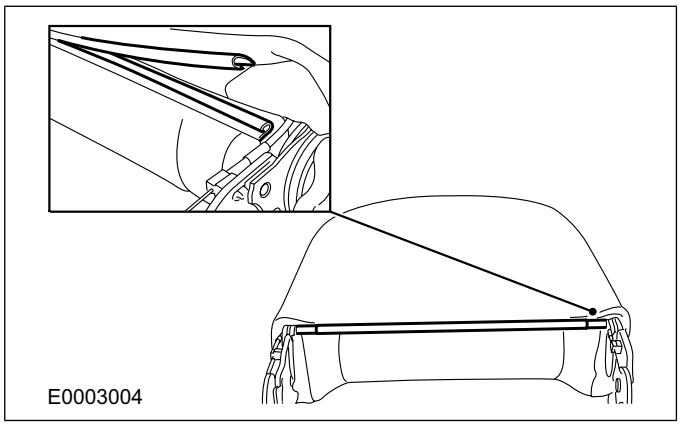
12. Remove the front seat backrest assembly.

- Remove the front seat backrest retaining bolts.



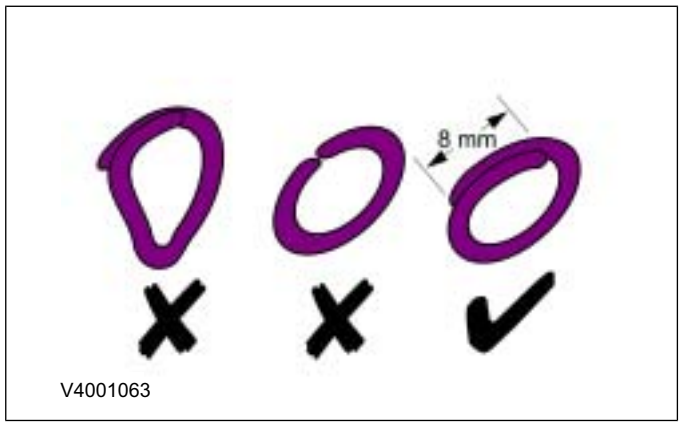
REMOVAL AND INSTALLATION

13. Detach the front seat backrest cover strip.



14. Remove the front seat backrest cover.

To install, reverse the removal procedure.



Installation

1. NOTE: Use hog ring pliers to close the hogrings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

REMOVAL AND INSTALLATION

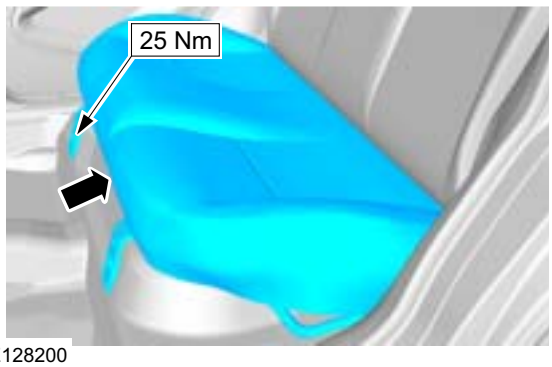
Rear Seat Backrest Cover

General Equipment

Hog ring pliers

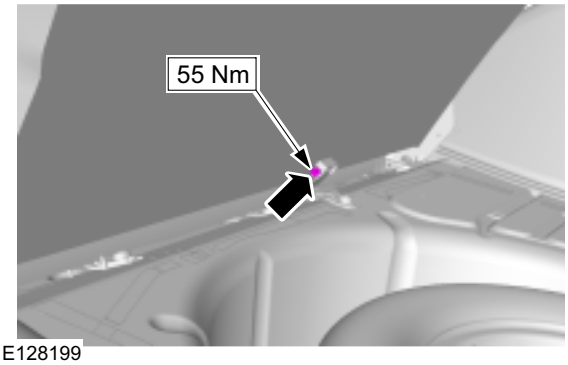
Removal

1. **Remove the rear seat cushion assembly.**



E128200

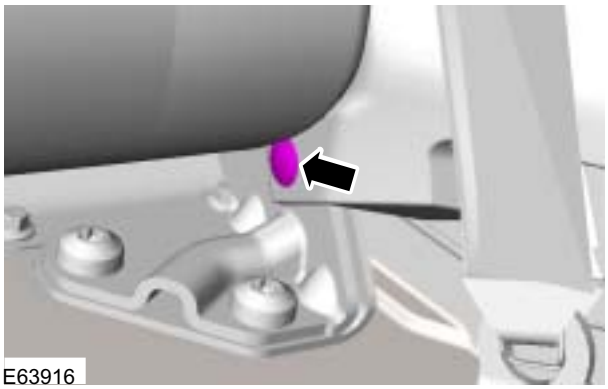
2. **Remove the safety belt bolt.**



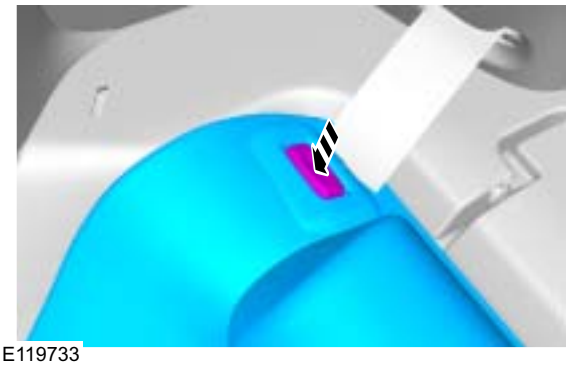
E128199

3. **Detach the retaining clip and remove the rear scuff plate trim panel.**

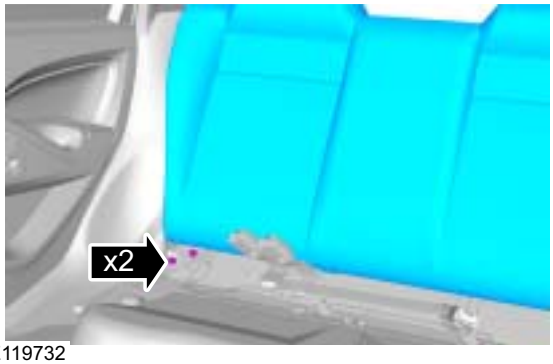
   For additional information, refer to: Rear Scuff Plate Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).


E63916

4. **Fold the rear seat back by pressing the push button on both the sides.**


E119733

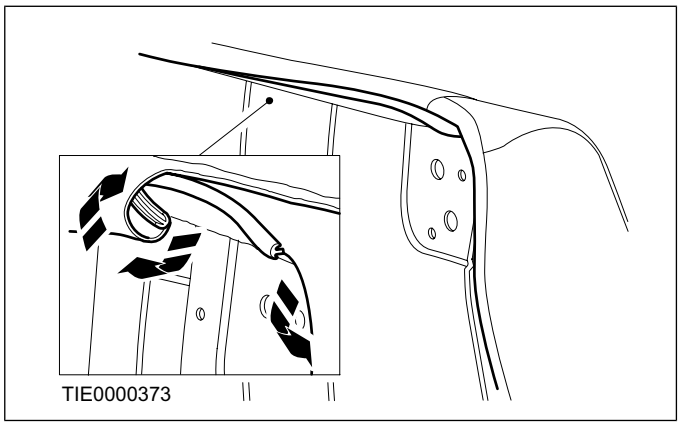
5. **Remove the rear seat backrest frame bolts (both sides).**



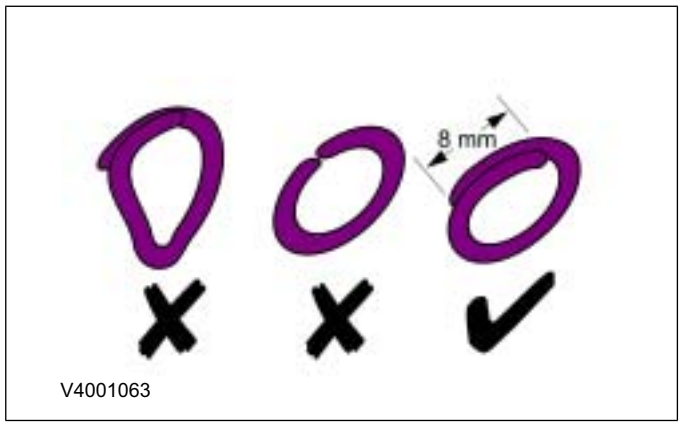
E119732

REMOVAL AND INSTALLATION

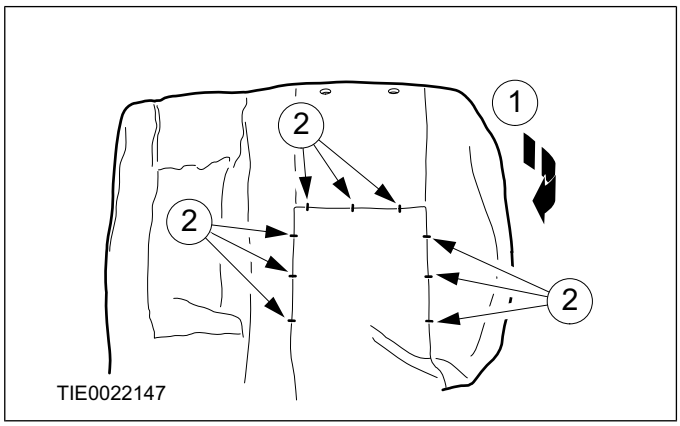
6. **Detach the retaining strip.**



1. **To install, reverse the removal procedure.**



7. **Remove the backrest cover.**
   1. Roll the backrest cover inwards to access the pleating hog rings.
   2. Cut the hog rings.



8. **Remove the rear seat backrest latch.**

   For additional information, refer to: Rear Seat Backrest Latch (501-10 Seating, Removal and Installation).

9. **Remove the rear seat backrest cover.**

Installation

NOTE: Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

REMOVAL AND INSTALLATION

Rear Seat Backrest Latch(40 534 0)

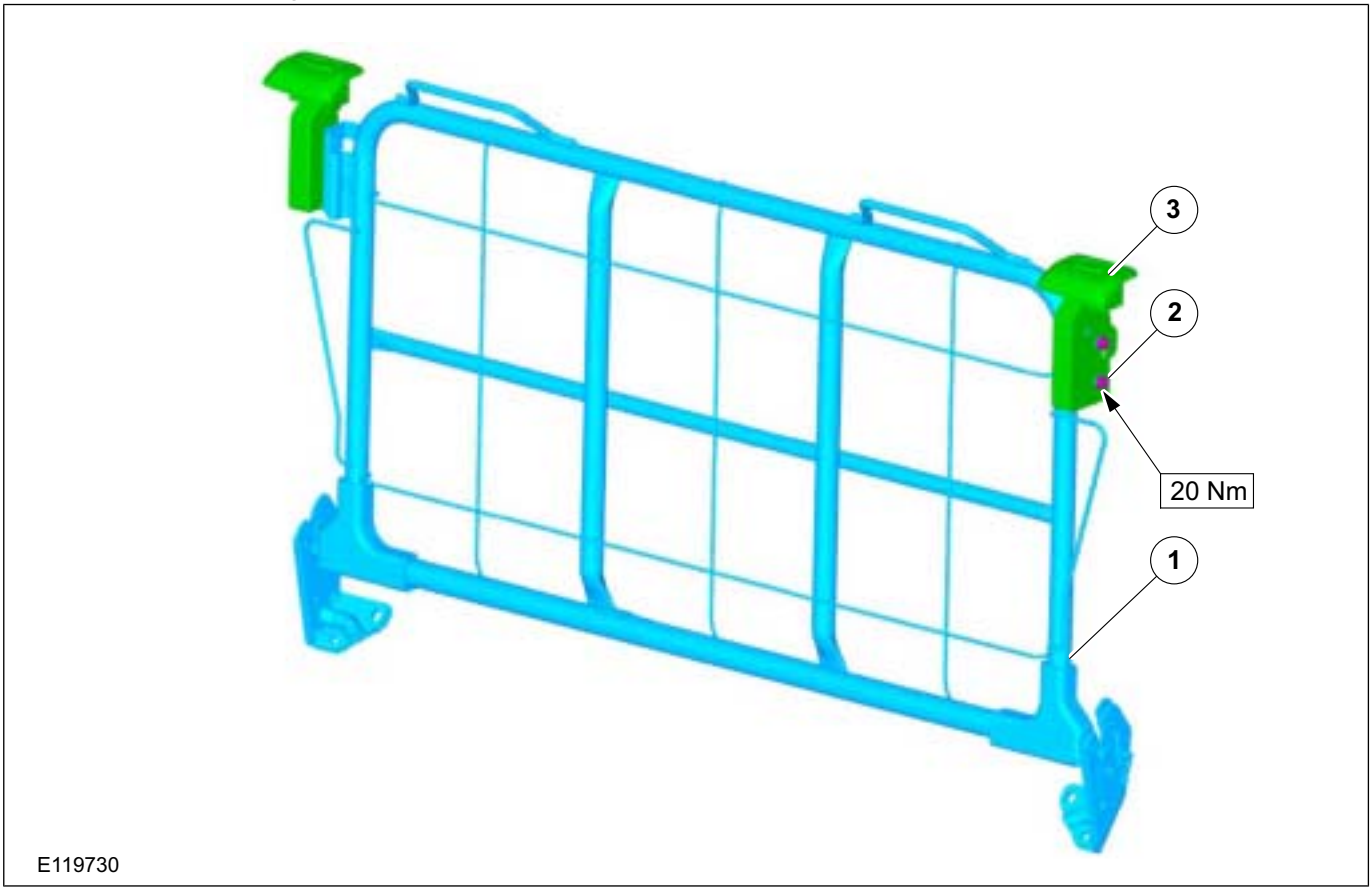
Removal

1. Remove the rear seat backrest cover.

For additional information, refer to: Rear Seat Backrest Cover (501-10 Seating, Removal and Installation).

2. Remove the rear seat backrest latch.

1. Remove the rear seat backrest frame from the rear seat backrest cover.
2. Remove the bolts.
3. Remove the latch.



Installation

1. To install, reverse the removal procedure.

SECTION 501-11 Glass, Frames and Mechanisms

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Description	Specification
Cleaner/activator	WSK-M2G342-A
Primer	WSK-M2G343-A
2K Adhesive	WSK-M11P57-A
2K Hardener/mixer	WSK-M2G322-B2

Torque Specifications

Item	Nm	lb-ft	lb-in
Front door regulator motor retaining screws	4	-	35
Door latch retaining nuts	12	9	-
Door window regulator retaining nuts	2	-	18
Door window glass clamp retaining bolts	7	-	62
Windshield wiper arm retaining nut	20	-	-

DESCRIPTION AND OPERATION

Glass, Frames and Mechanisms

Opening Windows

Manually operated windows are fitted as standard. There is a market option for power windows. The power windows are activated by switches on passenger door (Passenger side only) or by a multiple switch on the driver door (Driver & passenger side only).

Manually operated rear door windows are installed as standard.

Fixed/Direct Glazed Windows

The windshield and the rear window are directly glazed to the window opening flange by means of a polyurethane (PU) adhesive bead. In addition to fixing the glass to the opening flange, the adhesive bead also forms a water tight seal around the inner edge of the glass.

It is essential for good adhesion and sealing of direct glazed windows that the correct materials are used and that the PU adhesive is allowed to cure.

NOTE: Should the ambient temperature fall below 10°C, warming of the adhesive using a hot air gun should be employed. The curing time of the adhesive depends not only on temperature, but also on the relative humidity of the air. The cure time for a warm humid environment will be shorter than for a cool, dry atmosphere.

NOTE: A surface film of water on the bond line of the glass or on the window opening flange will prevent the adhesive correctly bonding the two surfaces.

Any moisture on the bond line of the glass or on the window opening flange must be removed using a hot air gun before applying the PU bead.

To carry out direct glazing operations, an oscillating cutter, an assortment of special cutting blades, a cartridge gun and two glaziers suction cups will be required, in addition to the contents supplied with the Ford repair kit.

DIAGNOSIS AND TESTING

Glass, Frames and Mechanisms

Refer to Wiring Diagrams Section 501-11, for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Window seal • Door window frame	• Fuse(s) • Electrical connector(s) • Switch(es) • Circuit(s)

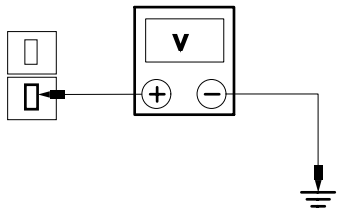
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

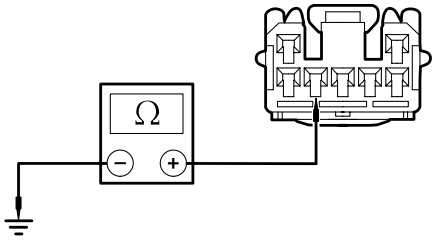
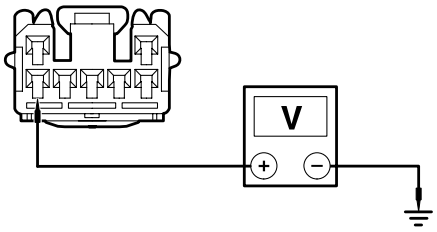
Symptom	Possible Sources	Action
• All power windows are inoperative	• Driver power window control switch. • Circuit(s).	• GO to Pinpoint Test A.
• A single power window is inoperative - driver side	• Driver power window control switch. • Power window motor. • Circuit(s).	• GO to Pinpoint Test B.
• A single power window is inoperative - passenger side	• Driver power window control switch. • Passenger power window control switch. • Power window motor. • Circuit(s).	• GO to Pinpoint Test C.
• The defrost system is inoperative	• Heated rear window control switch. • BFC. • Circuit(s).	• GO to Pinpoint Test D.
	• Heated rear window grid wire.	• CARRY OUT the Heated Rear Window Grid Wire Component Test in this procedure.
• The defrost system will not shut off automatically	• Heated rear window control switch. • BFC.	• If switch is giving power supply continously. REPLACE the heated rear window control switch. • Renew the BFC, if the shut off does not happen after 14 minutes.

DIAGNOSIS AND TESTING

PINPOINT TEST A : ALL POWER WINDOWS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK FUSE F57 (30A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect the Fuse F57 (30A) (CJB). • Is the fuse ok? → **Yes** GO to A2. → **No** INSTALL a new fuse. TEST the system for normal operation. If the fuse fails again repair circuit CDC21 (GY/BN) using the wiring diagram. INSTALL a new CJB if necessary.
A2: CHECK FUSE F57 (30A) (CJB) FOR POWER	
	1 Ignition switch in position 0.
	2 Ignition switch in position II.
 E67858	3 Measure the voltage between fuse F57 (30A) (CJB) pin no 2, circuit CBP57 (BN/GN) component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A3. → **No** Repair circuit CDC21 (GY/BN) using the wiring diagram. INSTALL a new CJB if necessary. TEST the system for normal operation.
A3: CHECK THE DRIVER POWER WINDOW CONTROL SWITCH LED	
	1 Ignition switch in position II. • Do the driver power window control switch LED illuminate? → **Yes** VERIFY the customer concern. → **No** GO to A4.
A4: CHECK FOR CONTINUITY BETWEEN THE DRIVER POWER WINDOW CONTROL SWITCH AND GROUND	
	1 Ignition switch in position 0.

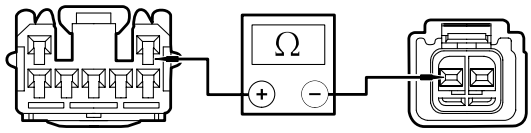
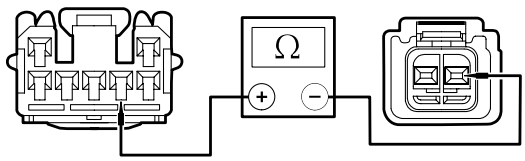
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Driver Window Control Switch CAPW10.
 E122936	3 Measure the resistance between the driver power window control switch CAPW10 pin 4, circuit GD356 (BK/VT), harness side and ground. • Is the resistance less than 2 ohms? → **Yes** GO to A5. → **No** LOCATE and RECTIFY the break in the circuit GD356 (BK/VT) between the driver side power window switch and soldered connection splice SAD356, ground G10 using the Wiring Diagram. CHECK the operation of the system.
A5: CHECK FOR VOLTAGE TO THE DRIVER POWER WINDOW CONTROL SWITCH	
	1 Ignition switch in position II.
 E122954	2 Measure the voltage between the driver power window control switch CAPW10 pin 3, circuit CBP57 (BN/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new driver side power window switch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit CBP57 (BN/GN) between the driver side power window switch and soldered connection splice SABP57 using the Wiring Diagram. CHECK the operation of the system.

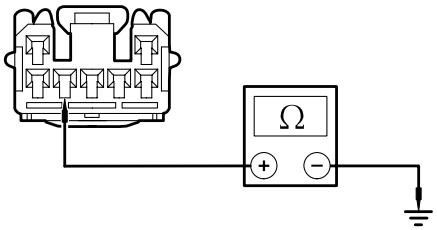
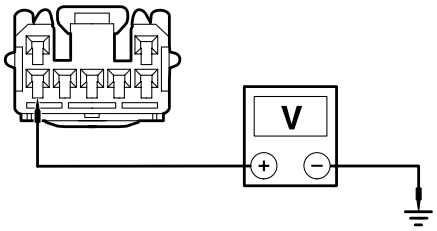
PINPOINT TEST B : A SINGLE POWER WINDOW IS INOPERATIVE - DRIVER SIDE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK FOR VOLTAGE TO THE DRIVER POWER WINDOW CONTROL SWITCH	
	1 Ignition switch in position II. • Does the driver power window control switch LED illuminate? → **Yes** GO to B2. → **No** GO to B4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK FOR CONTINUITY BETWEEN THE DRIVER POWER WINDOW CONTROL SWITCH AND THE MOTOR DOWN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Driver Power Window Control Switch CAPW10.
	3 Disconnect Driver Power Window Motor CAPW11.
 E122948	4 Measure the resistance between the driver power window control switch CAPW10 pin 2, circuit CPW11 (BU/GY), harness side and the driver power window motor CAPW11 pin 2, circuit CPW11 (BU/GY), harness side. • Is the resistance less than 2 ohms? → **Yes** GO to B3. → **No** REPAIR circuit CPW11 (BU/GY). TEST the system for normal operation.
B3: CHECK FOR CONTINUITY BETWEEN THE DRIVER POWER WINDOW CONTROL SWITCH AND THE MOTOR UP CIRCUIT	
 E122949	1 Measure the resistance between the driver power window control switch CAPW10 pin 6, circuit CPW10 (YE/VT), harness side and the driver power window motor CAPW11 pin 1, circuit CPW10 (YE/VT), harness side. • Is the resistance less than 2 ohms? → **Yes** INSTALL a new front door window regulator motor. REFER to: Front Door Window Regulator Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPW10 (YE/VT). TEST the system for normal operation.
B4: CHECK FOR CONTINUITY BETWEEN THE DRIVER POWER WINDOW CONTROL SWITCH AND GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Driver Power Window Control Switch CAPW10.

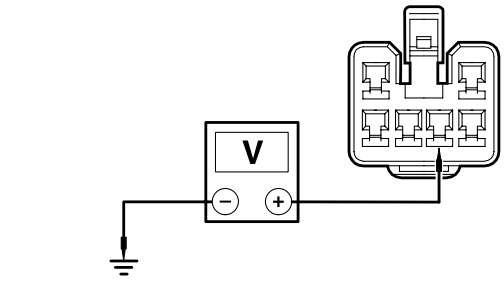
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E122952	3 Measure the resistance between the driver power window control switch CAPW10 pin 4, circuit GD356 (BK/VT), harness side and ground. • Is the resistance less than 2 ohms? → **Yes** GO to B5. → **No** REPAIR circuit GD356 (BK/VT), splice SAD356 and ground G10. TEST the system for normal operation.
B5: CHECK FOR VOLTAGE TO THE DRIVER POWER WINDOW CONTROL SWITCH	
	1 Ignition switch in position II.
 E122954	2 Measure the voltage between the driver power window control switch CAPW10 pin 3, circuit CBP57 (BN/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new driver side power window switch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit CBP57 (BN/GN) between the driver side power window switch and soldered connection splice SABP57 using the Wiring Diagram. CHECK the operation of the system.

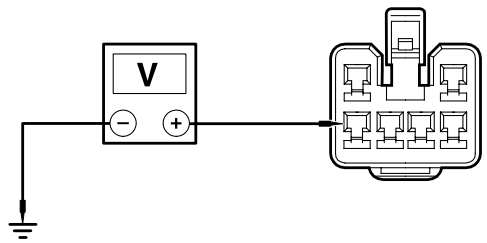
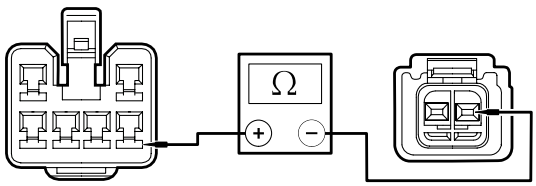
PINPOINT TEST C : A SINGLE POWER WINDOW IS INOPERATIVE - PASSENGER SIDE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
C1: DOES THE PASSENGER WINDOW OPERATE FROM THE DRIVER SIDE POWER WINDOW CONTROL SWITCH	
	1 Ignition switch in position II.
	2 Operate the passenger power window from the driver power window control switch. • Does the passenger power window operate? → **Yes** REPAIR circuit CBP57 (BN/GN). TEST the system for normal operation. → **No** GO to B4.

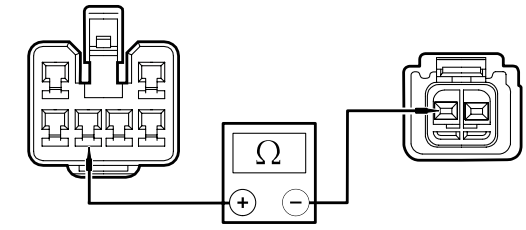
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C2: CHECK THE DRIVER SIDE PASSENGER POWER WINDOW CONTROL SWITCH LED (IF EQUIPPED)	
	1 Observe the driver side passenger power window control switch LED (if equipped). • Is the driver side passenger power window control switch LED illuminated? → **Yes** GO to C3. → **No** LOCATE and RECTIFY the break in the circuit between the driver side power window switch and soldered connection using the Wiring Diagram. CHECK the operation of the system.
C3: CHECK THE DOWN CIRCUIT VOLTAGE TO THE PASSENGER POWER WINDOW CONTROL SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Power Window Control Switch CBPW19.
	3 Ignition switch in position II.
	4 Operate the driver side passenger power window control switch to the DOWN position.
 E122995	5 Measure the voltage between the passenger power window control switch CBPW19 pin 4, circuit CPW12 (GN/OG), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to C4. → **No** REPAIR circuit CPW12 (GN/OG). TEST the system for normal operation.
C4: CHECK THE UP CIRCUIT VOLTAGE TO THE PASSENGER POWER WINDOW CONTROL SWITCH	
	1 Operate the driver side passenger power window control switch to the UP position.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E122996	2 Measure the voltage between the passenger power window control switch CBPW19 pin 6, circuit CPW13 (BN/YE), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new passenger side power window switch. CHECK the operation of the system. → **No** REPAIR circuit CPW13 (BN/YE). TEST the system for normal operation.
C5: CHECK FOR CONTINUITY BETWEEN THE PASSENGER POWER WINDOW CONTROL SWITCH DOWN CIRCUIT AND THE PASSENGER POWER WINDOW MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect Power Window Motor CBPW20.
 E122997	3 Measure the resistance between the passenger power window control switch CBPW19 pin 3, circuit CPW19 (VT), harness side and the passenger power window motor CBPW20 pin 1, circuit CPW19 (VT), harness side. • Is the resistance less than 2 ohms? → **Yes** GO to C6. → **No** REPAIR circuit CPW19 (VT). TEST the system for normal operation.

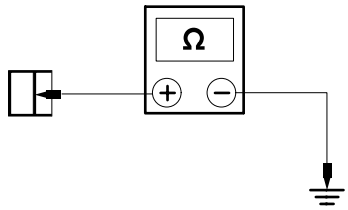
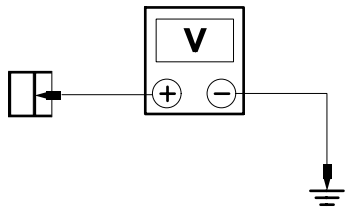
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C6: CHECK FOR CONTINUITY BETWEEN THE PASSENGER POWER WINDOW CONTROL SWITCH UP CIRCUIT AND THE PASSENGER POWER WINDOW MOTOR	
 E122998	1 Measure the resistance between the passenger power window control switch CBPW19 pin 5, circuit CPW20 (WH/OG), harness side and the passenger power window motor CBPW20 pin 2, circuit CPW20 (WH/OG), harness side. • Is the resistance less than 2 ohms? → **Yes** INSTALL a new front door window regulator motor. REFER to: Front Door Window Regulator Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPW20 (WH/OG). TEST the system for normal operation.

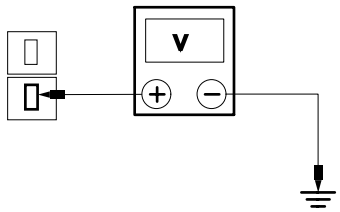
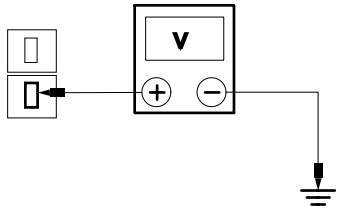
PINPOINT TEST D : THE DEFROST SYSTEM IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
D1: CHECK THE OPERATION OF THE HEATED REAR WINDOW	
	1 Ignition switch in position II.
	2 Activate on the heated rear window switch.
	3 Observe the heated rear window switch • Does the heated rear window LED illuminate? → **Yes** GO to D2. → **No** GO to D4.
D2: CHECK THE HEATED REAR WINDOW FOR GROUND	
	1 Switch off the heated rear window switch.
	2 Ignition switch in position 0.
	3 Disconnect Heated rear window C4RD02-B.

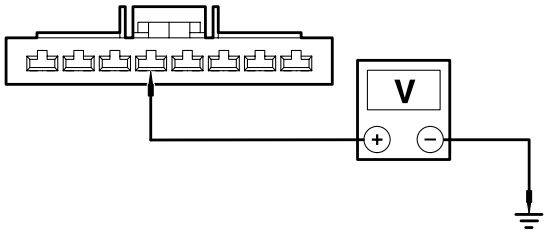
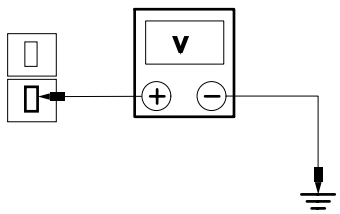
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E68556	4 Measure the resistance between the heated rear window C4RD02-B pin 1, circuit GD326 (BK/WH), harness side and ground. • Is the resistence less than 2 ohms? → **Yes** GO to D3. → **No** REPAIR circuit GD326 (BK/WH), splice S4D326 and ground connection G17, using the Wiring Diagrams. TEST the system for normal operation.
D3: CHECK THE HEATED REAR WINDOW FOR POWER	
	1 Disconnect Heated rear window C4RD02-A.
	2 Ignition switch in position II.
	3 Switch on the heated rear window.
 E68784	4 Measure the voltage between the heated rear window C4RD02-A pin 1, circuit CRD06 (BN/YE), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** REFER to COMPONENT TESTS, Heated Rear Window Grid Wire Test, at the end of this pinpoint routine. → **No** Repair circuit CRD06 (BN/YE) and splice S2RD06 using the Wiring Diagrams. TEST the system for normal operation.
D4: CHECK F26 (20 A) CJB AND F34 (3A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect F26 (20A) (CJB) and F34 (3A) (CJB).
	3 Check F26 (20A) (CJB) and F34 (3A) (CJB). • Is the fuse OK? → **Yes** GO to D5. → **No** INSTALL a new fuse. TEST the system for normal operation. If the fuse fails again, REPAIR circuit SBP26 (YE/RD) using the Wiring Diagrams. INSTALL a new CJB if necessary.

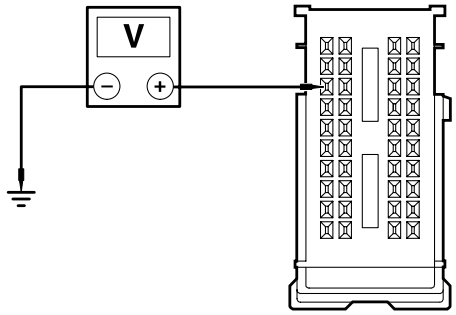
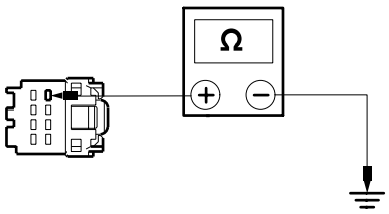
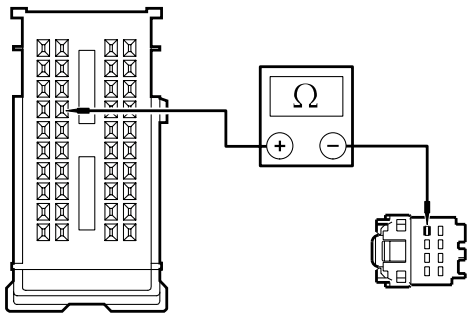
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D5: CHECK F26 (20 A) (CJB) FOR POWER.	
 E67858	1 Measure the voltage between F26 (20 A) (CJB) pin 2, circuit SBP26 (YE/RD), component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to D6. → **No** REPAIR circuit SBF05 (GY/RD), using the Wiring Diagrams. INSTALL a new CJB if necessary. TEST the system for normal operation.
D6: CHECK THE HEATED REAR WINDOW SWITCH FOR IGNITION POWER	
	1 Ignition switch in position II.
 E67858	2 Switch ON the heated rear window.
	3 Measure the voltage between the F34 (3 A) (CJB) pin 2, circuit CBP34 (VT/BN), Component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to D7. → **No** REPAIR circuit CRD06 (BN/YE), using the Wiring Diagrams. INSTALL a new CJB if necessary. TEST the system for normal operation.
D7: CHECK THE BFC FOR HEATED REAR WINDOW BATTERY POWER.	
	1 Ignition switch in position 0.
	2 Switch OFF the heated rear window.
	3 Disconnect BFC C2AM02-C.

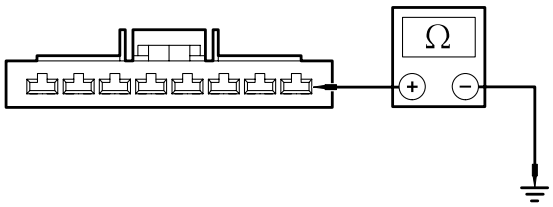
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E122955	4 Measure the voltage between the C2AM02-C pin 4, circuit SBP26 (YE/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to D8. → **No** REPAIR circuit SBP26 (YE/RD), using the Wiring Diagrams. TEST the system for normal operation.
D8: CHECK F38 (7.5 A) (CJB)	
	1 Connect BFC C2AM02-C.
	2 Disconnect F38 (7.5A) (CJB).
	3 Check F38 (7.5A) (CJB). • Is the fuse ok? → **Yes** GO to D9. → **No** INSTALL a new fuse. TEST the system for normal operation. If the fuse fails again, REPAIR circuit CBP38 (GY/BU), using the Wiring Diagrams. INSTALL a new CJB if necessary.
D9: CHECK F38 (7.5 A) (CJB) FOR POWER.	
	1 Ignition switch in position II.
 E67858	2 Measure the voltage between F38 (7.5 A) (CJB) pin 2, circuit CBP38 (GY/BU), Component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to D10. → **No** REPAIR circuit CBP38 (GN/BU), using the Wiring Diagrams. INSTALL a new CJB if necessary. TEST the system for normal operation.
D10: CHECK THE BFC FOR IGNITION POWER	
	1 Ignition switch in position 0.
	2 Disconnect BFC C2AM02-A.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Ignition switch in position II.
 E122953	4 Measure the voltage between the BFC C2AM02-A pin 33, circuit CBP38 (GY/BU), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to D11. → **No** REPAIR circuit CBP38 (GY/BU), using the Wiring Diagrams. TEST the system for normal operation.
D11: CHECK THE HEATED REAR WINDOW SWITCH FOR GROUND	
	1 Ignition switch in position 0.
 E68558	2 Measure the resistence between the heated rear window switch C2RD09 pin 4, circuit GD215 (BK/GY), harness side and ground. • Is the resistence less than 2 ohms? → **Yes** GO to D12. → **No** REPAIR circuit GD215 (BK/GY), ground G12 and Splice S2D215, using the Wiring Diagrams. TEST the system for normal operation.
D12: CHECK THE RESISTANCE OF CIRCUIT CRD09 (BU/GY)	
	1 Disconnect BFC C2AM02-A.
 E124042	2 Measure the resistence between the BFC C2AM02-A pin 24, circuit CRD09 (BU/GY), harness side and heated rear window switch C2RD09 pin 1, circuit CRD09 (BU/GY), harness side. • Is the resistence less than 2 ohms? → **Yes** INSTALL a new heated rear window switch. CHECK the operation of the system. If the problem still persists GO to D13. → **No** REPAIR circuit CRD09 (BU/GY), using the Wiring Diagrams. TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D13: CHECK THE RESISTANCE OF CIRCUIT GD357 (BK)	
 E122988	1 Measure the resistence between the BFC C2AM02-C pin 8, circuit GD357 (BK), harness side and ground. • Is the resistence less than 2 ohms? → **Yes** INSTALL a new BFC. TEST the system for normal operation. → **No** REPAIR circuit GD357 (BK) and ground G13, using the Wiring Diagrams. TEST the system for normal operation.

Component Tests

Heated Rear Window Grid Wire Test

1. Using a bright lamp inside the vehicle, visually inspect the grid wire from the outside. A broken grid conductor line will appear as a brown spot.
2. Run the engine at idle. Set the heated rear window control switch and lights to ON. The heated rear window indicator light should illuminate.
3. Working inside the vehicle with a multimeter, contact the broad red/brown strips on the heated rear window positive lead to battery side and negative lead to ground side. The multimeter should read 10-13 volts. A lower voltage reading indicates a loose heated rear window ground wire connection at the heated rear window ground wire screw.
4. Contact a ground point with the negative lead of the multimeter. The voltage reading should not change.
5. With the negative lead of the multimeter grounded, touch each grid line of the heated rear window at its pinpoint with the positive lead. A reading of approximately six volts indicates that the line is OK. A reading of zero volts indicates that the line is broken between the midpoint and the battery side of the grid line. A reading of 12 volts indicates that the circuit is broken between the midpoint of the grid line and ground.
6. INSTALL a new heated rear window glass.

   REFER to: Liftgate Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

GENERAL PROCEDURES

Door Window Glass Adjustment(42 001 0)

Adjustment

1. **Remove the door trim panel.**

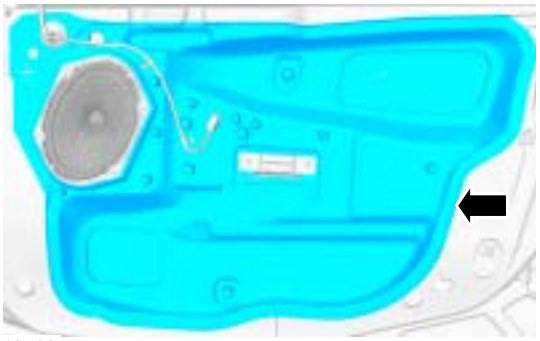
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

2. **CAUTION: Do not touch the adhesive surface as re-bonding will be impaired.**

NOTE: Do not detach the water shield fully.

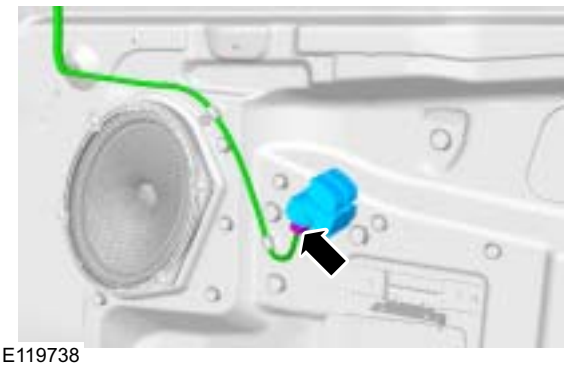
Detach the door panel watershield.

- Using a plastic knife (disposable cutlery), cut through the Butyl strip to enable the watershield to be peeled back.



E119739

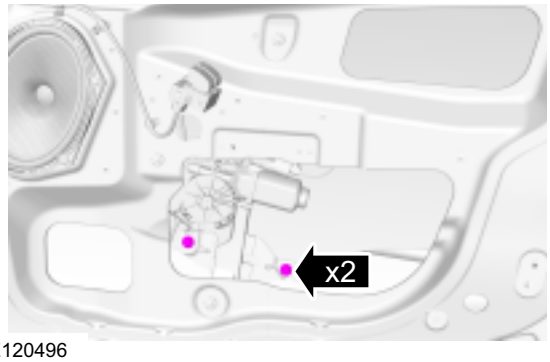
3. **Connect the window operating switch electrical connector.**



E119738

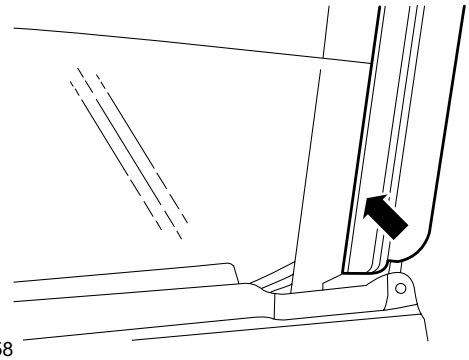
4. **Loosen the window glass clamp retaining bolts.**

- Align the retaining screws with the access hole.



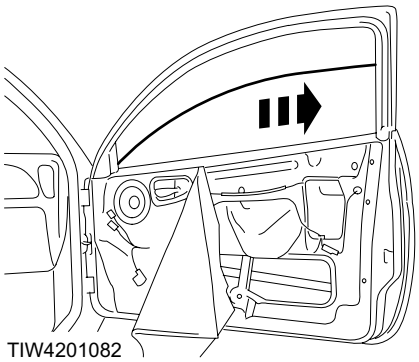
E120496

5. **Make sure the glass is inside the door frame outer seal.**



E111958

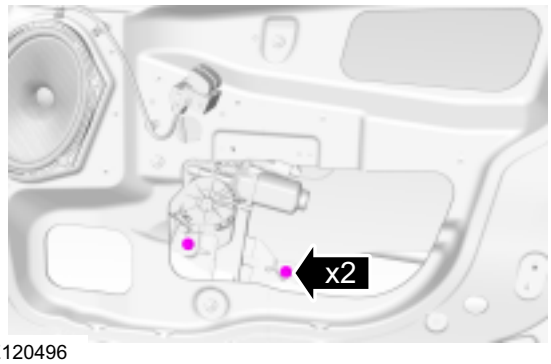
6. **Lower the glass to the bottom.**
7. **Standing inside the door, apply rearward hand pressure on the outside of the window glass, at the same time raising the glass to its fully closed position.**



TIW4201082

GENERAL PROCEDURES

8. Tighten the window glass clamp retaining bolts.



E120496

9. Attach the door panel watershield.
10. Install the door trim panel.

    For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

REMOVAL AND INSTALLATION

Windshield Glass(42 115 0)

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Direct glazing adhesive kit
Direct glazing adhesive oven
Glazing suction cups

Removal

All vehicles

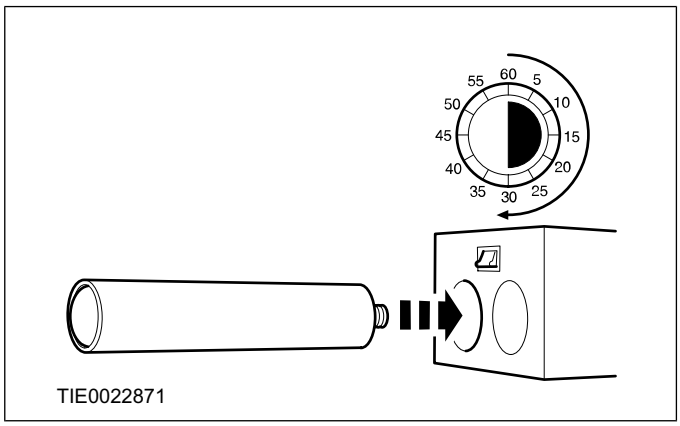
1. **Remove the battery ground cable.**

   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. **Remove the hood.**

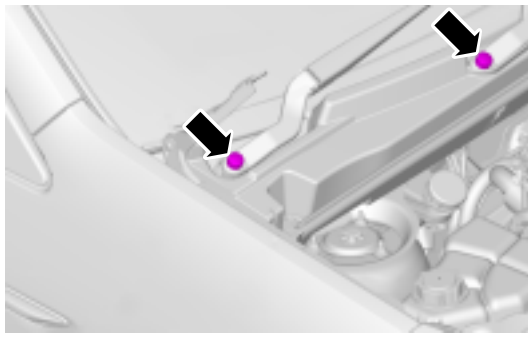
   For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

3. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**

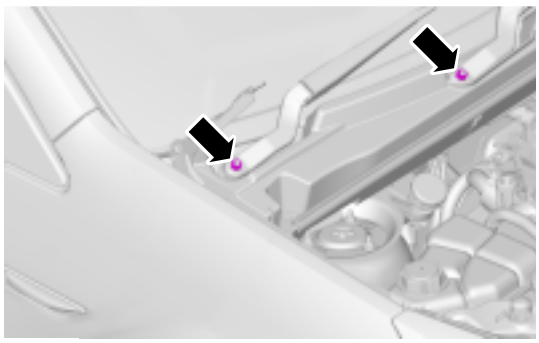


TIE0022871

4. **Remove the wiper arm covers on both sides.**

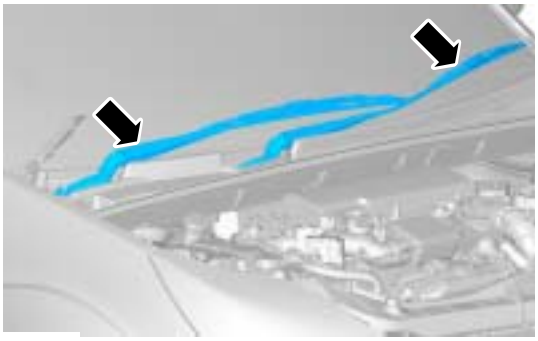

E119634

5. **Remove the wiper arm nuts on both sides.**


E119635

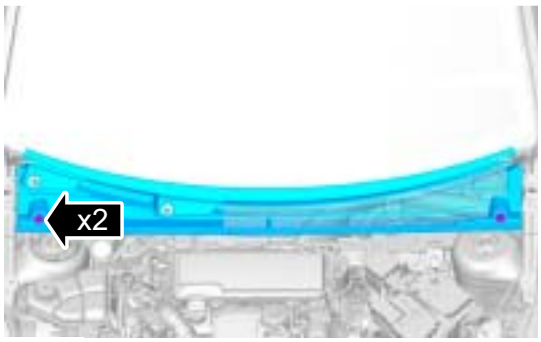
6. **NOTE: Make sure that the windshield wiper motor is in the park position.**

   Remove the windshield wiper arms.


E119636

REMOVAL AND INSTALLATION

7. Remove the cowl panel grille.

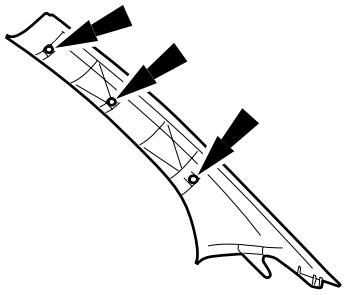


E119637

8. Detach the front door opening weatherstrip from the A-pillar on both sides.


E119720

9. Remove the A-pillar trim panels.


VUE0027052

All vehicles

10. Remove the interior mirror.

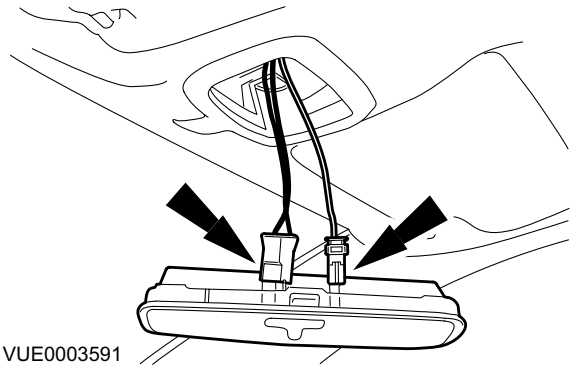

E119736

Vehicles without roof opening panel

11. Detach the interior lamp.


E120057

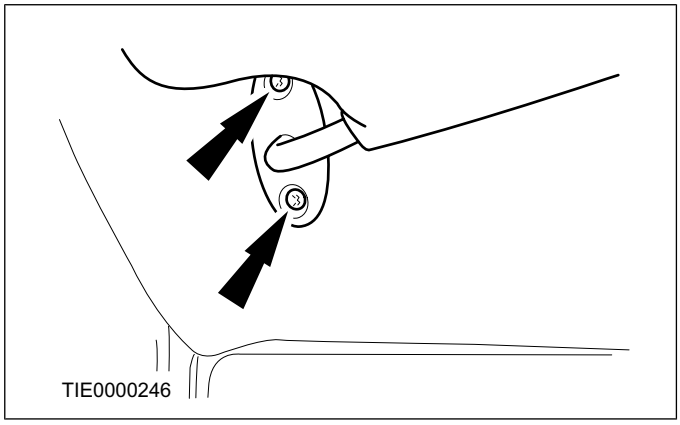
12. Disconnect the interior lamp electrical connectors and remove the interior lamp.


VUE0003591

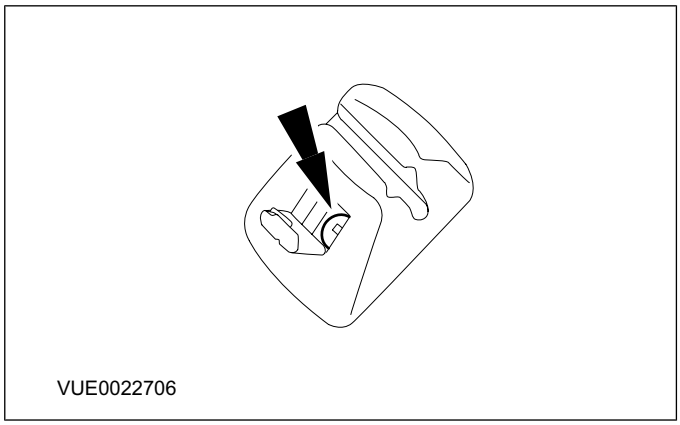
REMOVAL AND INSTALLATION

All vehicles

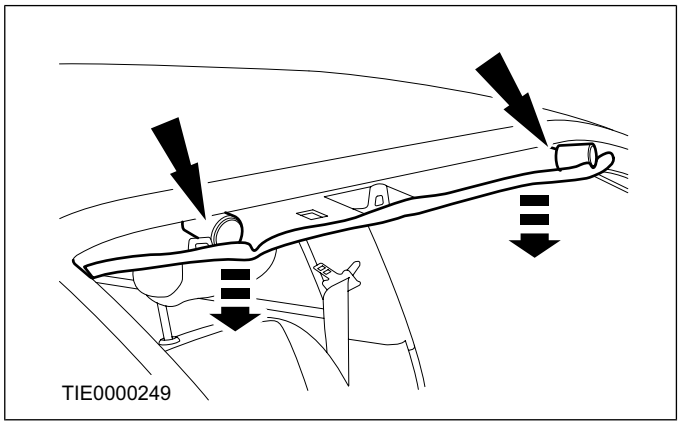
13. Remove the sun visors.



14. Lever open the covers to expose the screws and remove the sun visor retaining clips.



15. Detach the leading edge of the headliner and place two blocks of suitable material between the headliner and the roof panel to act as spacers.



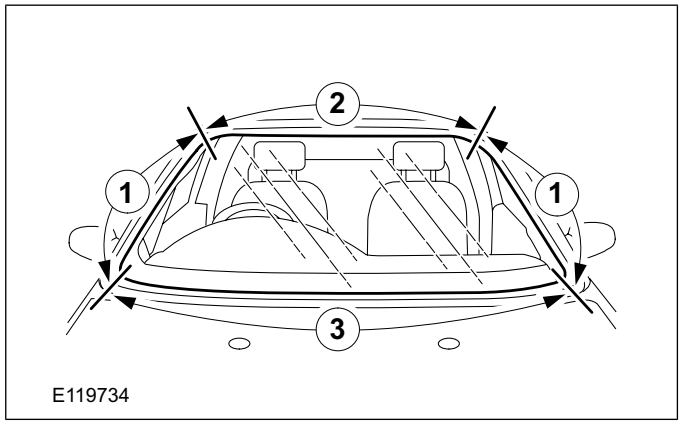
16. WARNING: Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.

CAUTION: Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

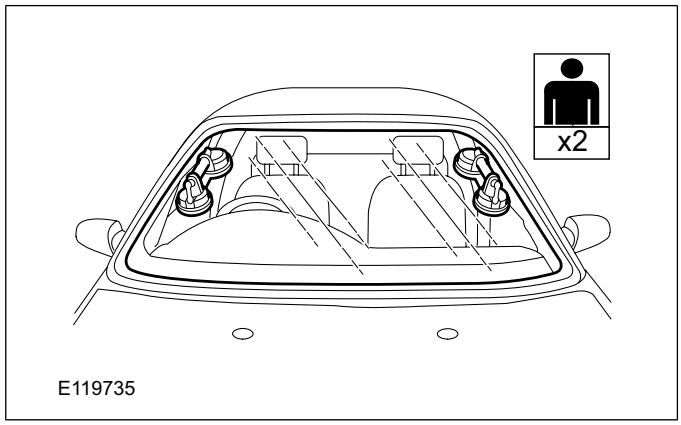
NOTE: Care must be taken when cutting in the area of the locating blocks along the lower edge of the windshield glass.

From inside the vehicle, using a suitable direct glazing cutter, cut the PU adhesive to the given maximum depths.

1. 23 mm.
2. 75 mm.
3. 160 mm.



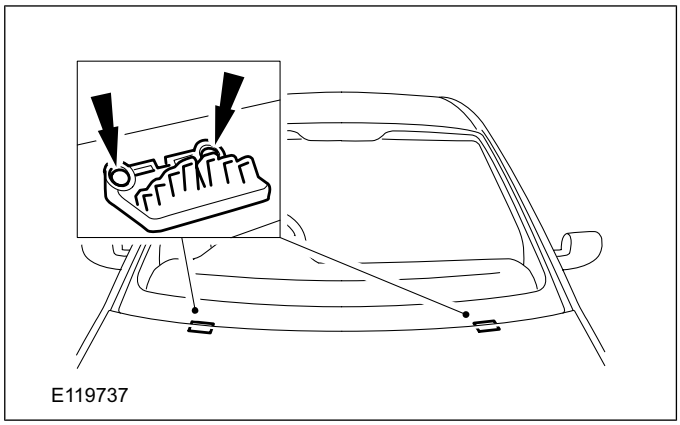
17. With the aid of another technician, use glazing suction cups to remove the windshield glass.



18. Remove the windshield glass locating blocks.

REMOVAL AND INSTALLATION

- Discard the locating blocks.

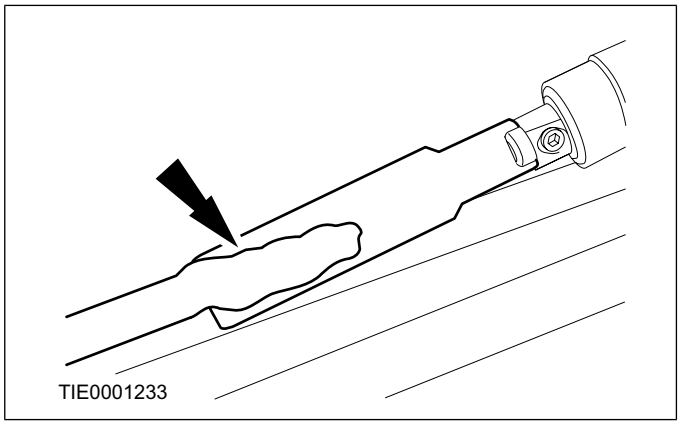


Installation

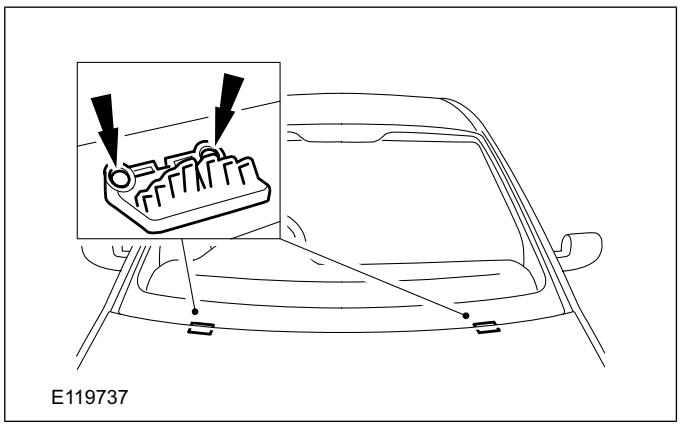
All vehicles

1. **CAUTION: Do not touch the adhesive surface as re-bonding will be impaired.**

   Carefully trim the remaining polyurethane (PU) adhesive from the windshield glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.



2. **Install new windshield glass locating blocks.**

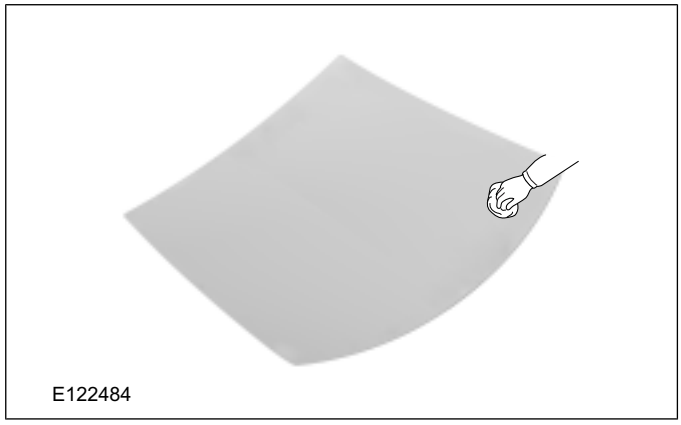


3. **Check the windshield glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**

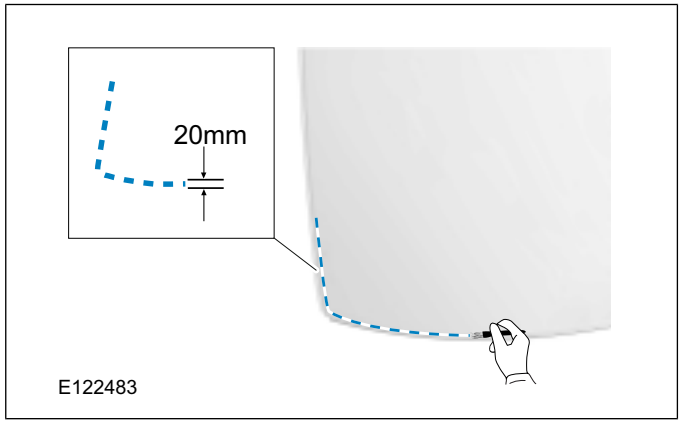
4. **CAUTION: To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

   Using a hot air gun, apply warm air (25°C) to the windshield glass flange and glass bond line to remove all traces of moisture.

5. **Clean the windshield with cleaner.**

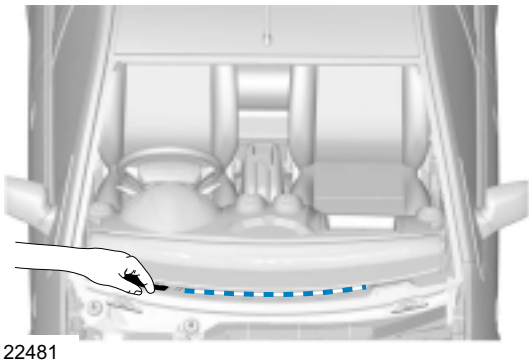


6. **Apply primer on to the windshield. Make sure that the width is approximately 2 cm as shown in the picture below. Do not allow the primer to dry more than 20 minutes.**



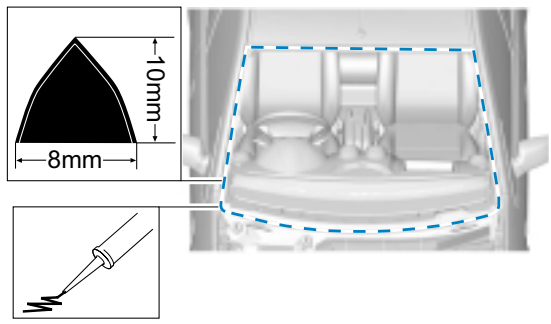
REMOVAL AND INSTALLATION

7. **Clean the body flange with cleaner & apply primer as shown in the adjacent picture.**


E122481

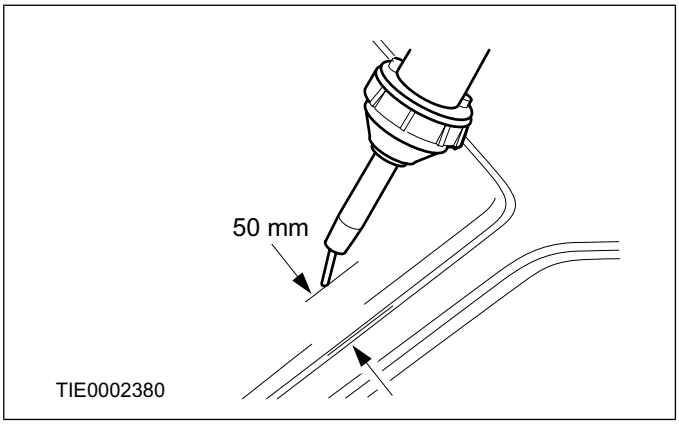
8. **NOTE: If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**

   Apply sealant on the body flange as specified. Make sure that the bead height & width is maintained as specified.



E122482

9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**



TIE0002380

10. **NOTE: Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

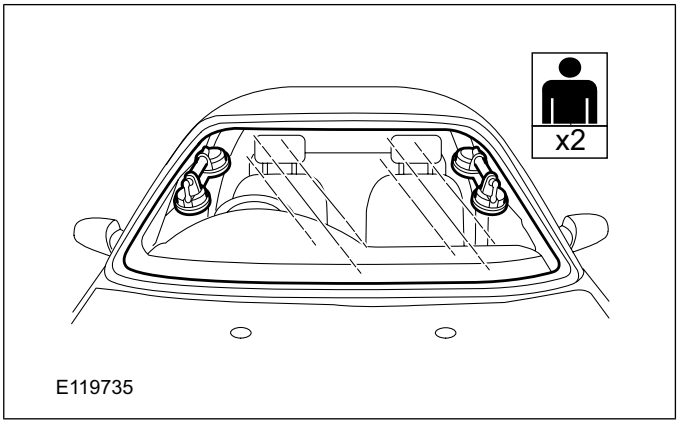
    Points to be taken care during sealant application.

    1. Sealant application should be done slowly to achieve the bead height specified in step 5. Take minimum10 minutes for sealant application.
    2. The sealant cartridge once opened should be consumed within 20 – 30 minutes.
    3. After sealant application the glass should be fixed to body within 10 minutes.
    4. All the operations including sealant application should be carried out only in room temperature & should not be exposed to direct sunlight.
    5. To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

CAUTION: During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

11. **NOTE: Do not handle the windshield in bare hands, use only glazing suction cups to handle it.**

    Locate the windshield on to the body flange & fix it. Press firmly & evenly throughout the area.

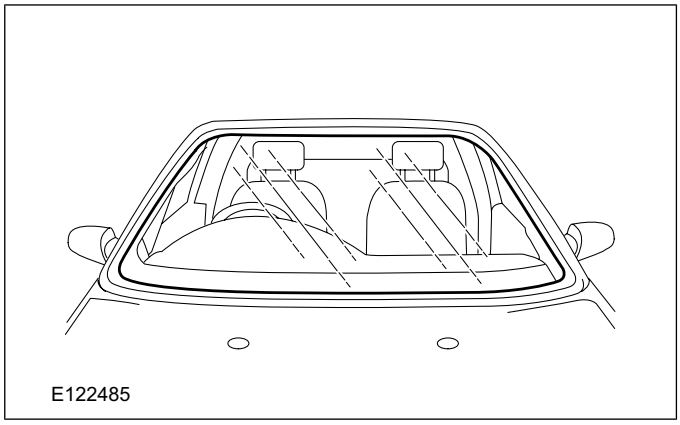


E119735

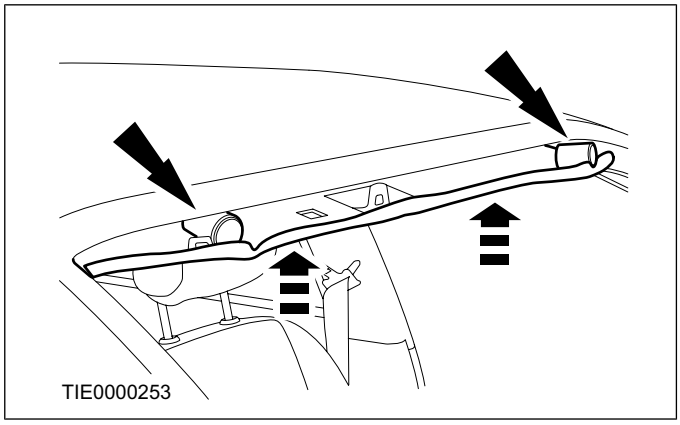
12. **Down the window glass & park the vehicle for at least 4 hours.**

REMOVAL AND INSTALLATION

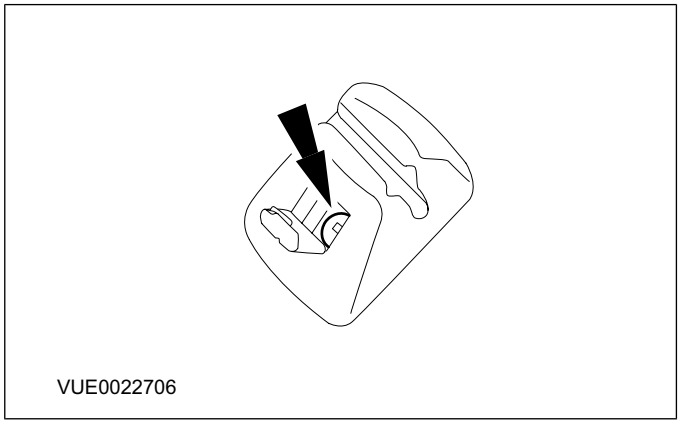
13. **Perform water leak test by spraying pressurised water on to the windshield edges.**



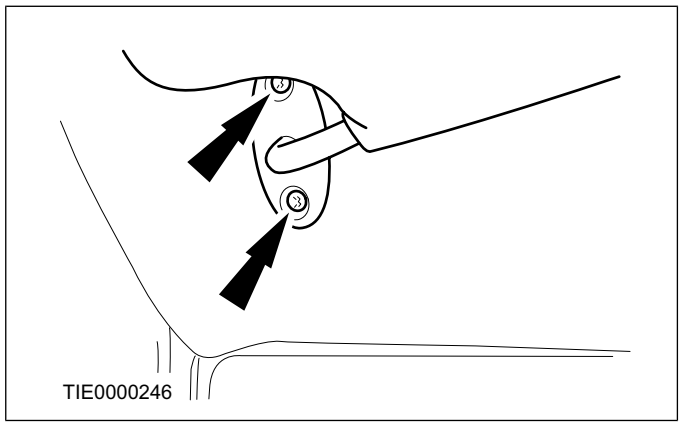
14. **Completely inspect for any leak in the passenger compartment.**
15. **Remove the spacers and attach the leading edge of the headliner to the roof panel.**



16. **Install the sun visor retaining clips.**

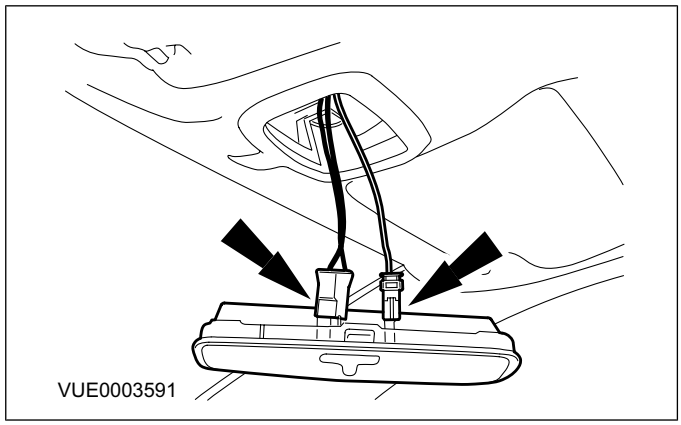


17. **Install the sun visors.**

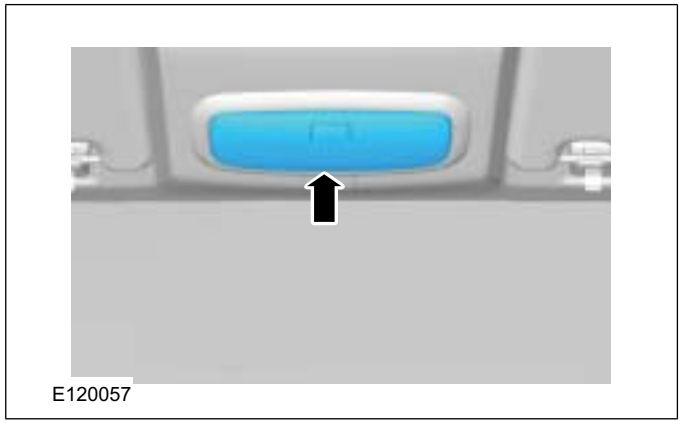


Vehicles without roof opening panel

18. **Connect the interior lamp electrical connectors.**



19. **Install the interior lamp.**



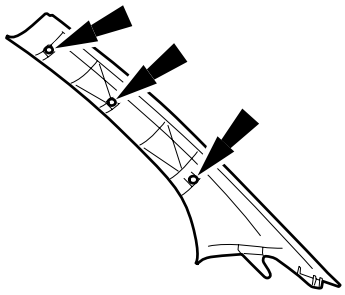
REMOVAL AND INSTALLATION

20. Install the interior mirror.


E119736

All vehicles

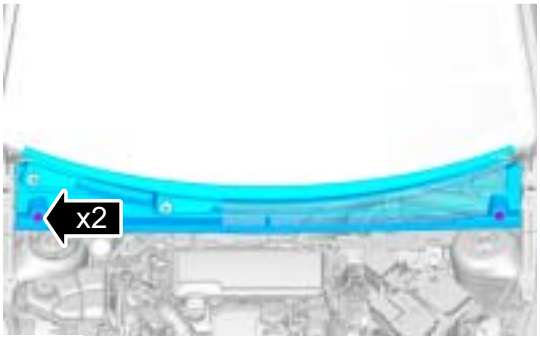
21. Install the A-pillar trim panels.


VUE0027052

22. Attach the front door opening weatherstrip to the A-pillar on both sides.


E119720

23. Install the cowl panel grille.



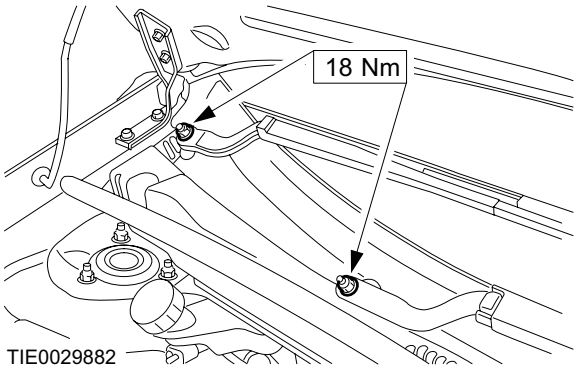
E119637

24. Install the hood.

    For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

25. Raise the hood.

26. Install the windshield wiper arms.



TIE0029882

27. Connect the battery ground cable.

    For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

28. Lower the hood.

REMOVAL AND INSTALLATION

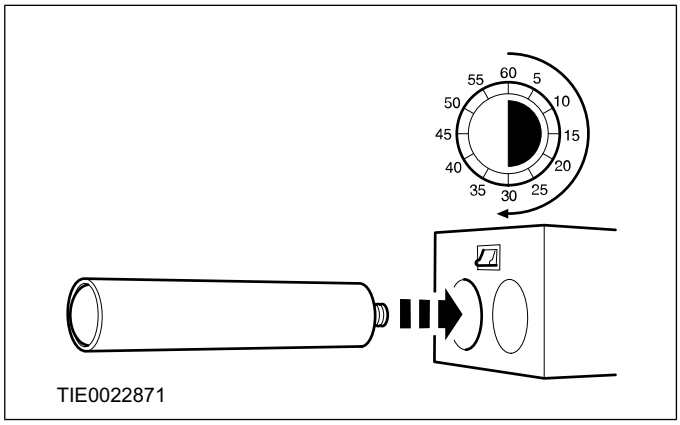
Liftgate Window Glass

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Direct glazing adhesive kit
Direct glazing adhesive oven
Glazing suction cups

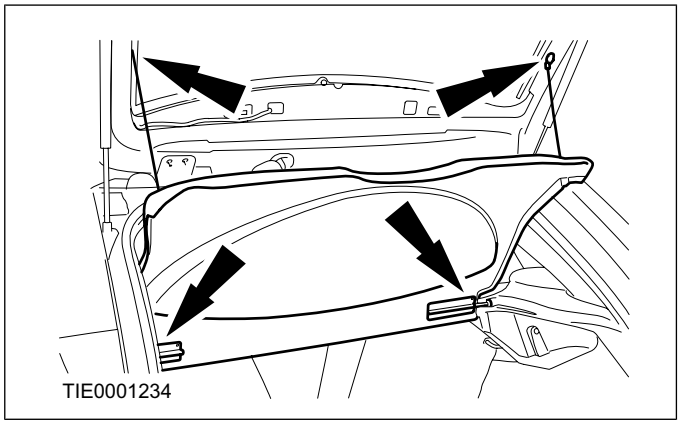
Removal

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**



TIE0022871

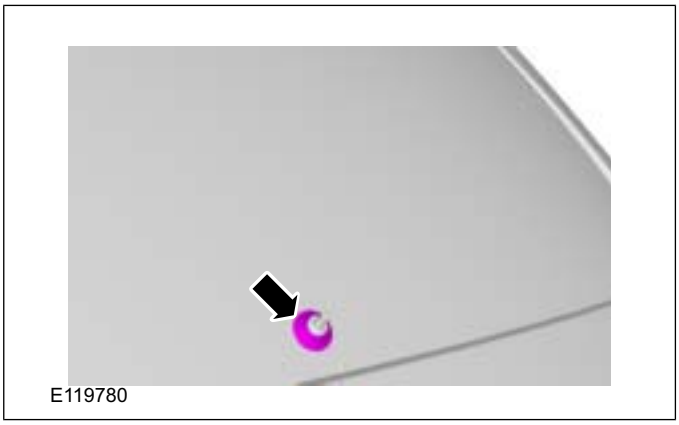
2. **Remove the parcel shelf (If equipped).**


TIE0001234

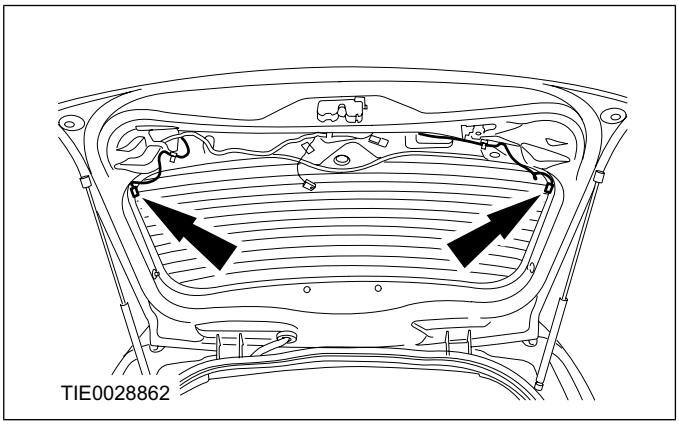
3. **Remove the liftgate window wiper motor.**

   For additional information, refer to: Rear Window Wiper Motor (501-16 Wipers and Washers, Removal and Installation).

4. **Remove the liftgate window wiper motor spindle grommet.**


E119780

5. **Disconnect the heated liftgate window glass electrical connectors.**


TIE0028862

6. **WARNING: Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in a personal injury.**

   CAUTION: Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

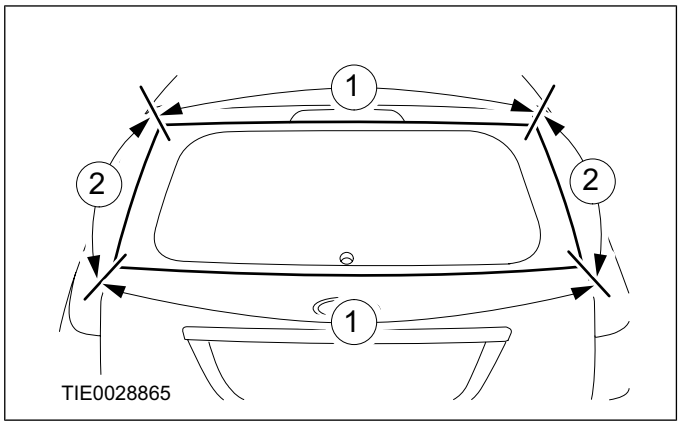
NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the corners of the glass.

From inside the vehicle using a suitable direct glazing cutter, cut the PU adhesive to the given maximum depths.

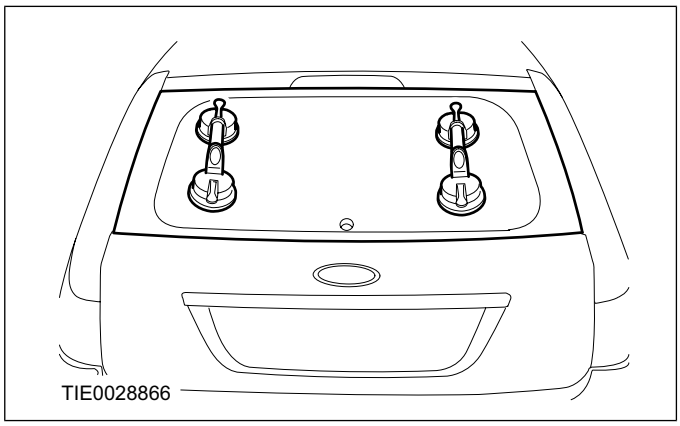
1. 22 mm.

REMOVAL AND INSTALLATION

2. 51 mm.



7. With the aid of another technician, use glazing suction cups to remove the liftgate window glass.

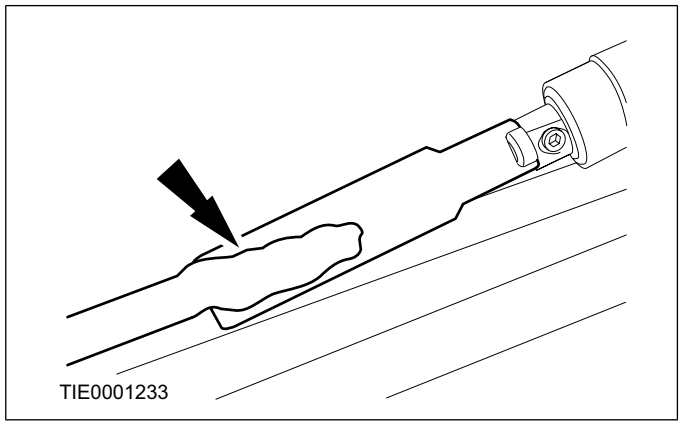


Installation

1. Carefully remove the remaining part of the locating pegs from the liftgate window glass flange.

2. CAUTION: Do not touch the adhesive surface as re-bonding will be impaired.

Carefully trim the remaining polyurethane (PU) adhesive from the liftgate window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.



3. Check the liftgate window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.

4. CAUTION: To make sure that the PU adhesive cures, it is essential that all the bonding surfaces are free of moisture.

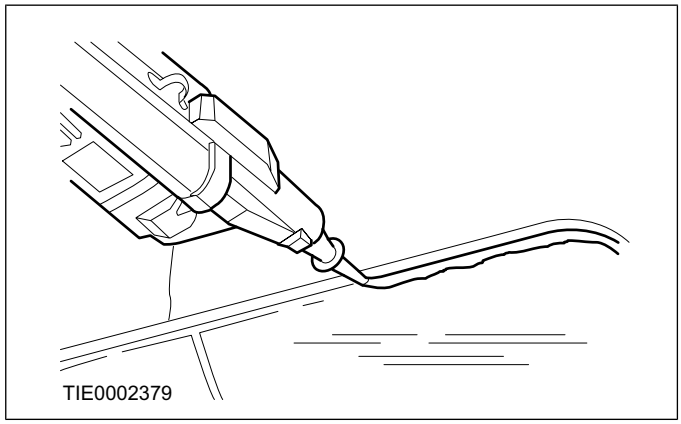
Using a hot air gun, apply warm air (25°C) to the liftgate window glass flange and glass bond line to remove all traces of moisture.

5. Prepare the glass, liftgate window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the PU adhesive kit.

6. NOTE: Discard the first 100 mm of PU adhesive as this may have a reduced working time.

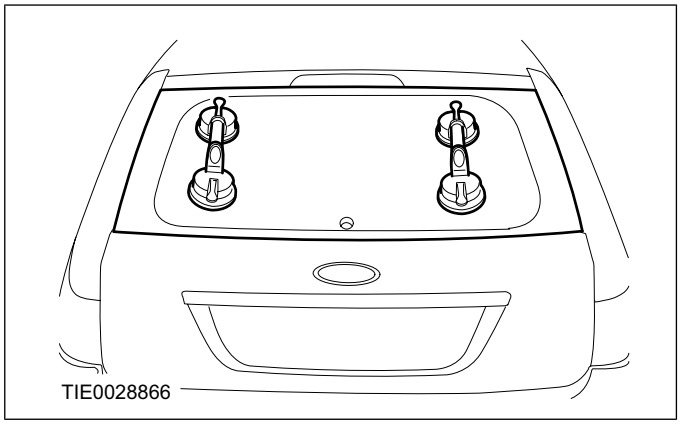
NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the liftgate window glass flange along the bond line.



REMOVAL AND INSTALLATION

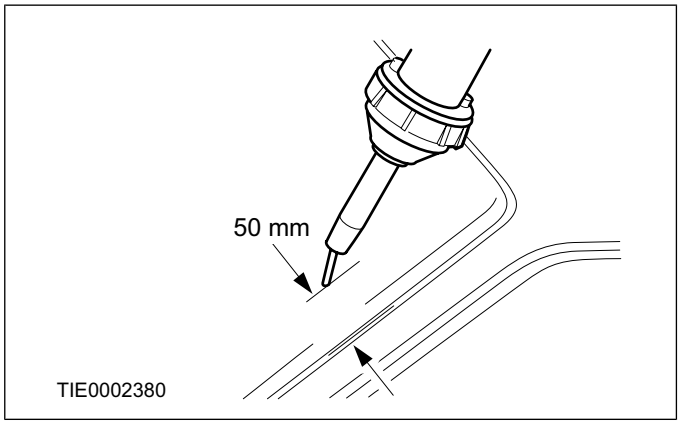
7. **With the aid of another technician, use glazing suction cups to install the liftgate window glass.**
   - Press firmly and evenly into position.



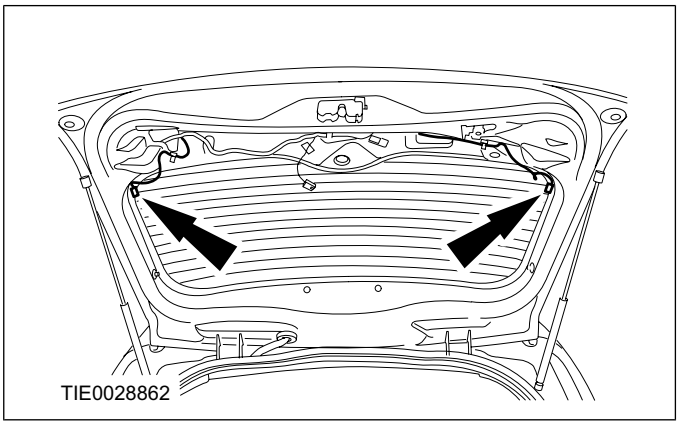
8. **CAUTION: During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.**

   Using suitable tape, secure the liftgate window glass in the correct position until the PU adhesive has cured.

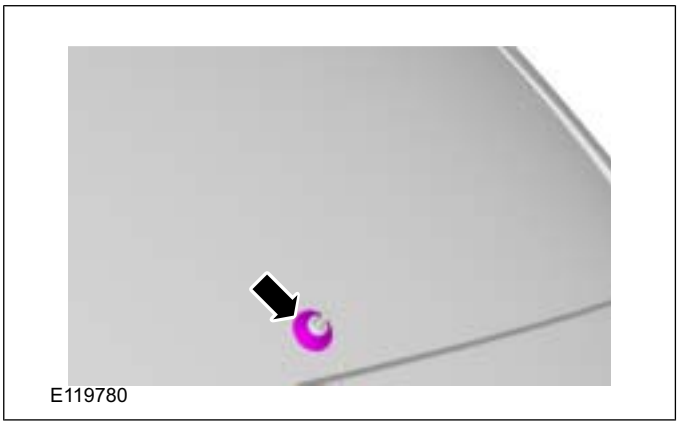
9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**



10. **Connect the heated liftgate window glass electrical connectors.**



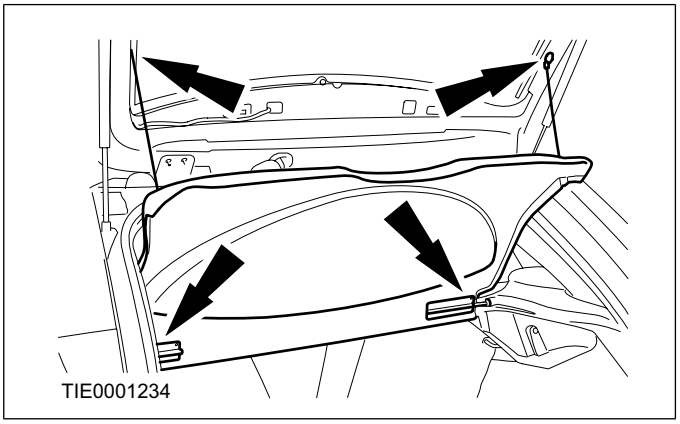
11. **Install the liftgate window wiper motor spindle grommet.**



12. **Install the liftgate window wiper motor.**

    For additional information, refer to: Rear Window Wiper Motor (501-16 Wipers and Washers, Removal and Installation).

13. **Install the parcel shelf (If equipped).**



REMOVAL AND INSTALLATION

Front Door Window Glass(42 314 0)

Removal

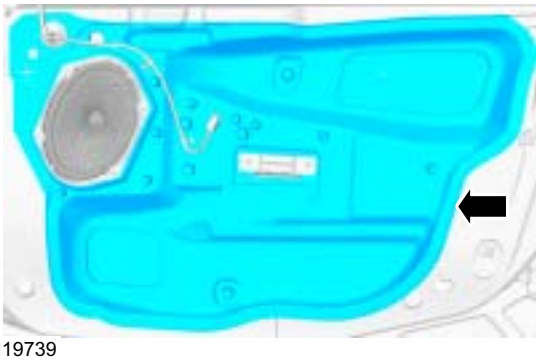
All vehicles

1. **Remove the front door trim panel.**

   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

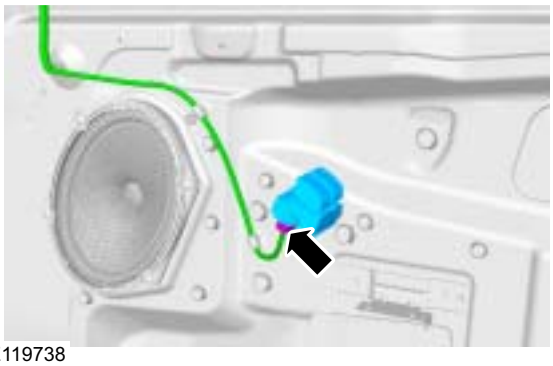
2. **NOTE: Do not detach the water shield fully.**

   Detach the water shield and keep it aside.


E119739

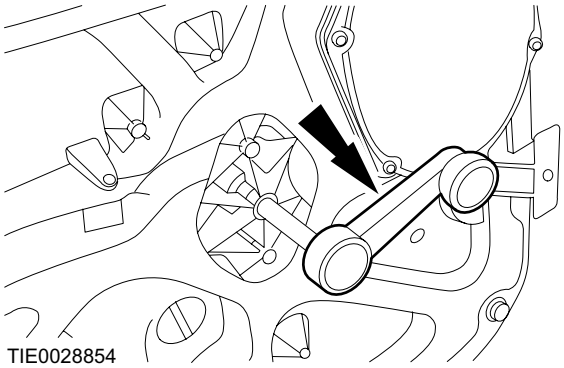
Vehicles with power windows

3. **Connect the power window control switch electrical connector.**


E119738

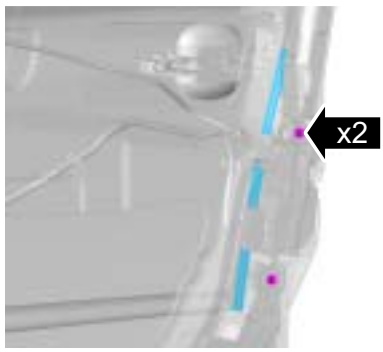
Vehicles with manual windows

4. **Install the window regulator handle.**


TIE0028854

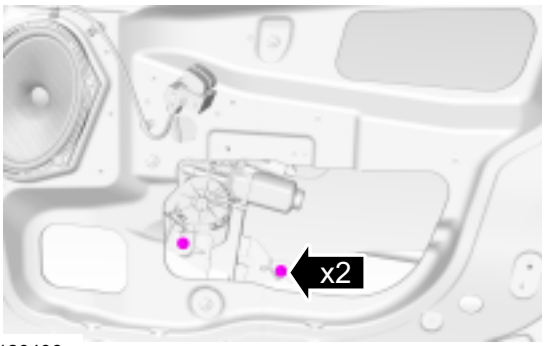
All vehicles

5. **Remove the front door window sash.**



E119912

6. **Loosen the front door window glass clamp bolts.**
   - Align the window glass clamp bolts with the access holes.



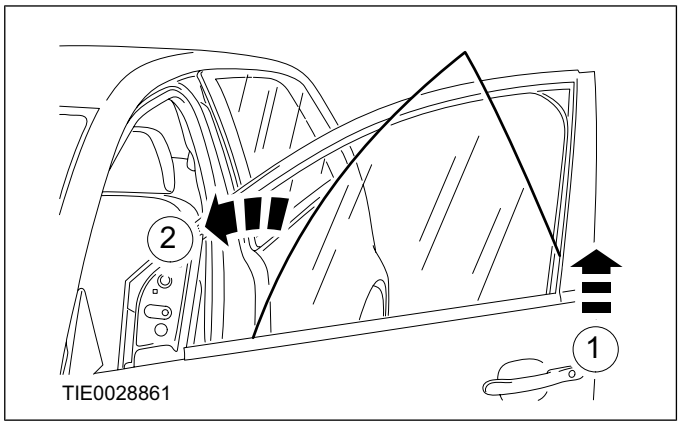
E120496

REMOVAL AND INSTALLATION

7. **NOTE: The front door window glass must be removed towards the outside of the window opening.**

   Remove the front door window glass.

   1. Lift the glass.
   2. Tip the glass forwards and remove the glass from the front door.



Installation

1. **NOTE: The front door window glass must be installed from the outside of the window opening.**

   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Front Door Window Regulator(42 338 0)

Removal

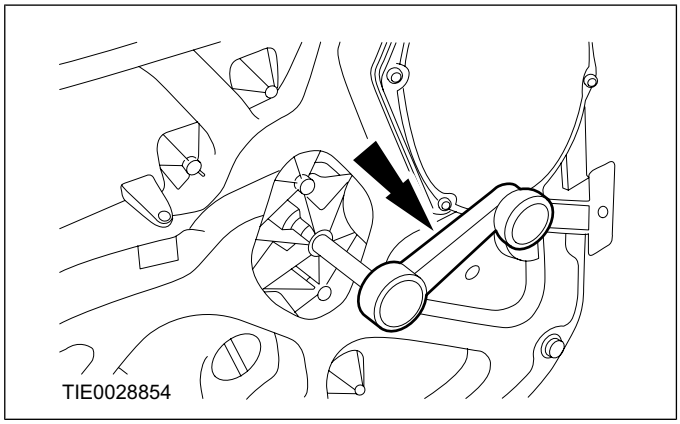
All vehicles

1. **Remove the front door window glass.**

   For additional information, refer to: Front Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

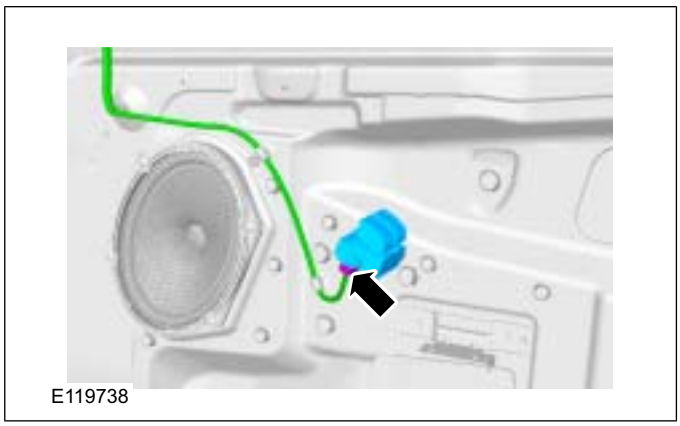
Vehicles with manual windows

2. **Remove the window regulator handle.**

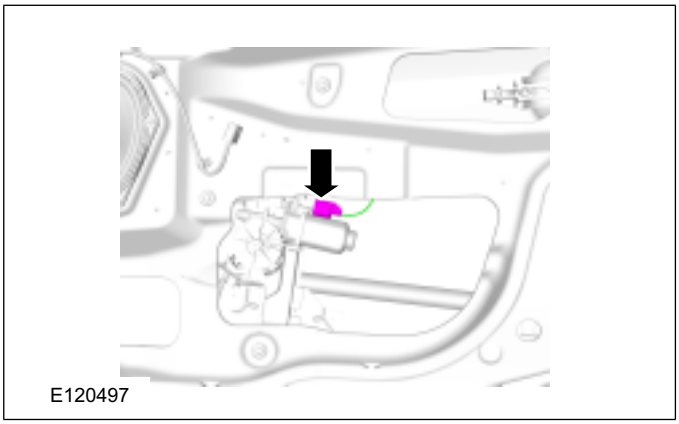


Vehicles with power windows

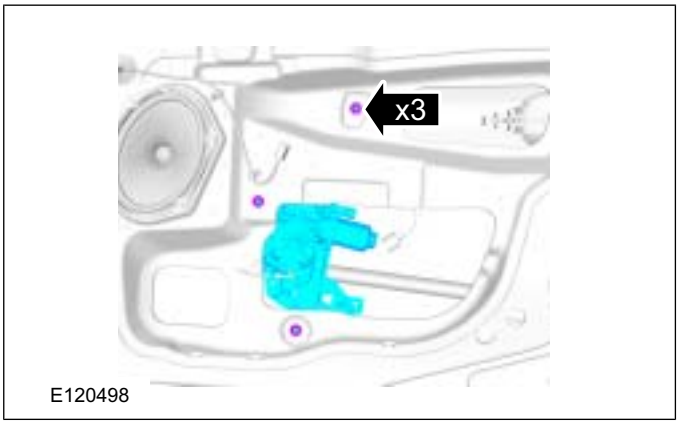
3. **Remove the power window electrical connector.**



4. **Remove the power window regulator motor electrical connector.**



5. **Remove the front door window regulator.**
   1. Remove the front door window regulator nuts.



6. **Remove the power window regulator motor.**

   For additional information, refer to: Front Door Window Regulator Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation).

Vehicles with manual windows

7. **Remove the front door window regulator.**

REMOVAL AND INSTALLATION

1. Remove the front door window regulator nuts.

E124240

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Front Door Window Regulator Motor(33 782 0)

Removal

1. **Remove the front door trim panel.**

   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

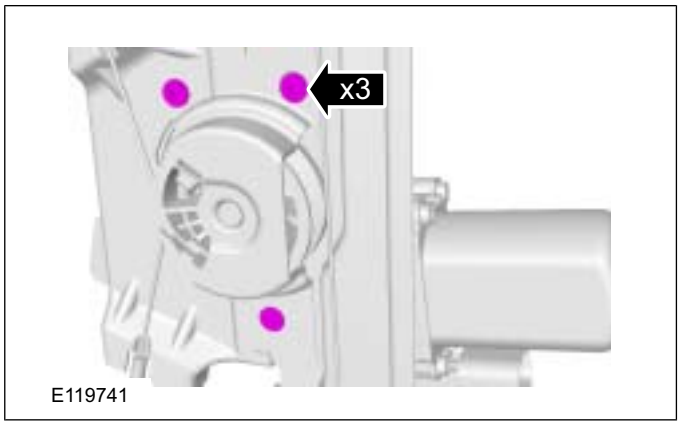
2. **Remove the front door regulator.**

   For additional information, refer to: Front Door Window Regulator (501-11 Glass, Frames and Mechanisms, Removal and Installation).

3. **NOTE: Support the window regulator.**

   Remove the window regulator motor.

   1. Remove the screws.



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

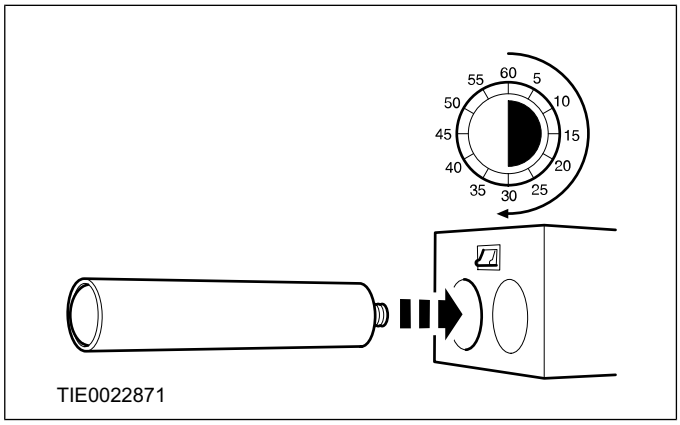
Rear Quarter Window Glass — 5-Door(42 514 0)

General Equipment

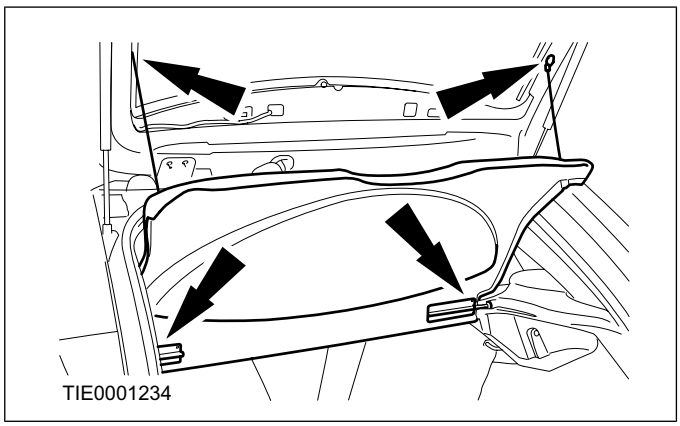
Hot air gun
Direct glazing cutter for bonded glass
Direct glazing adhesive kit
Direct glazing adhesive oven
Glazing suction cups

Removal

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**

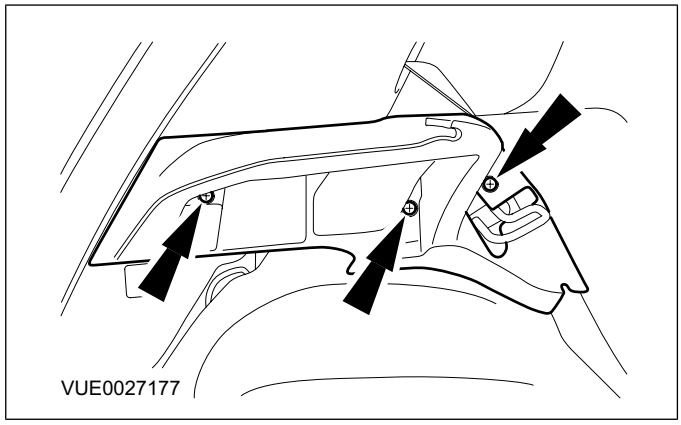


2. **Remove the parcel shelf.**



3. **Remove the C-Pillar trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**

4. **Remove the parcel shelf support.**



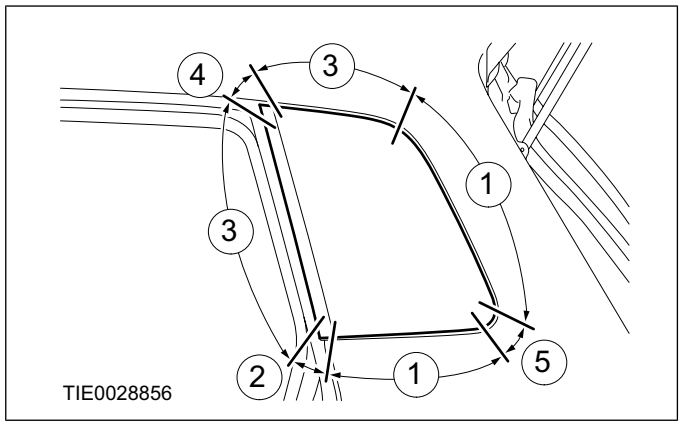
5. **WARNING: Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

CAUTION: Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the corners of the glass.

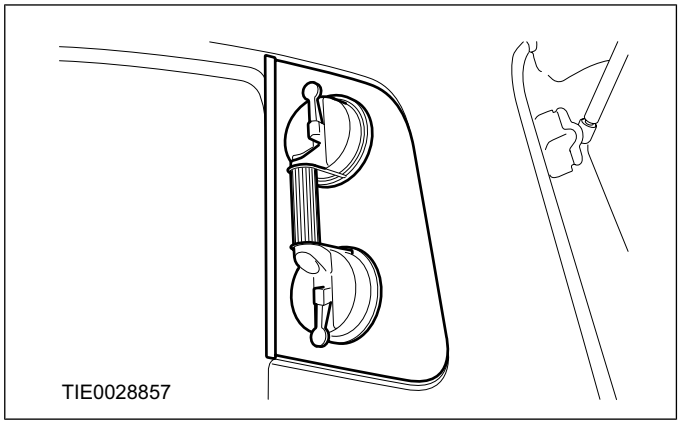
From inside the vehicle, using a suitable direct glazing cutter, cut the PU adhesive to the given maximum depths.

1. 17 mm.
2. 52 mm.
3. 30 mm.
4. 70 mm.
5. 32 mm.



REMOVAL AND INSTALLATION

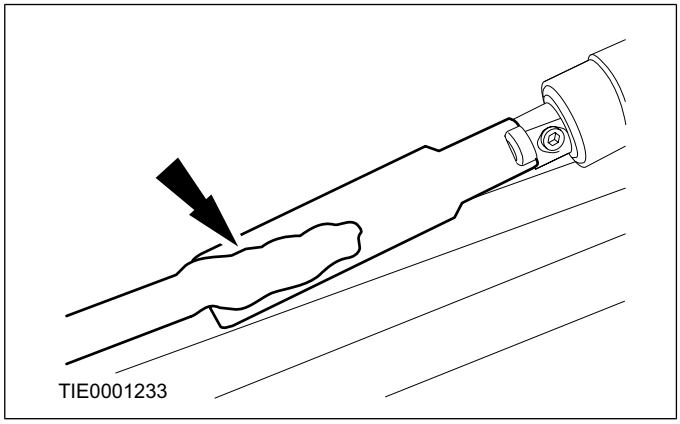
6. **With the aid of another technician, use glazing suction cups to remove the rear quarter window glass.**



Installation

1. **Carefully remove the remaining part of the locating pegs from the rear quarter window glass flange.**
2. **CAUTION: Do not touch the adhesive surface as re-bonding will be impaired.**

   Carefully trim the remaining PU adhesive from the rear quarter window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.

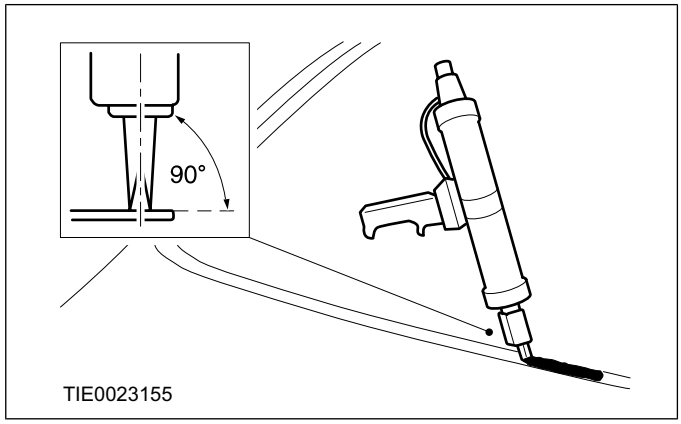


3. **Check the rear quarter window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **CAUTION: To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

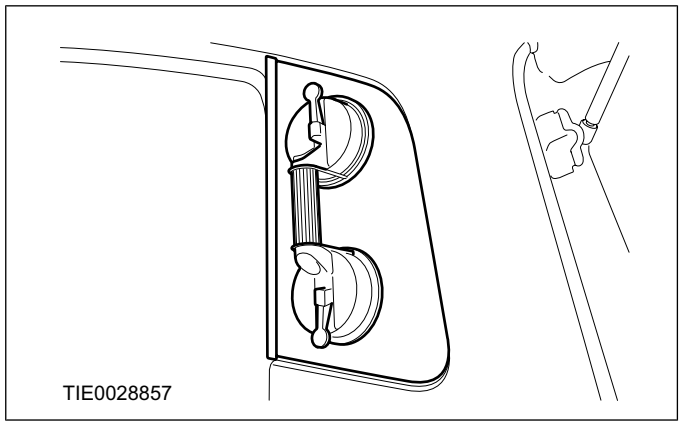
   Using a hot air gun, apply warm air (25°C) to the rear quarter window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, rear quarter window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the PU adhesive kit.**
6. **NOTE: Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead should be overlapped by 20 mm.

Apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the rear quarter window glass flange along the bond line.



7. **Use glazing suction cups to install the rear quarter window glass.**
   - Press firmly and evenly into position.

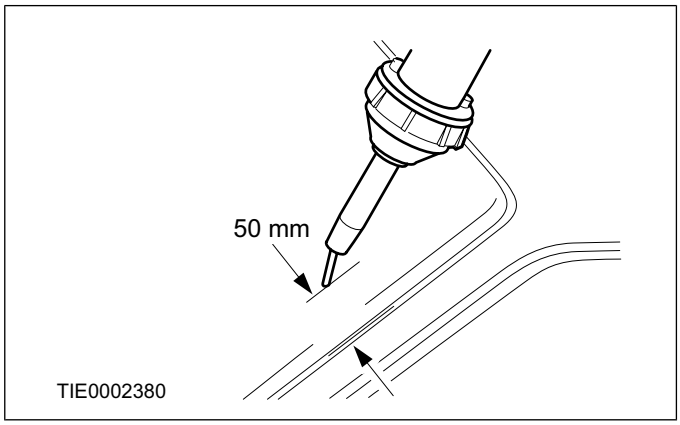


8. **CAUTION: During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.**

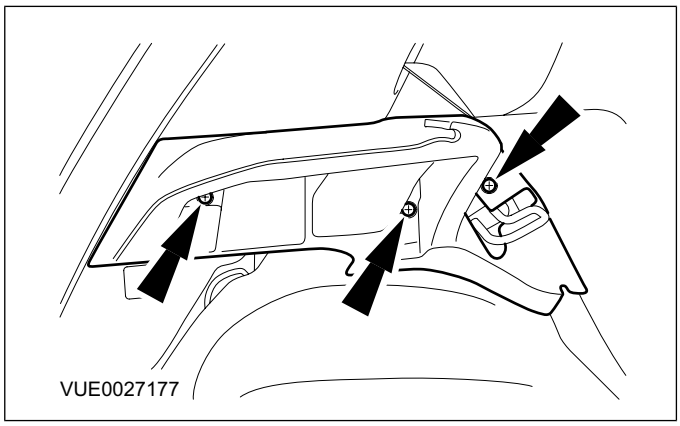
   Using suitable tape, secure the rear quarter window glass in the correct position until the PU adhesive has cured.
9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C)**

REMOVAL AND INSTALLATION

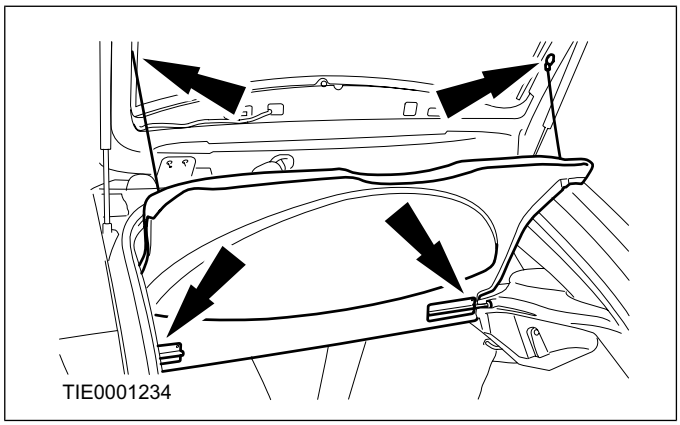
continuously for 15 minutes (inside or outside the vehicle).



10. **Install the parcel shelf support.**



11. **Install the C-Pillar trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
12. **Install the parcel shelf.**



REMOVAL AND INSTALLATION

Rear Door Window Glass(42 315 0)

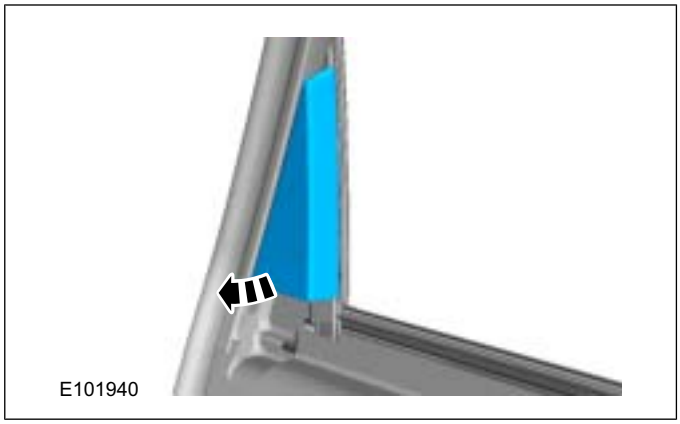
Removal

All vehicles

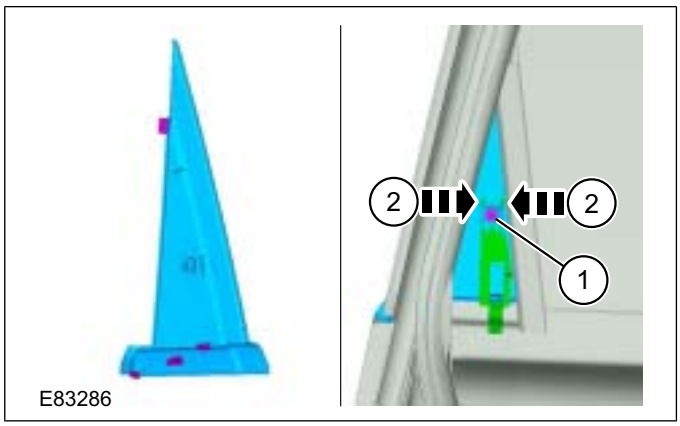
1. **Remove the rear door trim panel.**

   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

2. **Remove the rear door inner trim quarter panel.**

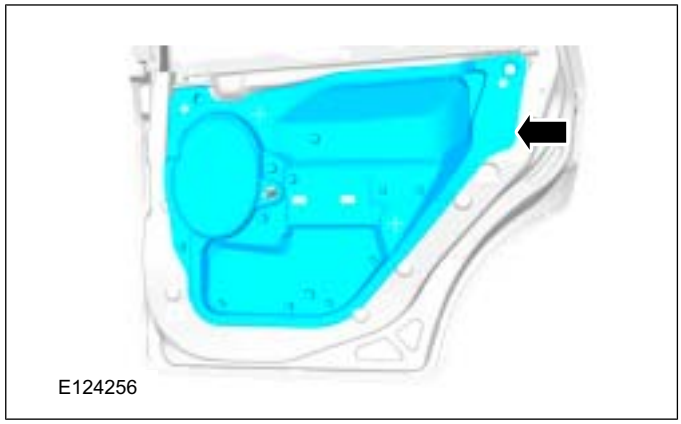


3. **Remove the rear door outer trim quarter panel.**
   1. Remove the screw and tilt the outer trim quarter panel away from the door.
   2. Depress the locking tangs.

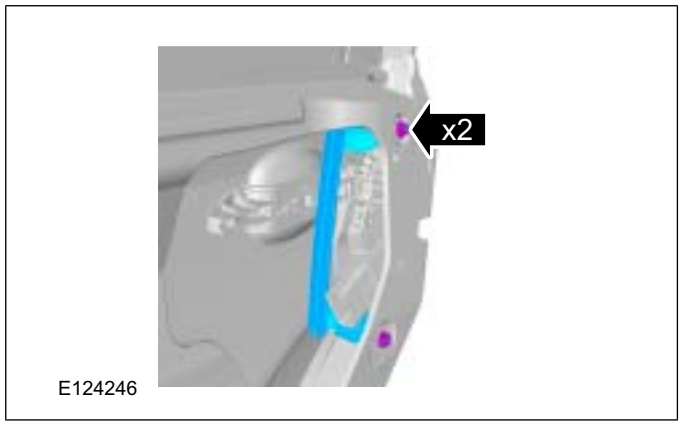


4. **NOTE: Do not detach the water shield fully.**

Detach the water shield and keep it aside.

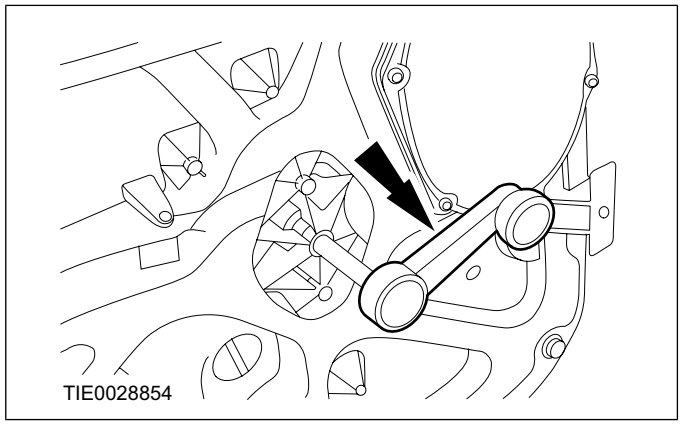


5. **Remove the rear door glass frame.**



Vehicles with manual windows

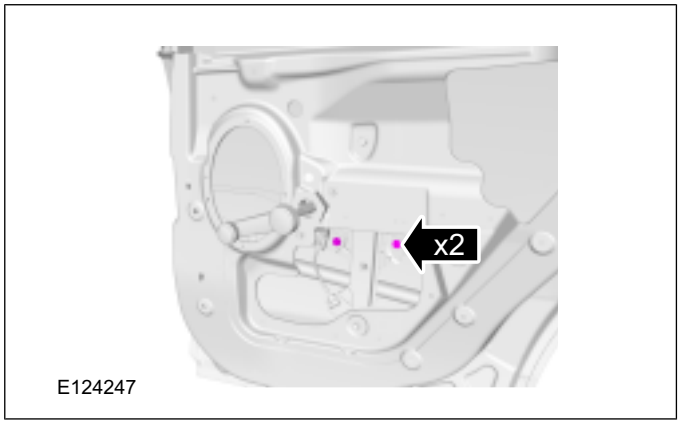
6. **Install the window regulator handle.**
   1. Align the window glass clamp with the access hole.



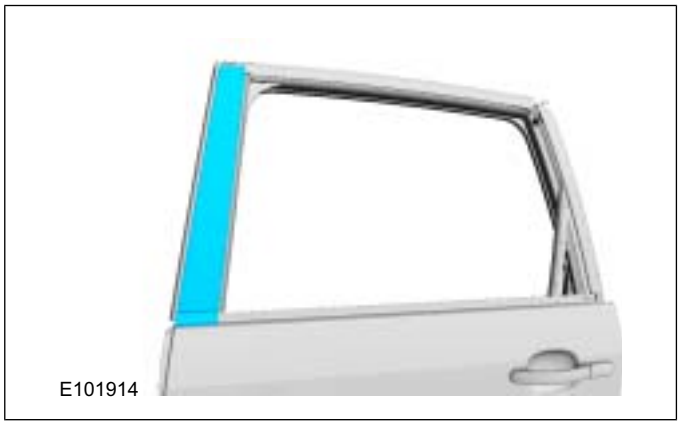
REMOVAL AND INSTALLATION

All vehicles

7. Remove the rear window glass bolts.



8. Remove the rear door trim panel.

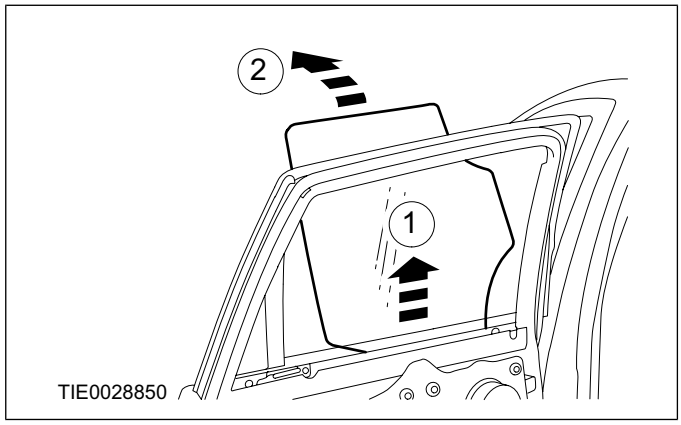


9. Detach the rear door window glass weatherstrip.

10. NOTE: The rear door window glass must be removed towards the outside of the window opening.

Remove the rear door window glass.

1. Lift the window glass.
2. Tip the window glass forwards and remove the window glass from the rear door.



Installation

1. NOTE: The rear door window glass must be installed from the outside of the window opening.

To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

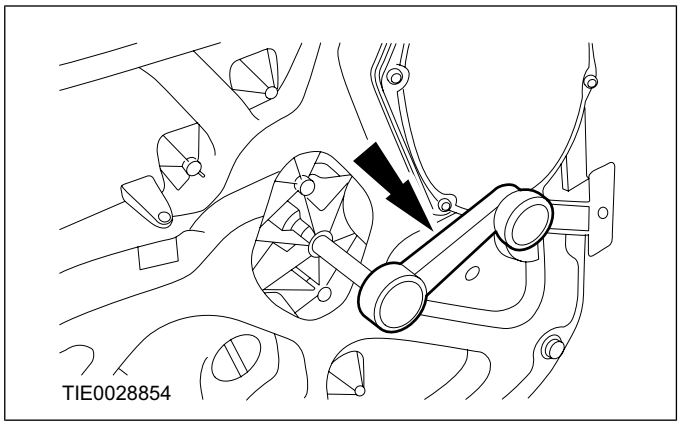
Rear Door Window Regulator(42 338 0)

Removal

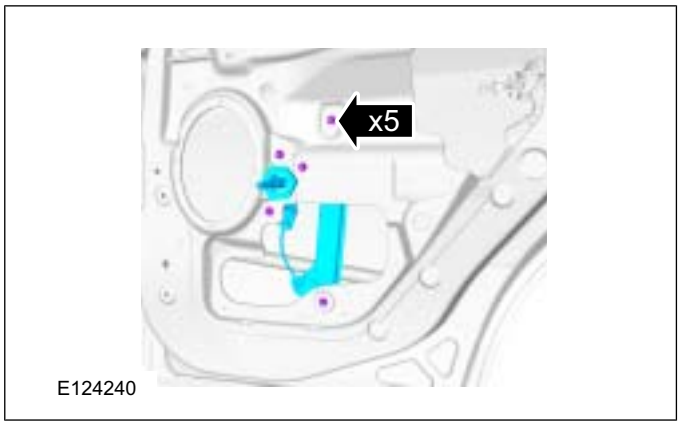
1. **Remove the rear door window glass.**

   For additional information, refer to: Rear Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

2. **Remove the window regulator handle.**



3. **Remove the window regulator.**
   1. Remove the window regulator nuts.



Installation

1. **To install, reverse the removal procedure.**

SECTION 501-12 Instrument Panel and Console

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Instrument panel upper retaining bolts	3	-	27
Instrument panel lower retaining bolts	19	14	-
Instrument panel side retaining bolts	19	14	-

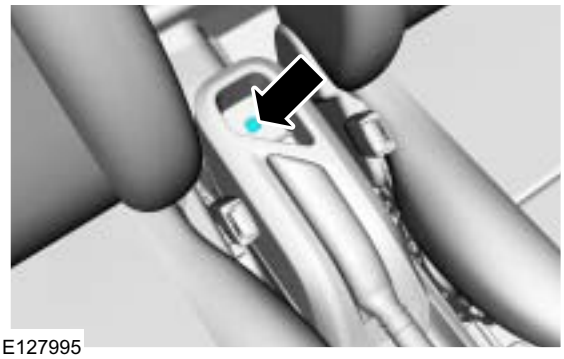
REMOVAL AND INSTALLATION

Floor Console(43 814 0)

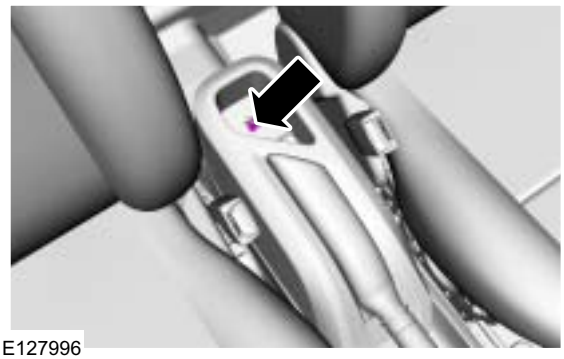
Removal

All vehicles

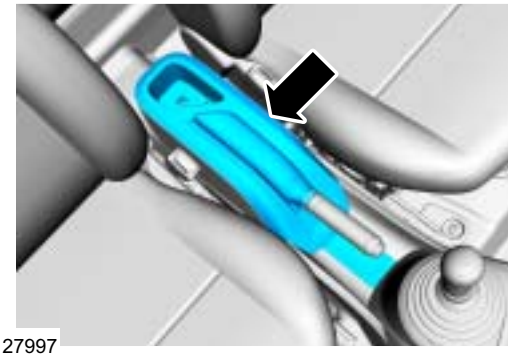
1. Remove the screw cover cap (if equipped).


E127995

2. Remove the screw.


E127996

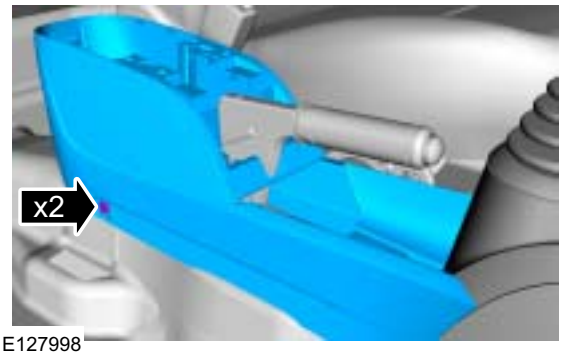
3. Remove the parking brake upper trim panel (if equipped).


E127997

4. NOTE: Seats removed shown for clarity.

Remove the parking brake trim panel (if equipped).

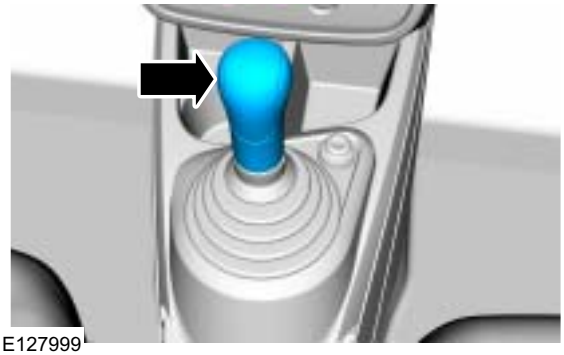
1. Remove the screws on both sides.



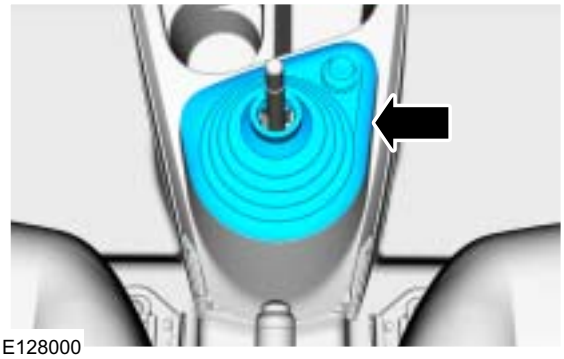
E127998

All vehicles

5. Remove the gear knob.


E127999

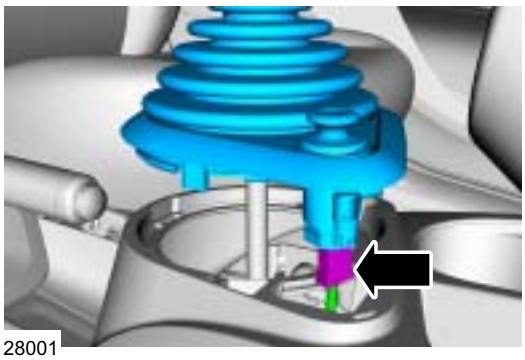
6. Detach the gearshift lever boot retaining trim panel.


E128000

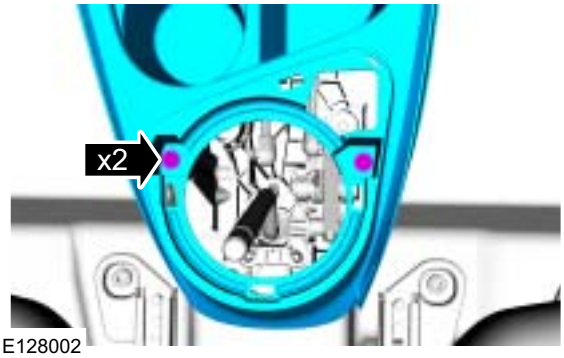
7. Remove the gearshift lever trim panel from the floor console.

REMOVAL AND INSTALLATION

- Disconnect the power socket electrical connector.

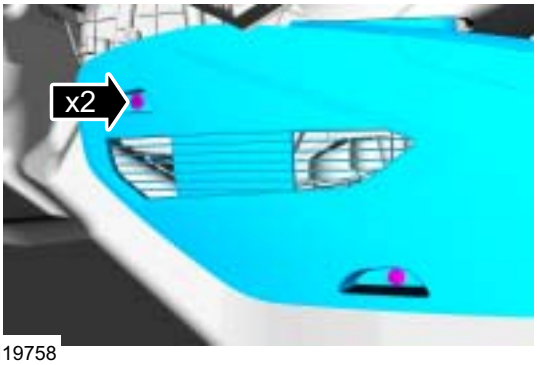

E128001

8. **Remove the floor console center retaining screws.**



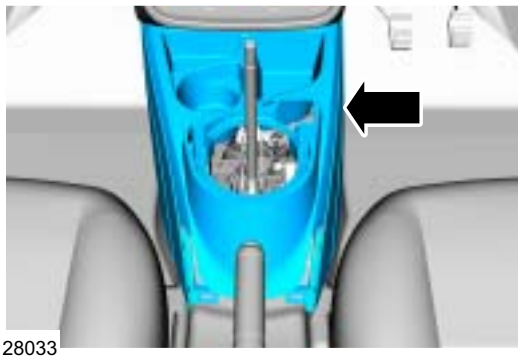
E128002

9. **Remove the retaining screw and clips on both sides.**



E119758

10. **Remove the floor console.**


E128033

Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Instrument Panel(43 644 0)

Removal

WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS). Failure to follow these instructions may result in personal injury.

CAUTION: When removing or installing the instrument panel, care must be taken not to scratch or damage the instrument panel surface.

1. **Remove the floor console.**

   For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

2. **Remove the steering column.**

   For additional information, refer to: Steering Column - 1.19L Duratec-16V (71PS) - Sigma/1.6L Duratec-16V (74kW/100PS) - Sigma/1.4L Duratec-16V (59kW/80PS) - Sigma, 1.4L Duratorq-TDCi (DV) Diesel (211-04 Steering Column, Removal and Installation).

3. **Remove the climate control assembly.**

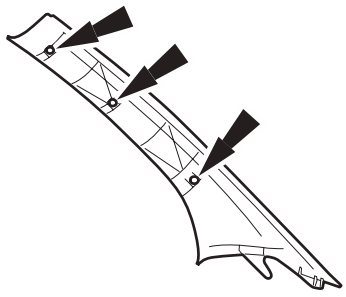
   For additional information, refer to: Climate Control Assembly (412-04 Control Components, Removal and Installation).

4. **Remove the instrument cluster.**

   For additional information, refer to: Instrument Cluster (413-01 Instrument Cluster, Removal and Installation).

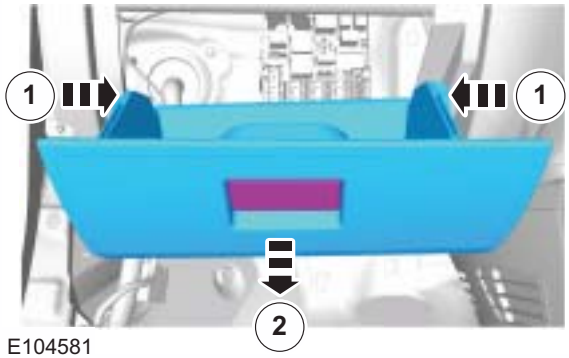
   -

5. **Remove the A-pillar trim panel (both sides).**



VUE0027052

6. **Remove the glove box.**
   1. Push glove box sides inwards.
   2. Tilt the glove box forward.
   3. Pull the glove box away from the instrument panel.



E104581

7. **Remove the passenger airbag (if equipped).**

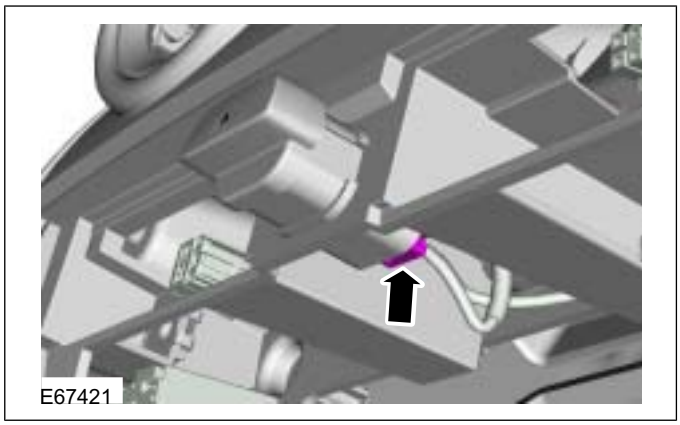
   For additional information, refer to: Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

8. **Detach the data link connector (DLC) from instrument panel.**

REMOVAL AND INSTALLATION

- Tilt the DLC retaining clip forward.

9. Disconnect the hazard switch electrical connector.

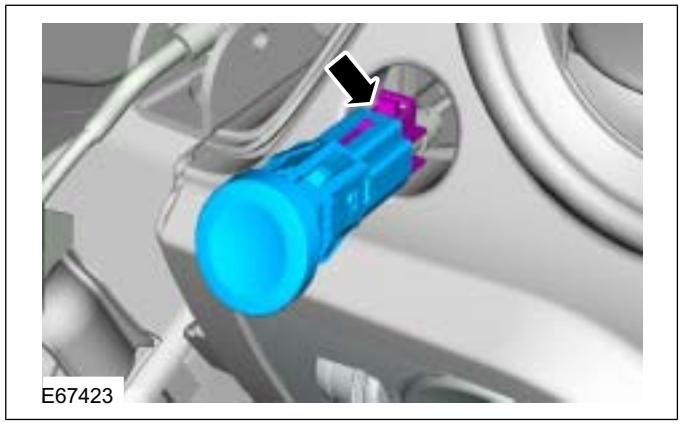


10. Detach the luggage compartment remote release switch (If equipped).

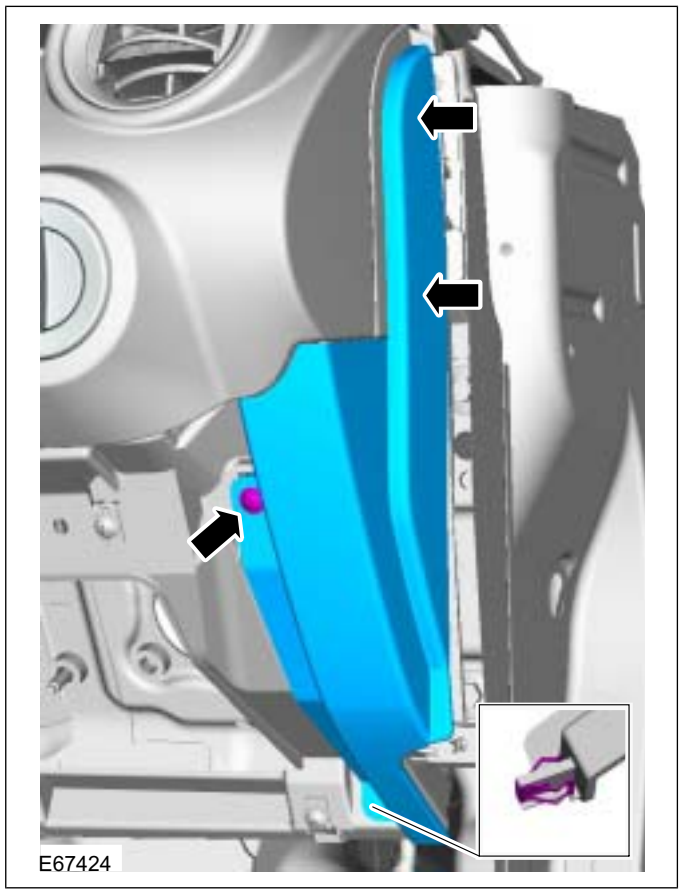
- Push out the luggage compartment remote switch from behind.

11. Remove the luggage compartment remote release switch (If equipped).

- Disconnect the luggage compartment remote release switch electrical connector.

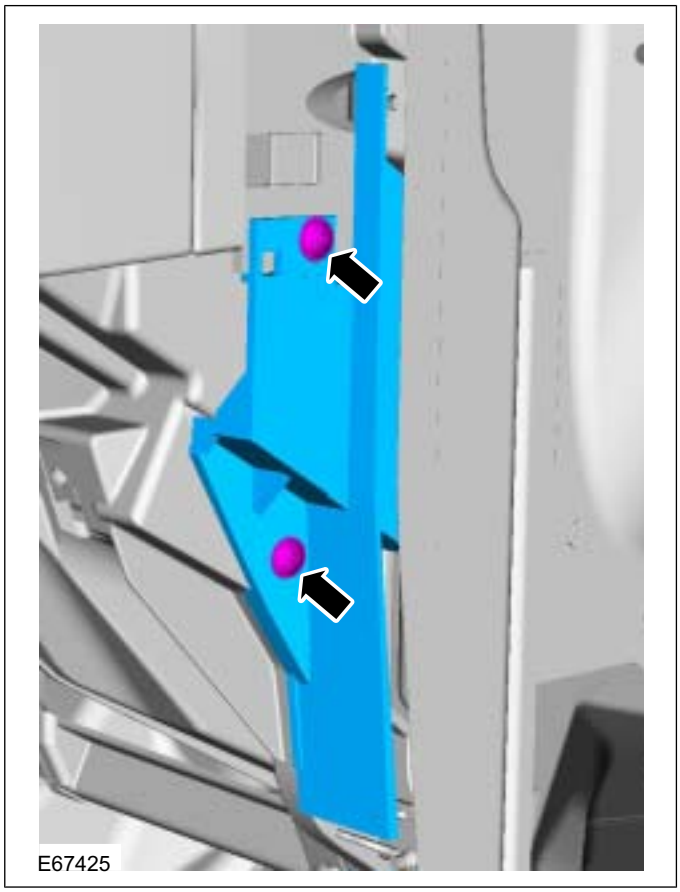


12. Remove the instrument panel outer side trim panel (both sides).

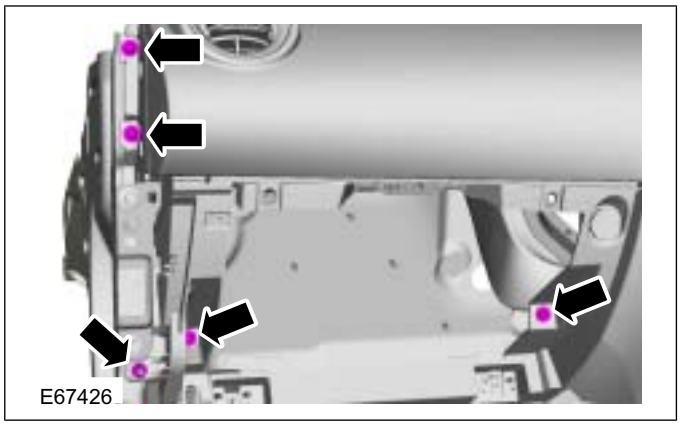


REMOVAL AND INSTALLATION

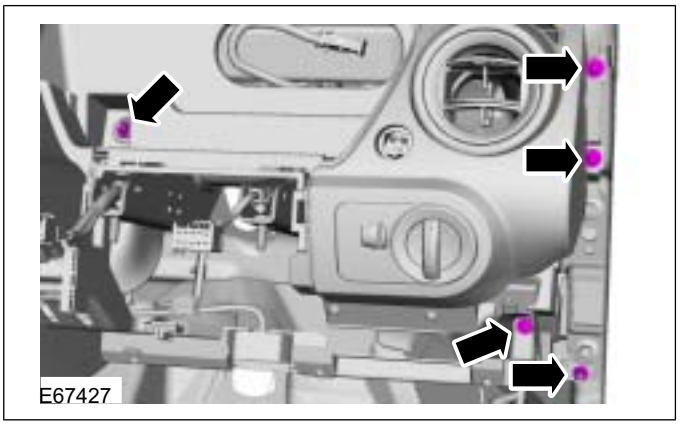
13. Remove the instrument panel inner side trim panel (both sides).



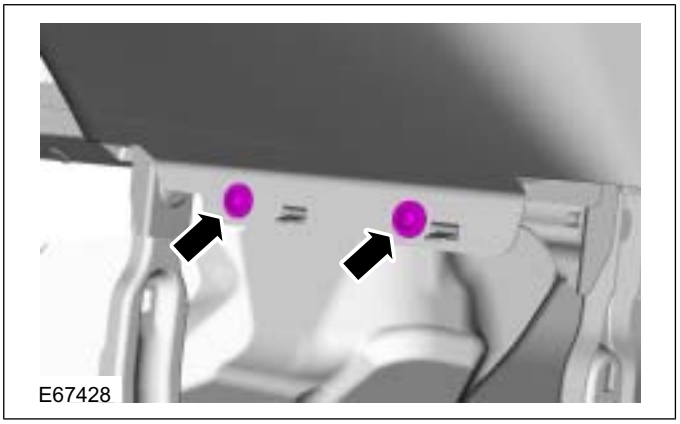
14. Remove the instrument panel left-hand side retaining screws and nut.



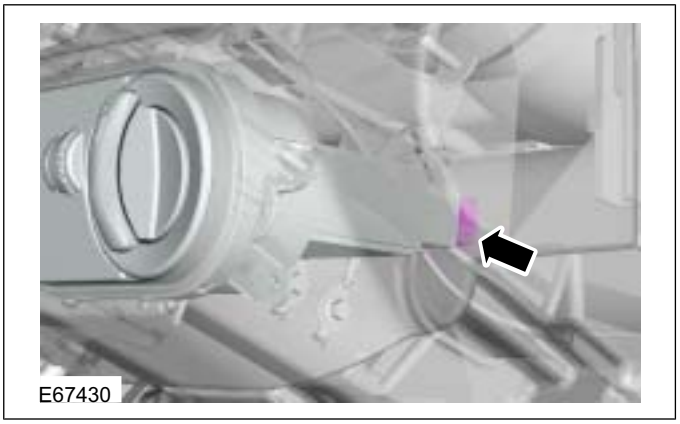
15. Remove the instrument panel right-hand side retaining screws and nuts.



16. Remove the instrument panel center retaining screws.

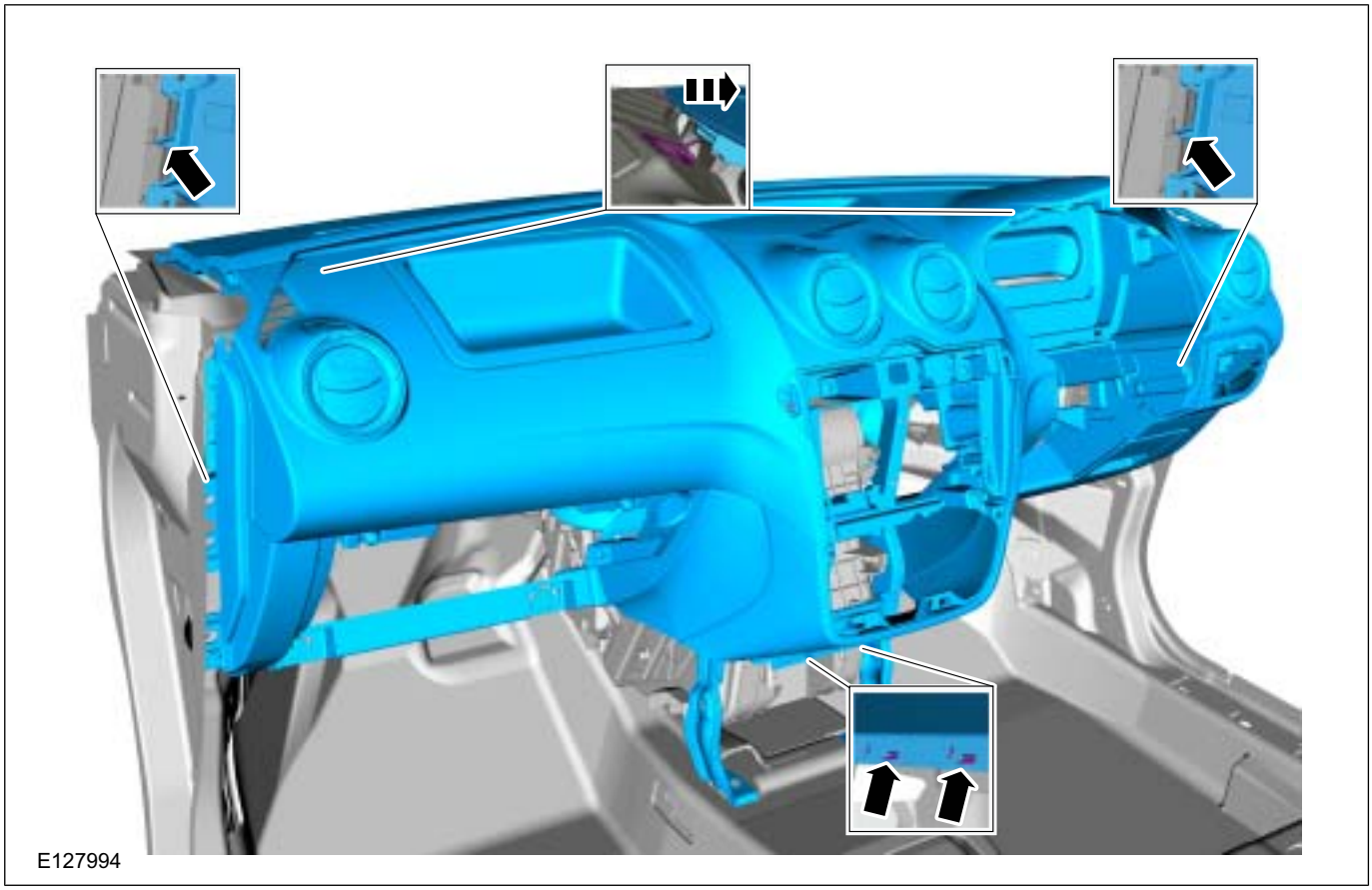


17. Disconnect the headlamp switch electrical connector.



18. Remove the instrument panel (vehicles without passenger airbag view shown).

REMOVAL AND INSTALLATION



Installation

1. **NOTE: Make sure the instrument panel upper guides locate correctly into the bulkhead panel.**

NOTE: Make sure that the instrument panel side guides locate correctly into the cross-vehicle beam.

NOTE: Make sure the cross-vehicle beam lower guides locate correctly into the instrument panel.

NOTE: Unlock the securing clip prior to removal of instrument cluster from the instrument panel.

To install, reverse the removal procedure.

SECTION 501-14 Handles, Locks, Latches and Entry Systems

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Door inner panel retaining bolts	8	-	71
Door latch retaining screws	12	9	-
Door window glass clamp retaining nuts	7	-	62
Hood latch retaining bolts	20	15	-
Liftgate latch retaining bolts	22	16	-
Liftgate latch actuator retaining bolts	5	-	44

DESCRIPTION AND OPERATION

Handles, Locks, Latches and Entry Systems

The passenger compartment doors, luggage compartment and hood are of the conventional latch to striker design.

The door latches are operated by the conventional actuating rod system connected to the exterior door handles and the door latch remote controls, with the front door latches also connected to the door lock cylinders.

The door latch remote controls have a single lever to lock, unlock and open the doors from the interior.

The hood latch is operated by a cable and release handle while the luggage compartment latch is operated by a cable and lock cylinder.

The door and luggage compartment lock cylinders may be overhauled using a service kit which consists of a lock housing, tumbler magazine, tumbler set, barrel return spring, operating lever and a sachet of grease.

For additional information, refer to: Door Lock Cylinder (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation).

DIAGNOSIS AND TESTING

Locks, Latches and Entry Systems

General Equipment

Ford Approved Diagnostic Tool

Refer to Wiring Diagrams Section 501-09, for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage

Visual Inspection Chart

Mechanical	Electrical
– Latches – Misaligned door(s) – Misaligned luggage compartment lid – Misaligned hood – Door latch(es) – Actuating rod(s) – Exterior door handle(s) – Door lock cylinder(s) – Luggage compartment lock cylinder – Cable(s)	– Door latch actuator(s) – Battery – Fuse(s) – Loose or corroded electrical connectors – Wiring Harness – BFC

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to Ford Approved Diagnostic Tool to diagnose the system.

Symptom	Possible Sources	Action
• All door locks inoperative	• Circuit, BFC, Door latch unit	• GO to Pinpoint Test A.
• Driver door lock inoperative	• Circuit, BFC, Front driver door latch unit	• GO to Pinpoint Test B.
• Front LH door lock inoperative	• Circuit, BFC, Front LH door latch unit	• GO to Pinpoint Test C.
• Rear RH door lock inoperative	• Circuit, BFC, Rear RH door latch unit	• GO to Pinpoint Test D.
• Rear LH door lock inoperative	• Circuit, BFC, Rear LH door latch unit	• GO to Pinpoint Test E.
• Tailgate release not working	• Circuit, BFC, Tailgate decklid/ajar release switch, Tailgate decklid motor	• GO to Pinpoint Test F.
• All doors lock and unlock immediately	• Door latch unit, Circuit	• GO to Pinpoint Test G.

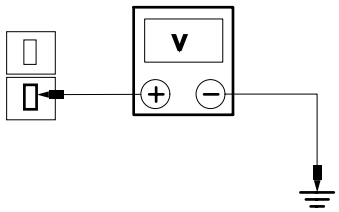
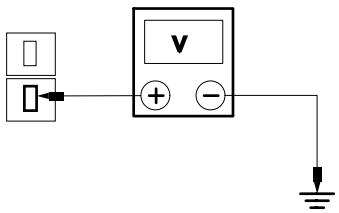
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Tailgate release not working via remote	• BFC, Tailgate decklid/ajar switch, Tailgate decklid motor, Remote battery	• Check tailgate release via interior switch mounted on Instrument Panel. If that works, check remote key for other functions. • Check charge of the remote key by pressing other remote functions. If no function works then replace the remote battery. • If none of the functions work with new battery, then learn the key again. • If none of the above actions solved the concern, then replace the BFC.
• On unlocking, only driver door unlocks	•	• This is a personalisation feature enabled on BFC. press remote lock & unlock together for more than 5 seconds and the mode toggles between all door unlock to driver door unlock & vice versa.
• Drive away locking (if equipped)	•	• On vehicles equipped with drive away locking, check the input on C2AM02-A, pin 15 for speed signal. Since this cannot be checked on multimeter (use Ford Approved Diagnostic Tool), replace the BFC & VSS

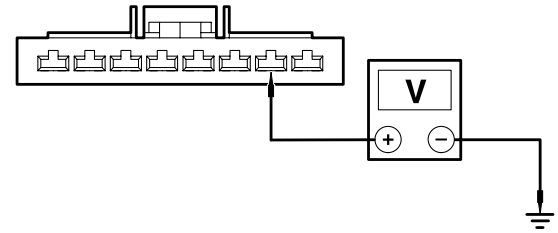
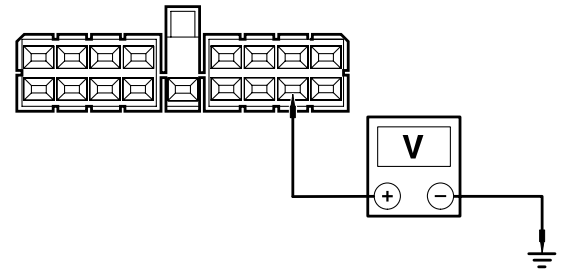
PINPOINT TEST A : ALL DOOR LOCKS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FUSE NO 24 (20A) (CJB).	
	1 Ignition switch in position 0.
	2 Disconnect F24 (20A) (CJB).
	3 Check F24 (20A) (CJB). • Is the fuse ok? → **Yes** GO to A2. → **No** Install a new fuse. Test the system for normal operation. If the fuse fail again, Repair circuit SBF05 (GY/RD) using the wiring diagrams. Install a new CJB if necessary.

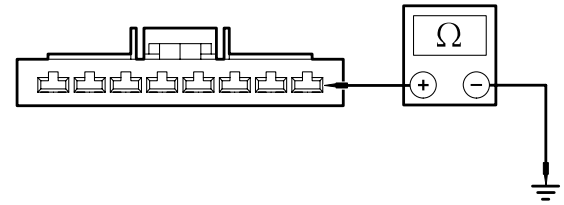
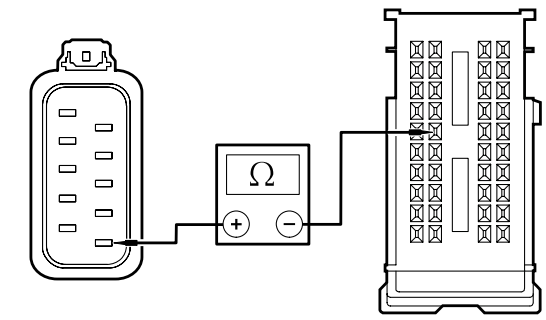
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK FUSE NO 24 (20A) CJB FOR POWER.	
 E67858	1 Measure the voltage between F24 pin 2 circuit SBP24 (VT/RD) component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A3. → **No** Repair the circuit SBF05 (GY/RD) using the wiring diagram, Install a new CJB if necessary, Test the system for normal operation.
A3: CHECK FUSE NO 32 (10A) (CJB).	
	1 Ignition switch in position 0.
	2 Disconnect F32 (10A) (CJB).
	3 Check F32 (10A) (CJB). • Is the fuse ok? → **Yes** GO to A4. → **No** Install a new fuse. Test the system for normal operation. If the fuse fail again, Repair circuit SBF05 (GY/RD) using the wiring diagrams. Install a new CJB if necessary.
A4: CHECK FUSE NO 32 (10A) CJB FOR POWER.	
	1 Connect the fuse.
 E67858	2 Measure the voltage between F32 pin 2 circuit SBP32 (VT/RD) component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A5. → **No** Repair the circuit SBF05 (GY/RD) using the wiring diagram, Install a new CJB if necessary, Test the system for normal operation.
A5: CHECK THE BFC FOR DOOR LOCK POWER.	
	1 Disconnect BFC connector C2AM02-C.

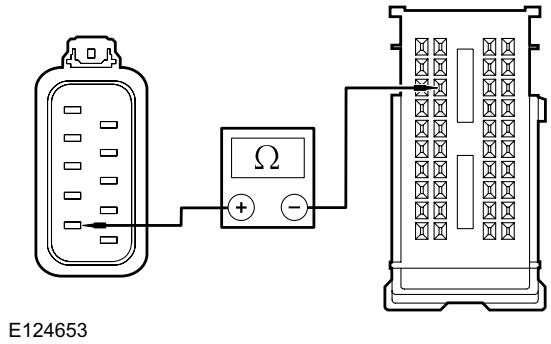
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124265	2 Measure the voltage between C2AM02-C pin 7 circuit SBP24 (VT/RD) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A6. → **No** Repair the circuit SBP24 (VT/RD) using the wiring diagram, test the system for normal operation.
A6: CHECK THE BFC FOR UNLOCK POWER.	
	1 Disconnect BFC connector C2AM02-B.
 E124266	2 Measure the voltage between C2AM02-B pin 10 circuit SBP32 (VT/RD) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A7. → **No** Repair the circuit SBP32 (VT/RD) using the wiring diagram, test the system for normal operation.
A7: CHECK THE GROUND CONNECTION OF THE BFC FOR OPEN CIRCUIT.	
	1 Disconnect the BFC connector C2AM02-C.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124268	2 Measure the resistance between the BFC connector C2AM02-C pin 8 circuit GD357 (BK) wiring harness side and ground. • Is the resistance 2 ohms registered? → **Yes** All door locks inoperative with key. GO to A8. Driver door lock in operative. GO to Pinpoint Test B. Front LH door lock in operative. GO to Pinpoint Test C. Rear LH door lock in operative. GO to Pinpoint Test D. Rear RH door lock in operative. GO to Pinpoint Test E. → **No** Locate and rectify the break in the circuit GD357 (BK) between the BFC and ground connection G13 using the wiring diagram. Check the operation of the system.
A8: CHECK CIRCUIT CPL27 (WH/BN) BETWEEN THE BFC AND DRIVER DOOR LATCH UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect the BFC C2AM02-A.
	3 Disconnect the driver door latch unit connector CAPL63.
 E124652	4 Measure the resistance between the BFC C2AM02-A, pin 25, circuit CPL27 and driver door latch unit connector CAPL63, pin 10, circuit CPL27 wiring harness side. • Is the resistance less than 2 ohms ? → **Yes** RENEW driver door latch unit. Check the operation of the system. → **No** Locate and rectify the break in the circuit between the driver door latch unit and BFC using the wiring diagram. Test the system for normal operation.

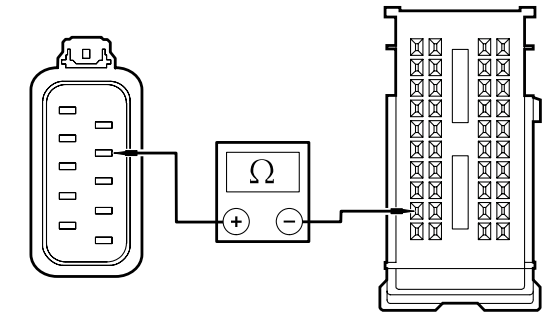
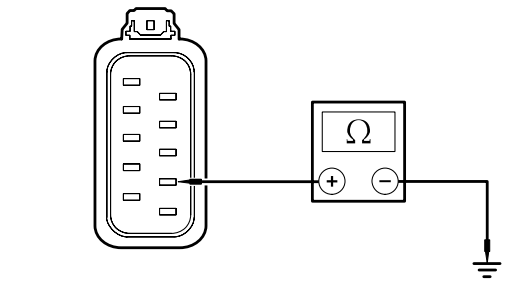
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A9: CHECK CIRCUIT CPL30 (BU/BN) BETWEEN THE BFC AND DRIVER DOOR LATCH UNIT FOR OPEN CIRCUIT	
 E124653	1 Measure the resistance between the BFC C2AM02-A, pin 23, circuit CPL30 (BU/GN) and driver door latch unit connector CAPL63, pin 9, circuit CPL30 (BU/GN) wiring harness side. • Is the resistance less than 2 ohms ? → **Yes** RENEW driver door latch unit. Check the operation of the system. → **No** Locate and rectify the break in the circuit between the driver door latch unit and BFC using the wiring diagram. Test the system for normal operation.
A10: CENTRAL LOCK INOPERATIVE WITH KEY	
	1 Check whether lock and unlock function works by using remote (tailgate is ok). • If yes? → **Yes** RENEW BFC. Check the operation of the system. → **No** GO to B.

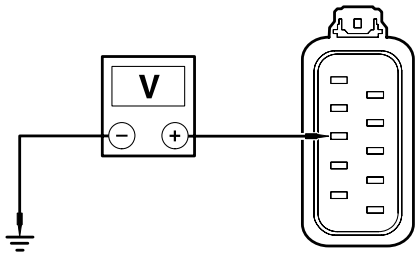
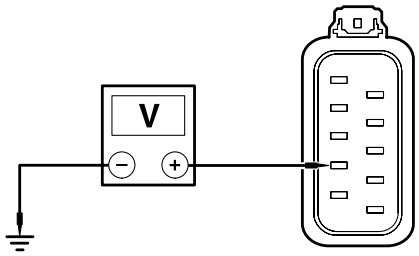
PINPOINT TEST B : DRIVER DOOR LOCK IS IN OPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Remaining doors are OK.	
B1: CHECK THE OPERATION OF THE DOOR LOCK.	
	1 Check for binding or struck condition by manually operating the driver door lock. • Is the lock struck or binding? → **Yes** Repair the binding component as necessary. Test the system for normal operation. → **No** GO to B2.
B2: CHECK CONTINUITY BETWEEN THE BFC/DRIVER DOOR LATCH UNIT CIRCUIT.	
	1 Ignition switch in position 0.
	2 Disconnect the BFC C2AM02-A.

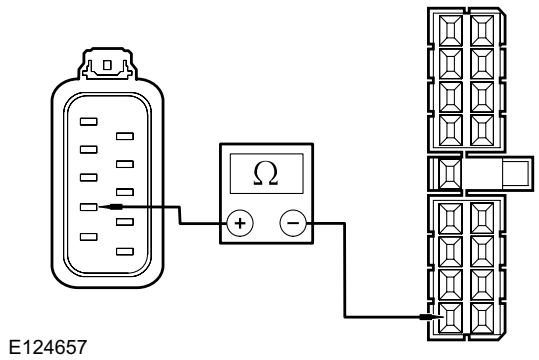
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Disconnect the driver door latch unit connector CAPL63.
 E124654	4 Measure the resistance between the driver door latch unit connector CAPL63, pin 4, circuit CPL26 (GN/VT) and BFC C2AM02-A, pin 39, circuit CPL26 (GN/VT) wiring harness side. • Is the resistance less than 2 ohms ? → **Yes** GO to B3. → **No** Repair the circuit CPL26 (GN/VT) using the wiring diagram. Test the system for normal operation.
B3: CHECK THE GROUND CONNECTION OF DRIVER DOOR LATCH UNIT.	
	1 Disconnect the front driver door latch unit connector CAPL63.
 E124270	2 Measure the resistance between the driver door latch unit connector CAPL63 pin 8 circuit GD353 (BK/YE) harness side and ground. • Is the resistance less than 2 ohms ? → **Yes** GO to B4. → **No** Locate and rectify the break in the circuit GD353 (BK/YE), and splice S3D353 between the front driver door latch unit ground connection G8, using the wiring diagram. Test the system for normal operation.
B4: CHECK THE OPERATION OF DRIVER DOOR LATCH UNIT (LOCK POSITION).	
	1 Disconnect the driver door latch unit connector CAPL63.
	2 Connect the 20A fused jumper wire between the driver door latch unit connector, pin 4, circuit CPL26 (GN/VT) wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124655	3 After pressing remote lock position, measure the voltage between the driver door latch unit connector CAPL63, pin 5, circuit CPL11 (GY/BN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the driver door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL11 (GY/BN) and splice S2PL11 using the wiring diagram. Test the system for normal operation.
B5: CHECK THE OPERATION OF DRIVER DOOR LATCH UNIT (UNLOCK POSITION).	
	1 Disconnect the driver door latch unit connector CAPL63.
	2 Connect the 20A fused jumper wire between the driver door latch unit connector, pin 4, circuit CPL26 (GN/VT) harness side and ground.
 E124656	3 After pressing remote unlock position, measure the voltage between the driver door latch unit connector CAPL63 pin 7, circuit CPL51 (BU/GN) harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the driver door latch unit. CHECK the system for operation. → **No** GO to B6.
B6: CHECK THE CIRCUIT CPL51 (BU/GN) BETWEEN THE BFC AND DRIVER DOOR LATCH UNIT FOR OPEN CIRCUIT.	
	1 Ignition switch in position 0.
	2 Disconnect the BFC C2AM02-B.

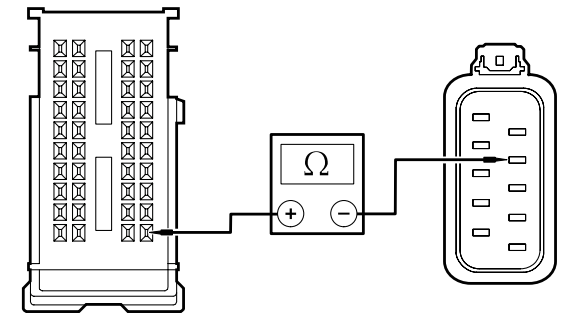
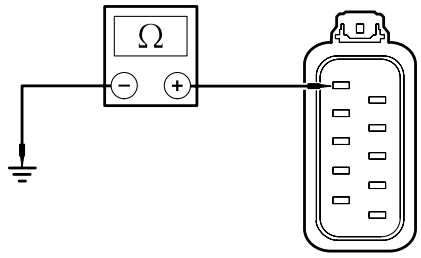
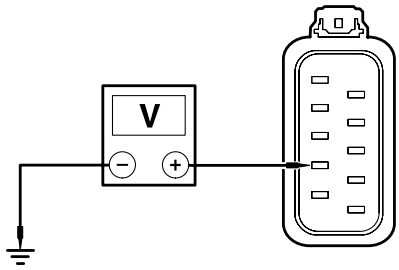
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124657	3 Measure the resistance between the BFC C2AM02-B, pin 9, circuit CPL51 (BU/GN) and driver door latch unit connector CAPL63, pin 7, circuit CPL51 ((BU/GN) wiring harness side and ground. • Is the resistance less than 2 ohms? → **Yes** RENEW the driver door latch unit. CHECK the operation of the system. → **No** LOCATE and RECTIFY break in the circuit between BFC and door latch unit using the wiring diagram. Test the system for normal operation.

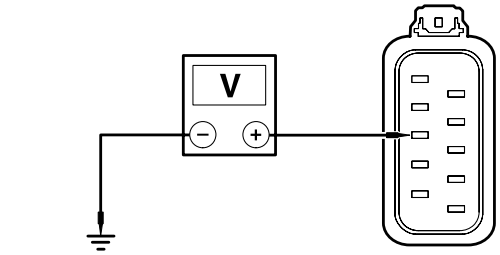
PINPOINT TEST C : FRONT LH DOOR LOCK IN OPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Remaining doors are OK.	
C1: CHECK THE OPERATION OF THE FRONT LH DOOR LATCH.	
	1 Check for binding or stuck condition by manually operating the front LH door lock. • Is the lock stuck or binding? → **Yes** Repair the binding components as necessary. Test the system for normal operation. → **No** GO to C2.
C2: CHECK CONTINUITY BETWEEN THE BFC FRONT LH DOOR LATCH UNIT CIRCUIT.	
	1 Ignition switch in position 0.
	2 Disconnect the front LH door latch unit connector CBPL64.
	3 Disconnect the BFC C2AM02-A.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124658	4 Measure the resistance between the front LH door latch unit connector CAPL64, pin 4, circuit CPL31 (WH) and BFC C2AM02-A, pin 10, circuit CPL31 (WH) wiring harness side. • Is the resistance less than 2 ohms ? → **Yes** GO to C3. → **No** Repair the circuit CPL31 (WH) using the wiring diagram. Test the system for normal operation.
C3: CHECK THE FRONT LH DOOR LATCH UNIT FOR GROUND	
 E124276	1 Measure the resistance between front LH door latch unit connector CBPL64, pin 1, circuit GD353 (BK/YE) harness side and ground. • Is the resistance less than 2 ohms? → **Yes** GO to C4. → **No** Locate and rectify the break in the circuit GD353 (BK/YE) between the splice SBD353 and ground connection G8, using the wiring diagram. Test the system for normal operation.
C4: CHECK THE OPERATION OF FRONT LH DOOR LATCH UNIT (LOCK POSITION).	
	1 Ignition switch in position 0.
	2 Disconnect the front LH door latch unit connector CAPL64.
	3 Connect the 20A fused jumper wire between the front LH door latch unit connector, pin 4, circuit CPL31 (WH) wiring harness side and ground.
 E124659	4 After pressing remote lock position, measure the voltage between the front LH door latch unit connector CAPL64, pin 7, circuit CPL11 (GY/BN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the front LH door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL11 (GY/BN) and splice S2PL11 using the wiring diagram. Test the system for normal operation.

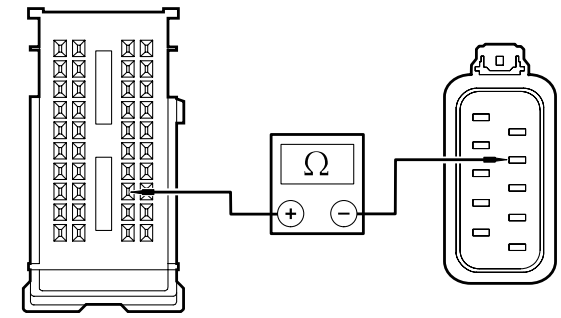
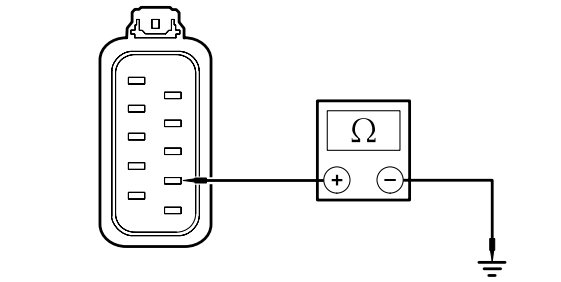
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C5: CHECK THE OPERATION OF FRONT LH DOOR LATCH UNIT (UNLOCK POSITION).	
	1 Disconnect the front LH door latch unit connector CAPL64.
	2 Connect the 20A fused jumper wire between the front LH door latch unit connector, pin 4, circuit CPL31 (WH) wiring harness side and ground.
 E124660	3 After pressing remote unlock position, measure the voltage between the front LH door latch unit connector CAPL64, pin 5, circuit CPL13 (BN/GN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the front LH door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL13 (BN/GN) and splice S2PL13 using the wiring diagram. Test the system for normal operation.

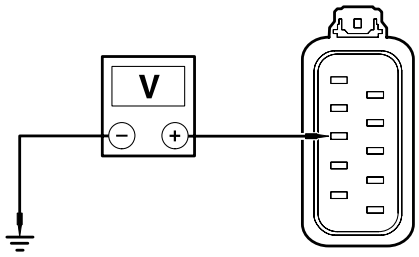
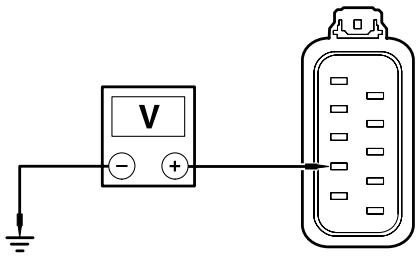
PINPOINT TEST D : REAR RH DOOR LOCK IN OPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Remaining doors are OK.	
D1: CHECK THE OPERATION OF THE REAR RH DOOR LOCK	
	1 Check for binding or stuck condition by manually operating the rear RH door lock. • Is the lock stuck or binding? → **Yes** Repair the binding components as necessary. Test the system for normal operation. → **No** GO to D2.
D2: CHECK THE CIRCUIT CPL36 (GN) BETWEEN BODY FUNCTION CONTROLLER AND REAR RH DOOR LATCH UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect the BFC C2AM02-A.
	3 Disconnect the rear RH door latch unit connector CCPL72.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124661	4 Measure the resistance between Body Function Controller connector C2AM02-A, pin 18, circuit CPL36 (GN) and rear RH door latch unit connector CCPL72, pin 4, circuit CPL36 (GN) wiring harness side. • Is the resistance 2 ohms registered? → **Yes** GO to D3. → **No** Locate and rectify the break in the circuit between BFC and rear RH door latch unit using the wiring diagram. Test the system for normal operation.
D3: CHECK THE GROUND CONNECTION OF THE REAR RH DOOR LATCH UNIT FOR OPEN CIRCUIT	
	1 Disconnect the rear RH door latch unit connector CCPL72.
 E124280	2 Measure the resistance between the rear RH door latch connector CCPL72 pin 8 circuit GD327 (BK/BU) harness side and ground. • Is the resistance 2 ohms registered? → **Yes** GO to D4. → **No** Repair the circuit GD327 (BK/BU) and ground connection G18. using the wiring diagram. Test the system for normal operation.
D4: CHECK THE OPERATION OF REAR RH DOOR LATCH UNIT (LOCK POSITION).	
	1 Ignition switch in position 0.
	2 Connect the BFC connector C2AM02-A.
	3 Disconnect the rear RH door latch unit connector CCPL72.
	4 Connect the 20A fused jumper wire between the rear RH door latch unit connector CCPL72, pin 4, circuit CPL36 (GN) wiring harness side and ground.

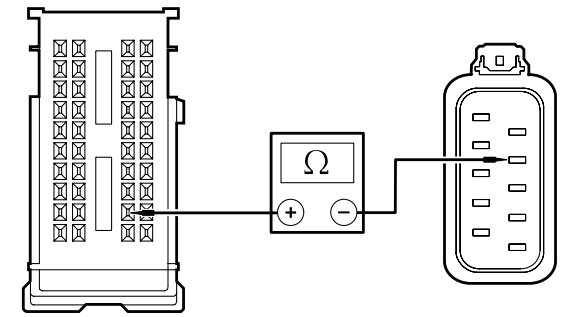
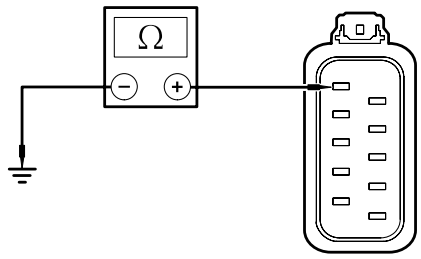
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124662	5 After pressing remote lock position, measure the voltage between the rear RH door latch unit connector CCPL72, pin 5, circuit CPL11 (GY/BN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the rear RH door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL11 (GY/BN) and splice S2PL11 using the wiring diagram. Test the system for normal operation.
D5: CHECK THE OPERATION OF REAR RH DOOR LATCH UNIT (UNLOCK POSITION).	
	1 Connect the 20A fused jumper wire between the rear RH door latch unit connector CCPL72, pin 4, circuit CPL36 (GN) wiring harness side and ground.
 E124663	2 After pressing remote unlock position, measure the voltage between the rear RH door latch unit connector CCPL72, pin 7, circuit CPL13 (BN/GN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the rear RH door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL13 (BN/GN) and splice S2PL13 using the wiring diagram. Test the system for normal operation.

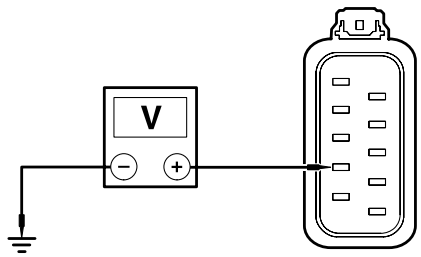
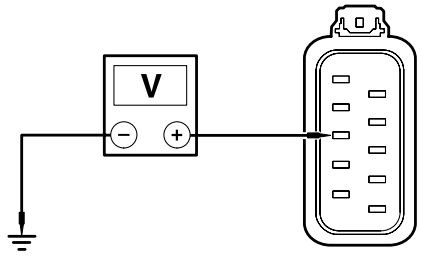
PINPOINT TEST E : REAR LH DOOR LOCK IN OPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Remaining doors are OK.	
E1: CHECK THE OPERATION OF THE REAR LH DOOR LOCK	
	1 Check for binding or stuck condition by manually operating the rear LH door lock. • Is the lock stuck or binding? → **Yes** Repair the binding components as necessary. Test the system for normal operation. → **No** GO to E2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E2: CHECK THE CIRCUIT CPL39 (YE) BETWEEN THE BODY FUNCTION CONTROLLER AND REAR LH DOOR LATCH UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect the BFC connector C2AM02-A.
	3 Disconnect the rear LH door latch unit connector CDPL71.
 E124664	4 Measure the resistance between BFC connector C2AM02-A, pin 19, circuit CPL39 (YE) and rear LH door latch unit connector CDPL71 pin 4 circuit CPL39 (YE) harness side. • Is a resistance less than 2 ohms Registered? → **Yes** GO to E3. → **No** LOCATE and RECTIFY the break in the circuit between BFC and rear LH door latch unit using the wiring diagram. Check the operation of the system.
E3: CHECK THE GROUND CONNECTION OF THE REAR LH DOOR LATCH UNIT FOR OPEN CIRCUIT	
	1 Disconnect the rear LH door latch unit connector CDPL71.
 E124284	2 Measure the resistance between rear LH door latch unit connector CDPL71 pin 1 circuit GD326 (BK/WH) harness side and ground. • Is a resistance less than 2 ohms Registered? → **Yes** GO to E4. → **No** Repair the circuit GD326 (BK/WH) soldered connection splice S4D326 and ground connection G17,using the wiring diagram. Check the operation of the system.
E4: CHECK THE OPERATION OF REAR LH DOOR LATCH UNIT (LOCK POSITION).	
	1 Connect the 20A fused jumper wire between the rear LH door latch unit connector CDPL71, pin 4, circuit CPL39 (YE) wiring harness side and ground.

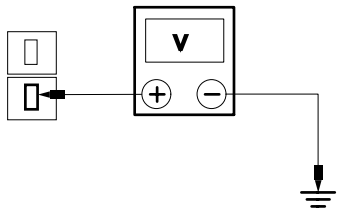
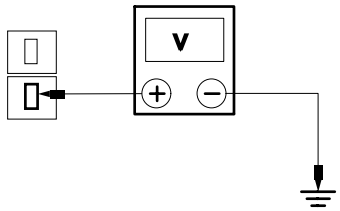
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124665	2 After pressing remote lock position, measure the voltage between the rear LH door latch unit connector CDPL71, pin 7, circuit CPL11 (GY/BN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the rear LH door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL11 (GY/BN) and splice S2PL11 using the wiring diagram. Test the system for normal operation.
E5: CHECK THE OPERATION OF REAR LH DOOR LATCH UNIT (UNLOCK POSITION).	
	1 Connect the 20A fused jumper wire between the rear LH door latch unit connector CDPL71, pin 4, circuit CPL39 (YE) wiring harness side and ground.
 E124666	2 After pressing remote unlock position, measure the voltage between the rear LH door latch unit connector CDPL71, pin 5, circuit CPL13 (BN/GN) wiring harness side and ground. • Is the voltage greater than 5 volts? → **Yes** RENEW the rear LH door latch unit. CHECK the system for operation. → **No** Repair the circuit CPL13 (BN/GN) and splice S2PL13 using the wiring diagram. Test the system for normal operation.

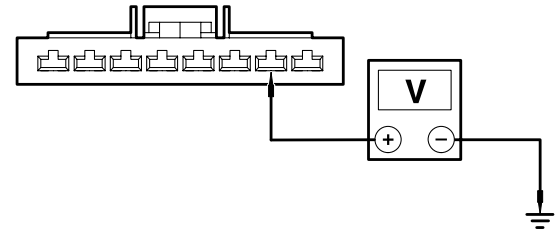
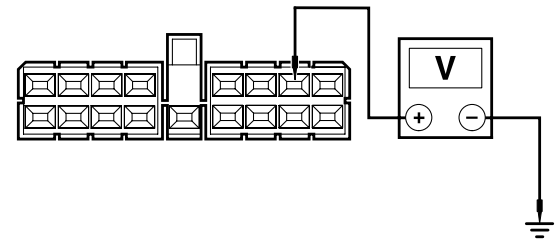
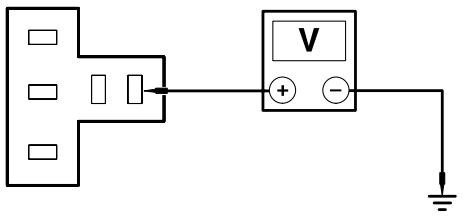
PINPOINT TEST F : TAIL GATE NOT WORKING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK FUSE NO 24 (20A) CJB	
	1 Ignition switch in position 0.
	2 Disconnect F24 (20A) CJB. • Is the fuse Ok? → **Yes** GO to F2. → **No** Install a new fuse. Test the system for normal operation. If the fuse fails again Repair circuit SBP24 (VT/RD) using the wiring diagram. Install a new CJB if necessary.

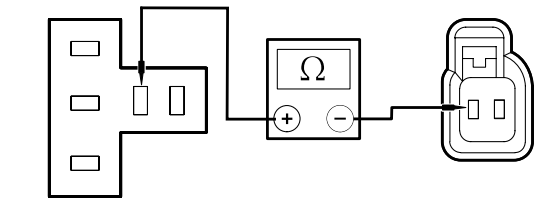
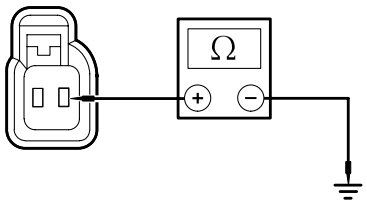
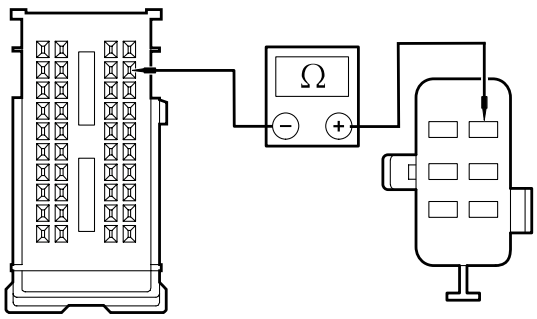
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F2: CHECK FUSE 24 (20A) CJB FOR POWER	
 E67858	1 Measure the voltage between F24 pin 2 circuit SBP24 (VT/RD). component side and ground. • Is the Voltage greater than 10 Volts? → **Yes** GO to F3. → **No** Repair circuit SBF05 (GY/RD) using the wiring diagram. Install a new CJB if necessary Test the system for normal operation.
F3: CHECK FUSE F7 (10A) (CJB).	
	1 Disconnect the fuse F7 (10A) (CJB). • Is the fuse ok? → **Yes** GO to F4. → **No** Install a new fuse. Test the system for normal operation. If the fuse fails again Repair circuit SBP07 (WH/RD) using the wiring diagram. Install a new CJB if necessary.
F4: CHECK FUSE NO 7 [10A] CJB FOR POWER.	
 E67858	1 Measure the voltage between fuse no 7 pin 2 circuit SBP07 (WH/RD), component side and ground • Is the voltage greater than 10 volts? → **Yes** GO to F5. → **No** Repair circuit SBF08 (VT/RD) using the wiring diagram. Install a new CJB if necessary Test the system for normal operation.
F5: CHECK THE BFC FOR POWER	
	1 Disconnect the BFC connector C2AM02-C.

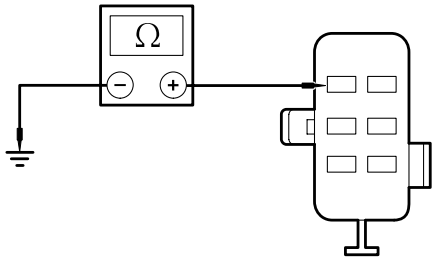
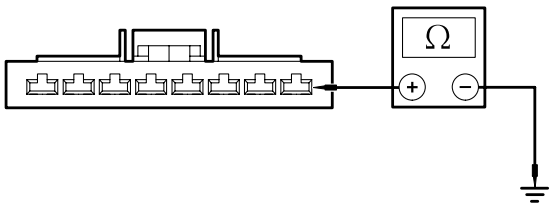
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124667	2 Measure the volts between BFC connector C2AM02-C pin 7 circuit SBP24 (VT/RD) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to F6. → **No** Repair the circuit SBP24 (VT/RD) using the wiring diagram. Test the system for normal operation.
F6: CHECK THE BFC FOR OPEN	
	1 Disconnect the BFC connector C2AM02-B.
 E124668	2 Measure the voltage between BFC connector C2AM02-B pin 2 circuit CPL79 (BN/VT) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to F7. → **No** Repair the circuit CPL79 (BN/VT) using the wiring diagram. Test the system for normal operation.
F7: CHECK FOR VOLTAGE TO THE TAIL GATE RELAY	
	1 Connect the BFC connector C2AM02-B.
 E124287	2 Measure the voltage between tail gate release relay connector C2BP02-R10 pin 3 circuit SBP07 (WH/RD) harness side and ground. • Is the voltage greater than 10 Volts? → **Yes** GO to F8. → **No** Repair the circuit SBP07 (WH/RD) using the wiring diagram. Test the system for normal operation.
F8: CHECK FOR CONTINUITY BETWEEN TAIL GATE RELEASE RELAY AND TAIL GATE DECKLID MOTOR FOR OPEN CIRCUIT	
	1 Disconnect the tail gate decklid motor connector C4PR57.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124288	2 Measure the resistance between tail gate release relay connector C2BP02-R10 pin 5, CPL84 (GN/BN) and tail gate decklid motor connector C4PR57 pin 1, CPL84 (GN/BN) harness side. • Is the resistance less than 2 ohms? → **Yes** GO to F9. → **No** Repair the circuit CPL84 (BN) using the wiring diagram. Test the system for normal operation.
F9: CHECK THE GROUND CONNECTION OF THE TAIL GATE DECKLID MOTOR FOR OPEN	
 E124669	1 Measure the resistance between tail gate decklid motor connector C4PR57 pin 2 circuit GD326 (BK/WH) harness side and ground. • Is the resistance less than 2 ohms? → **Yes** GO to F10. → **No** Locate and rectify in the circuit GD326 (BK) and soldered connection splice S4D326 and Using the wiring diagram. Check the operation of the system.
F10: CHECK THE CONTINUITY BETWEEN BFC AND TAIL GATE DECKLID RELEASE SWITCH	
	1 Connect the tail gate decklid motor connector C4PR57.
	2 Disconnect the BFC connector C2AM02-A.
	3 Disconnect the tail gate decklid release switch connector C2PL45.
 E124670	4 Measure the resistance between BFC connector C2AM02-A pin 2 circuit CPL45 (BN) and tail gate decklid release switch connector C2PL45 pin 6 harness side. • Is the resistance less than 2 ohms? → **Yes** GO to F11. → **No** Repair the circuit CPL45 (BN) between BFC and tailgate decklid release switch. Test the operation of the system.

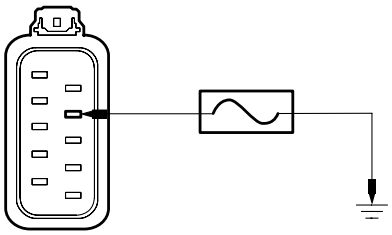
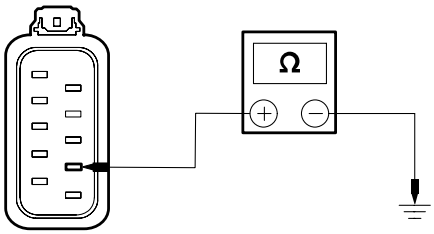
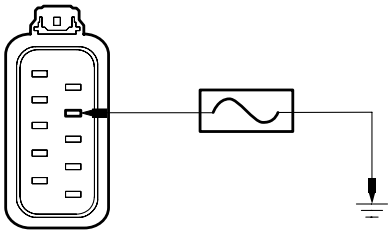
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F11: CHECK THE GROUND CONNECTION OF THE TAIL GATE DECKLID RELEASE SWITCH FOR OPEN	
 E124671	1 Measure the resistance between tail gate decklid release switch connector C2PL45 pin 3 circuit GD265 (BK) harness side and ground. • Is the resistance less than 2 ohms? → **Yes** GO to F12. → **No** Locate and rectify circuit GD265 (BK) splice S2D265 using the wiring diagram. Check the operation of the system.
F12: CHECK GROUND CONNECTION OF BFC FOR OPEN CIRCUIT	
	1 Disconnect BFC connector C2AM02-C.
 E122943	2 Measure the resistance between the BFC, – Connector C2AM02-C, pin 8, circuit GD357 (BK), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the BFC. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD357 (BK), ground G13 between the BFC using the Wiring Diagrams. CHECK the operation of the system.

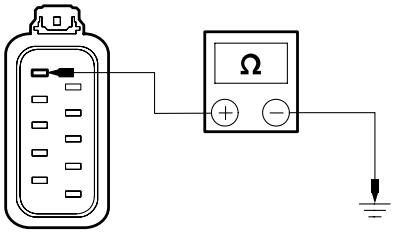
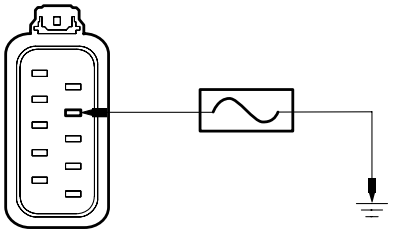
PINPOINT TEST G : CHECK ALL THE DOOR LATCH UNIT CIRCUITS

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: DETERMINE THE FAULT CONDITION AT DRIVER DOOR LATCH UNIT	
	1 Ignition switch in position 0.
	2 Disconnect door latch unit connector CAPL63.
	3 Connect fused jumper wire between the driver door latch unit connector CAPL63, pin 4, circuit CPL26 (GN/VT) wiring harness side and ground..

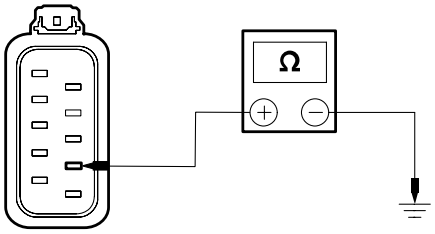
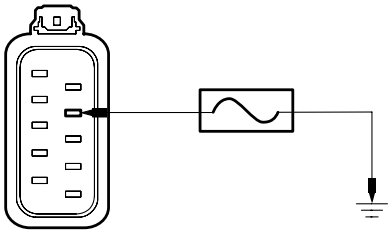
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E125244	• Are all other doors locks normally by using remote? → **Yes** GO to G2. → **No** REPAIR circuit CPL26 (GN/VT) using the Wiring Diagrams. CHECK the operation of the system.
G2: CHECK THE CIRCUIT GD353 (BK/YE)	
 E125245	1 Measure the resistance between the driver door latch unit connector CAPL63, pin 8, circuit GD353 (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** Install a door latch unit, if necessary → **No** LOCATE and REPAIR the break in circuit GD353 (BK/YE), between soldered S3D353 connection and ground connection G8 using the Wiring Diagrams. CHECK the operation of the system..
G3: DETERMINE THE FAULT CONDITION AT PASSENGER DOOR LATCH UNIT	
	1 Ignition switch in position 0.
	2 Disconnect passenger door latch unit connector CBPL64.
	3 Connect fused jumper wire between the passenger door latch unit connector CBPL64, pin 4, circuit CPL31 (WH) wiring harness side and ground..
 E125244	• Are all other doors locks normally by using remote? → **Yes** GO to G4. → **No** REPAIR circuit CPL31 (WH), using the Wiring Diagrams. CHECK the operation of the system.

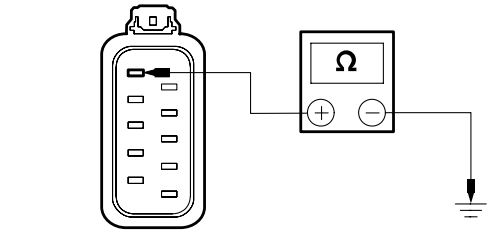
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G4: CHECK THE CIRCUIT GD353 (BK/YE)	
 E125246	1 Measure the resistance between the passenger door latch unit connector CBPL64, pin 1, circuit GD353 (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** Install a door latch unit, if necessary → **No** LOCATE and REPAIR the break in circuit GD353 (BK/YE), between soldered SBD353 connection and ground connection G8 using the Wiring Diagrams. CHECK the operation of the system..
G5: DETERMINE THE FAULT CONDITION AT REAR RHS DOOR LATCH UNIT	
	1 Ignition switch in position 0.
	2 Disconnect R/RH door latch unit connector CCPL72.
	3 Connect fused jumper wire between the R/RH door connector CCPL72, pin 4, circuit CPL36 (GN) wiring harness side and ground..
 E125244	• Are all other doors locks normally by using remote? → **Yes** GO to G6. → **No** REPAIR circuit CPL36 (GN) using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G6: CHECK THE CIRCUIT GD327 (BK/BU)	
 E125245	1 Measure the resistance between the R/RH door latch unit connector CCPL72, pin 8, circuit GD327 (BK/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** Install a door latch unit, if necessary → **No** LOCATE and REPAIR the break in circuit GD327 (BK/BU), between ground connection G18 using the Wiring Diagrams. CHECK the operation of the system..
G7: DETERMINE THE FAULT CONDITION AT REAR LHS DOOR LATCH UNIT	
	1 Ignition switch in position 0.
	2 Disconnect R/LH door latch unit connector CDPL71.
	3 Connect fused jumper wire between the R/LH door connector CDPL71, pin 4, circuit CPL39 (YE) wiring harness side and ground..
 E125244	• Are all other doors locks normally by using remote? → **Yes** GO to G8. → **No** REPAIR circuit CPL39 (YE) using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G8: CHECK THE CIRCUIT GD326 (BK/WH)	
 E125247	1 Measure the resistance between the R/LH door latch unit connector CDPL71, pin 1, circuit GD326 (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** Install a door latch unit, if necessary → **No** LOCATE and REPAIR the break in circuit GD326 (BK/WH), between soldered S4D326 connection and ground connection G17 using the Wiring Diagrams. CHECK the operation of the system..

REMOVAL AND INSTALLATION

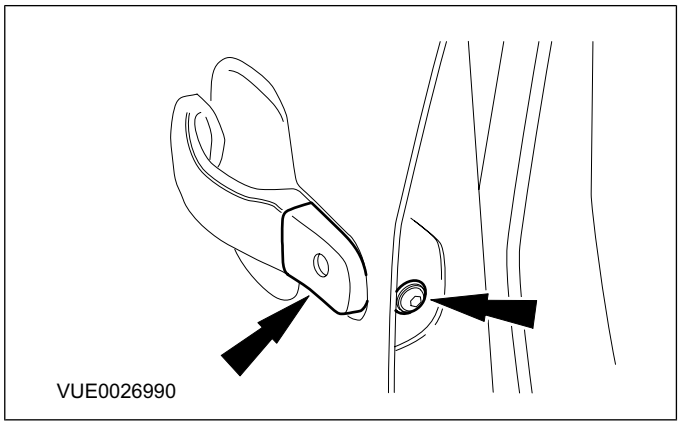
Door Lock Cylinder(41 336 0)

Removal

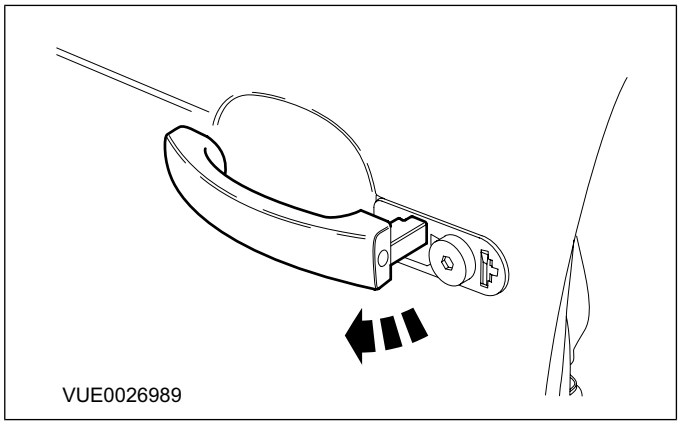
1. **Remove the front door window glass.**

   For additional information, refer to: Front Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

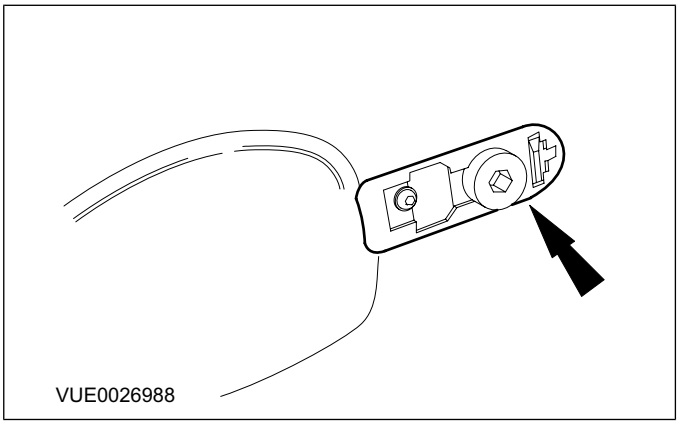
2. **Remove the front door lock cylinder cover retaining screw and remove the front door lock cylinder cover.**



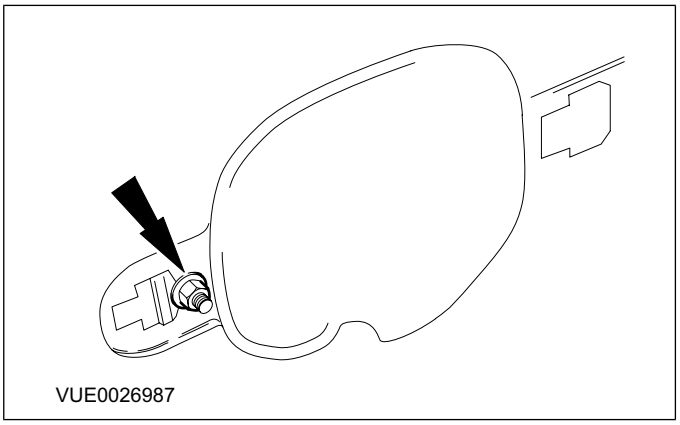
3. **Remove the exterior front door handle.**



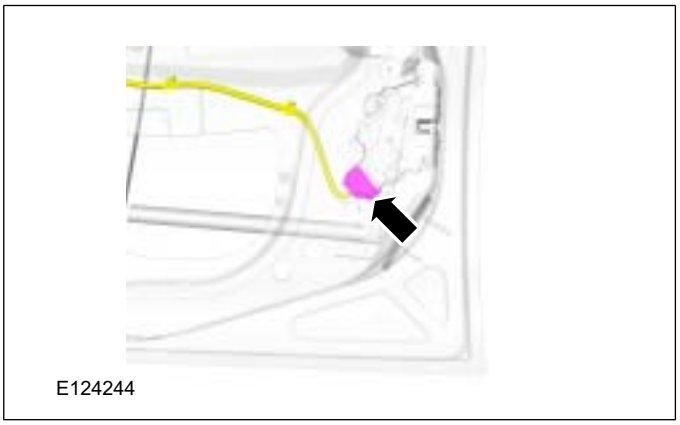
4. **Remove the exterior front door handle gasket.**



5. **Remove the exterior front door handle reinforcement plate retaining nut.**



6. **Disconnect the front door latch electrical connector.**



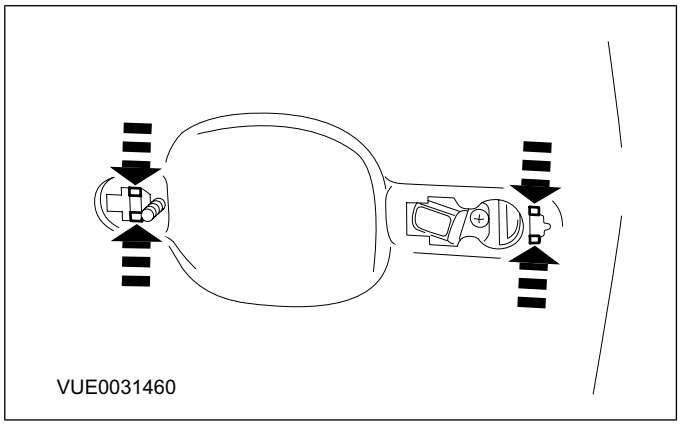
7. **Remove the front door latch.**

   For additional information, refer to: Front Door Latch (501-14 Handles, Locks,

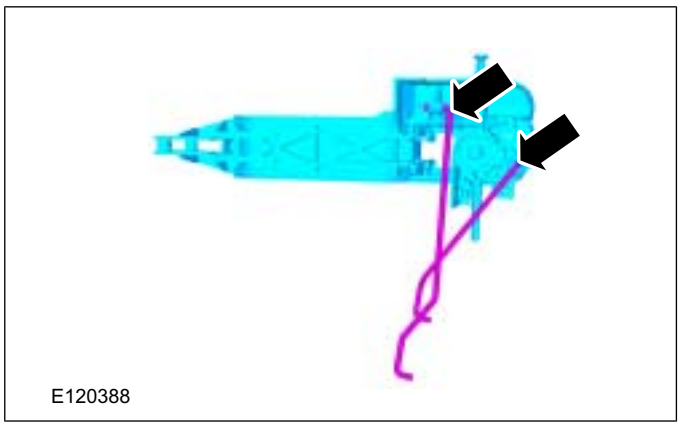
REMOVAL AND INSTALLATION

Latches and Entry Systems, Removal and Installation).

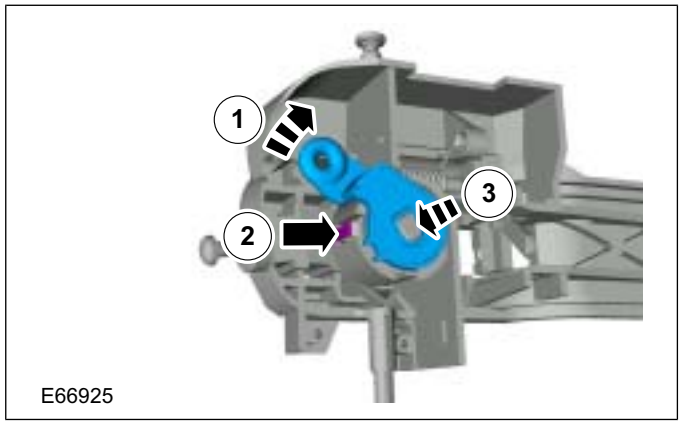
8. **Push the front door lock cylinder and exterior front door handle reinforcement plate into the door by releasing the clips.**



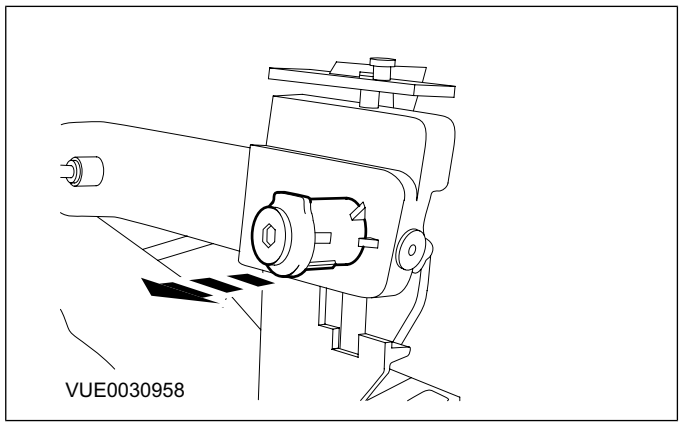
9. **Remove the door inner handle assembly and detach the connecting rods.**



10. **Remove the door lock cylinder.**
    1. Rotate the door lock cylinder lever clockwise to expose the door lock cylinder retaining clip.
    2. Release the door lock cylinder retaining clip using a suitable flat blade screwdriver.
    3. Press the door lock cylinder out of the door lock cylinder lever.



11. **Remove the door lock cylinder (continued).**



Installation

1. **To install reverse the removal procedure.**
2. **Install the front door window glass.**

   For additional information, refer to: Front Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

REMOVAL AND INSTALLATION

Front Door Latch(41 351 0)

Removal

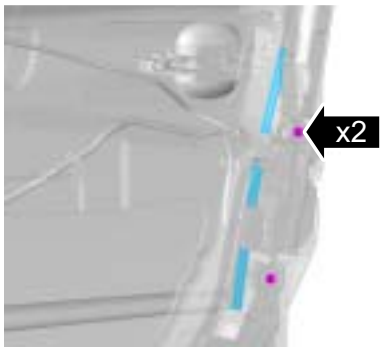
1. **Remove the front door trim panel.**

   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

2. **Disconnect the front door latch electrical connector.**

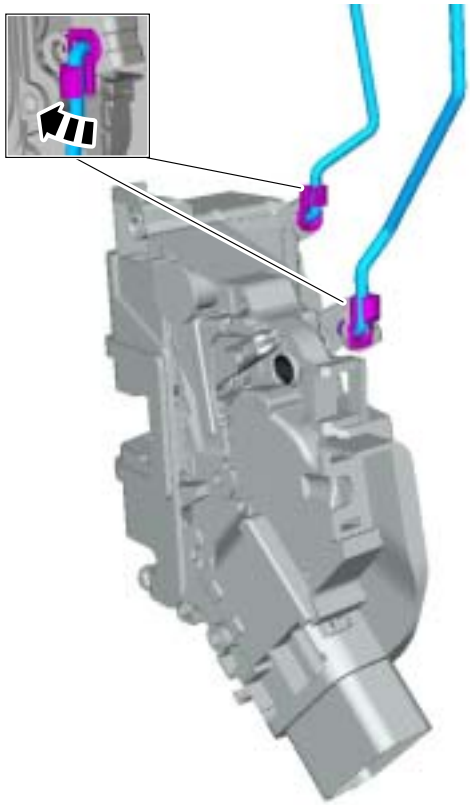
E124244

3. **Remove the front door window sash.**



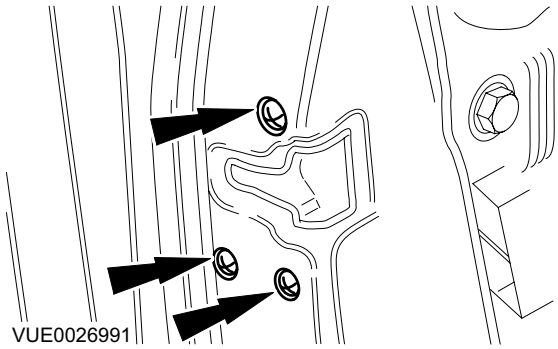
E119912

4. **Detach the exterior front door handle and lock cylinder connecting rods.**



E66003

5. **Remove the front door latch retaining screws.**



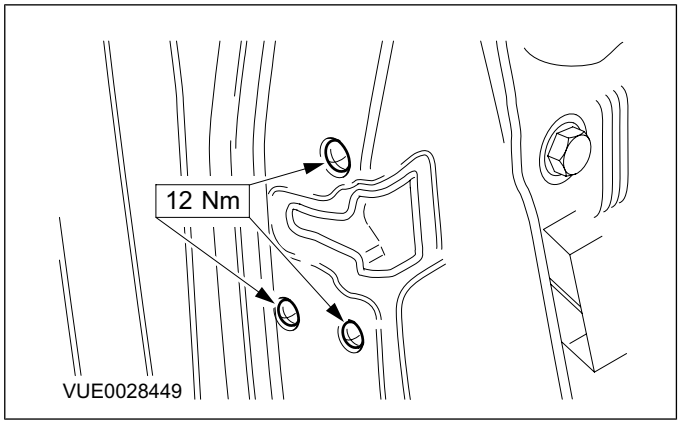
VUE0026991

6. **Remove the front door latch.**

REMOVAL AND INSTALLATION

Installation

1. **To install reverse the removal procedure.**



2. **Install the front door trim panel.**

   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

REMOVAL AND INSTALLATION

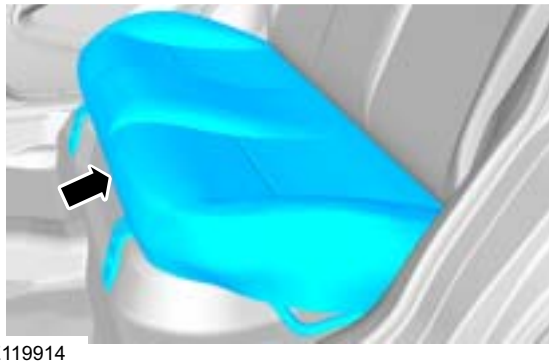
Fuel Filler Door Release Handle and Cable

Removal

1. Remove both side front seats.

   For additional information, refer to: Front Seat (501-10 Seating, Removal and Installation).

2. Remove the rear seat cusion.



E119914

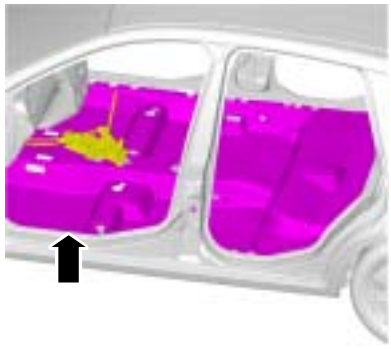
3. Remove the rear seat back rest cover.

   For additional information, refer to: Rear Seat Backrest Cover (501-10 Seating, Removal and Installation).

4. Remove the center console, front door, rear door scuff plates, B pillar trims and all required parts. For additional information, refer to:

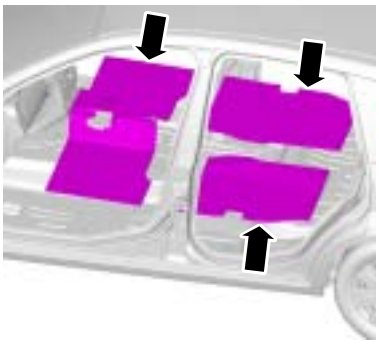
   Floor Console (501-12 Instrument Panel and Console, Removal and Installation),
   B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation),
   Front Scuff Plate Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation),
   Rear Scuff Plate Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

5. Remove the floor carpet.



E122465

6. Remove the secondary carpets.



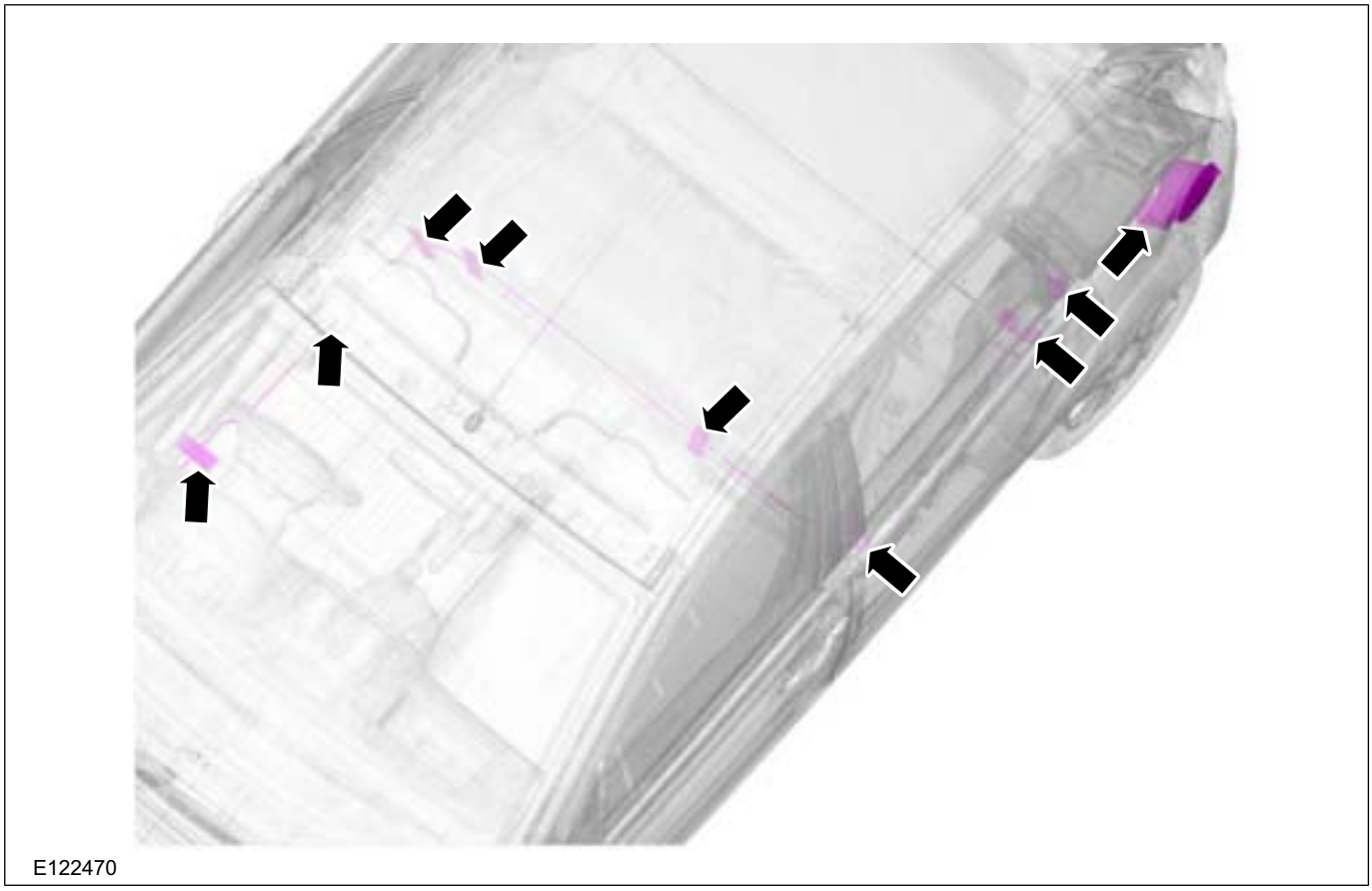
E122466

7. For removal of the cable, reverse the installation procedure.

Installation

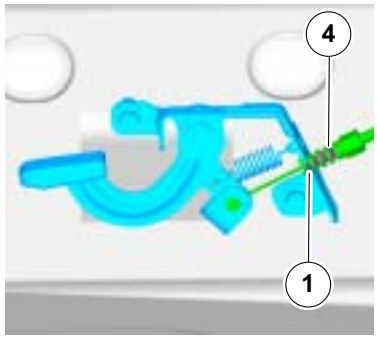
1. The general routing of the cable routing, tape fitment locations are shown.

REMOVAL AND INSTALLATION



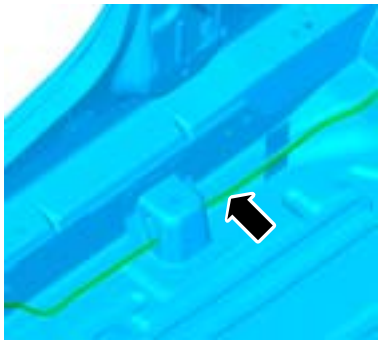
E122470

2. Make sure that the 1st notch of the cable is fitted in the lever.



E122464

3. Route the cable in to the panel.

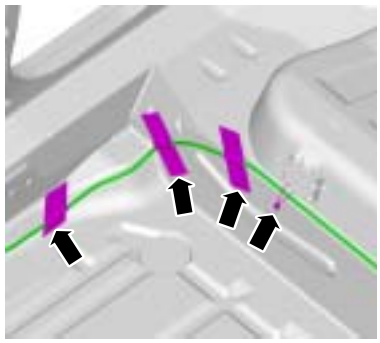


E122467

4. Route the cable inside the RH seat bracket reinforcement.
   1. Ensure that the tapes are pasted in the location.
   2. Fit a tie strap through the seat bracket.

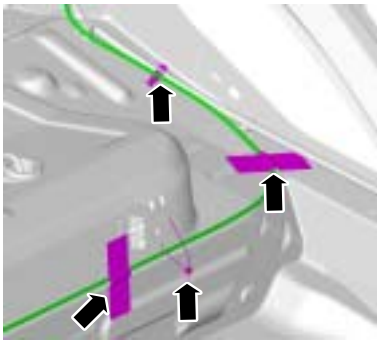
REMOVAL AND INSTALLATION

3. Make sure that the cable is routed above the edge of the body embossing near the heal kick area.



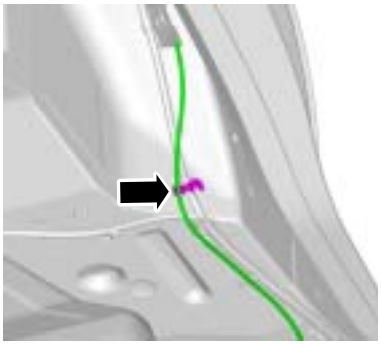
E122468

5. Route the cable inside the LH seat bracket reinforcement & put the tie strap.



E122469

6. Lock the cable into the wiring loom clip.

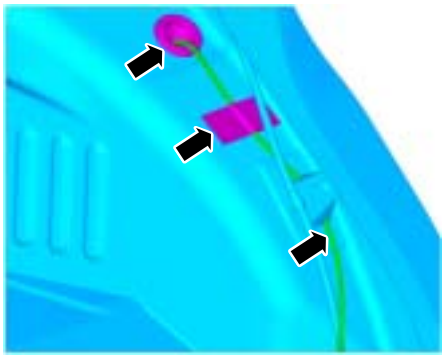


E122471

7. Insert the grommet into the body hole.

1. Ensure that the tapes are pasted in the location.

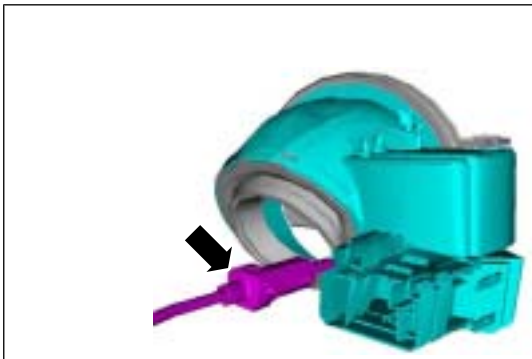
2. Route the cable in to the panel.



E122473

8. NOTE: Removed view shown for clarity.

Insert the cable end to the fuel lid housing slot & turn clockwise (half rotation) to lock it.



E122472

9. For installation of the removed parts, reverse the removal steps 1 to 6.

REMOVAL AND INSTALLATION

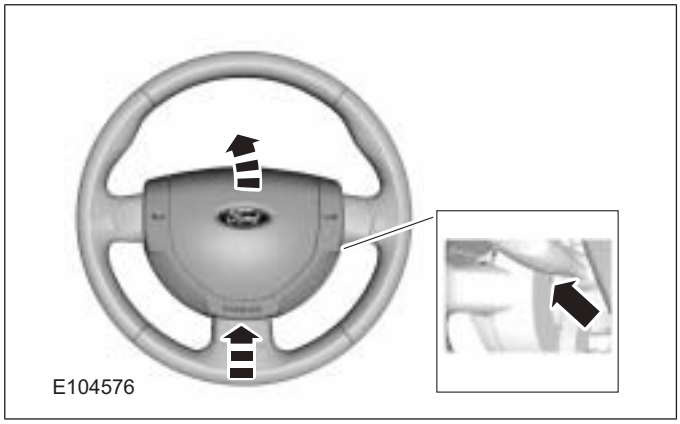
Ignition Lock Cylinder(33 513 0)

Removal

Vehicles with driver air bag

1. Detach the driver air bag module from the steering wheel.

1. Pull the top of the air bag module away from the steering wheel.
2. Push the air bag module upwards to detach the lower retaining clips.



Vehicles without driver air bag

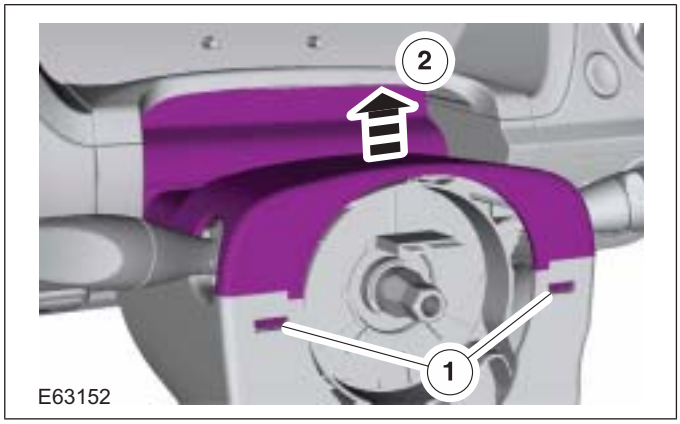
2. Remove the steering wheel.

For additional information, refer to: Steering Wheel (211-04 Steering Column, Removal and Installation).

All vehicles

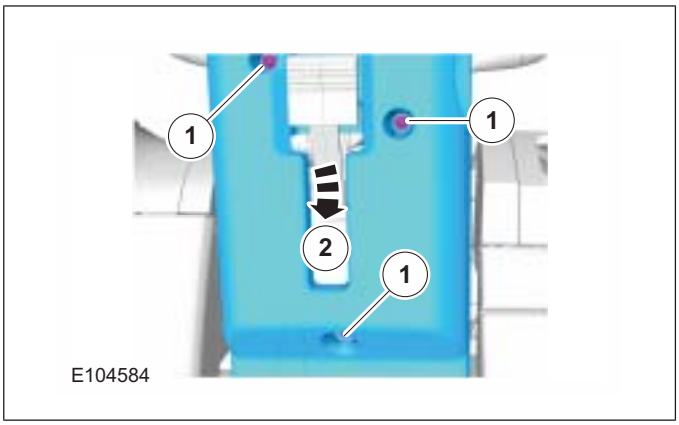
3. Detach the steering column upper shroud.

- Using a thin bladed screwdriver, release the two clips, (one each side).



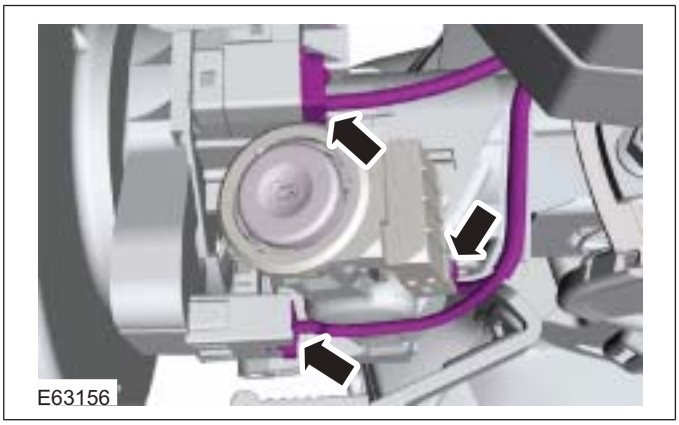
4. Remove the steering column lower shroud (steering wheel shown removed for clarity).

1. Remove the retaining screws.
2. Release the steering column locking lever (If equipped).



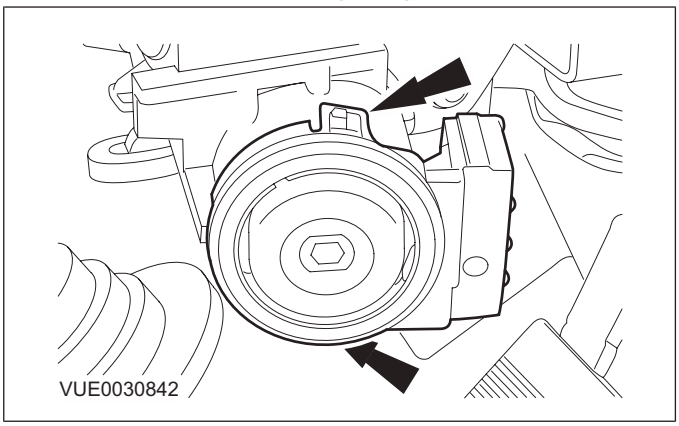
Vehicles with PATS

5. Disconnect the passive anti-theft (PATS) transceiver electrical connector.



6. Remove the PATS transceiver (steering column multifunction switch shown removed for clarity).

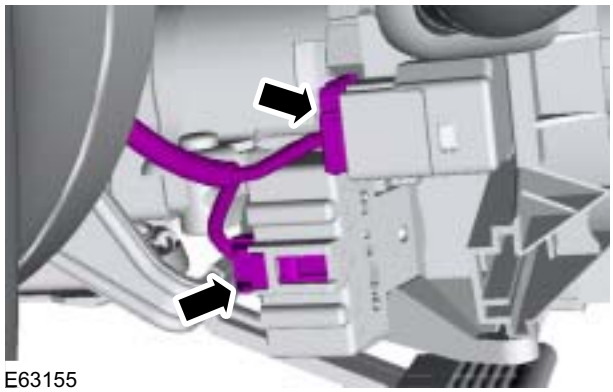
- Release the locking tangs.



REMOVAL AND INSTALLATION

All vehicles

7. Disconnect the ignition switch and turn signal electrical connectors.


E63155

Vehicles with driver air bag

8. Remove the clock spring assembly.

For additional information, refer to: Clockspring (501-20 Supplemental Restraint System, Removal and Installation).

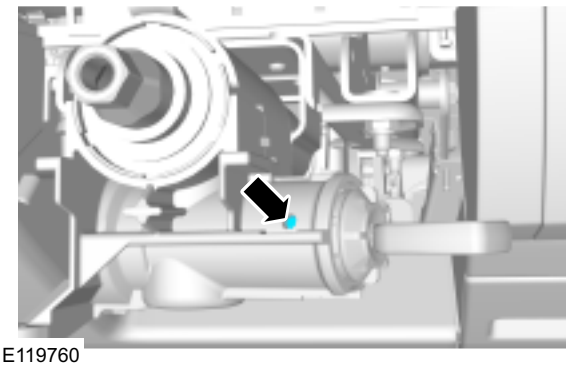
All vehicles

9. Turn the ignition key to position 1.

Right-hand drive vehicles

10. Remove the ignition lock cylinder.

- Depress the 1 detents at the top and bottom of the housing and pull out the cylinder.


E119760

Installation

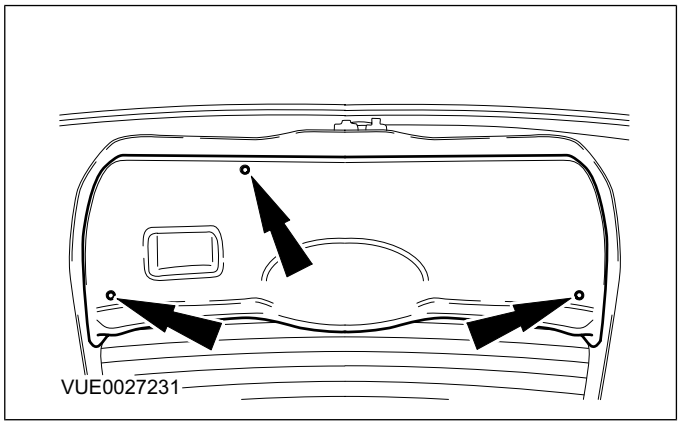
1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

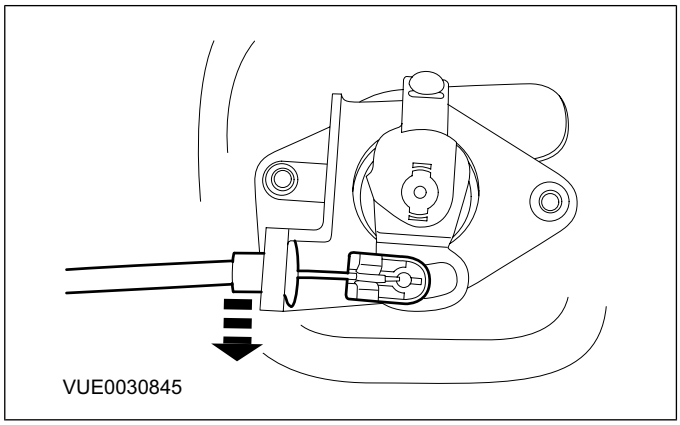
Liftgate Latch(41 666 0)

Removal

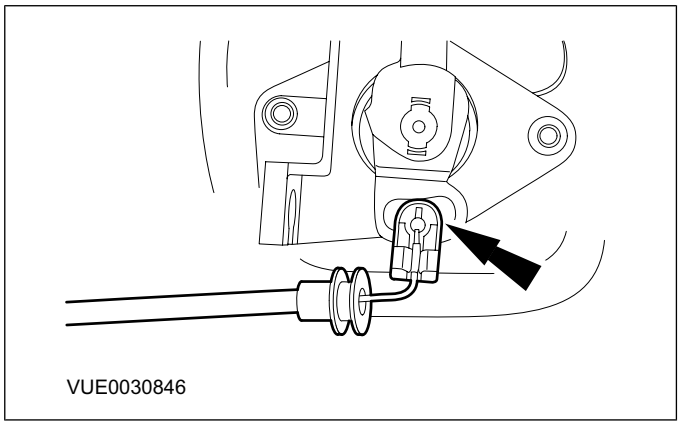
1. Remove the liftgate trim panel.



2. Detach the liftgate latch cable from the liftgate lock cylinder retaining plate

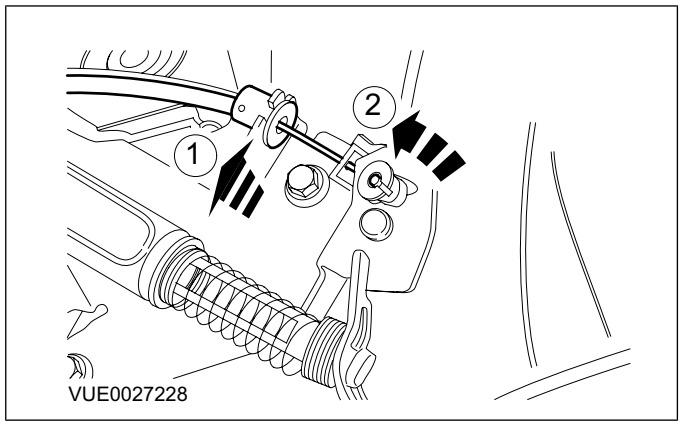


3. Disconnect the liftgate latch cable from the liftgate lock cylinder actuator.

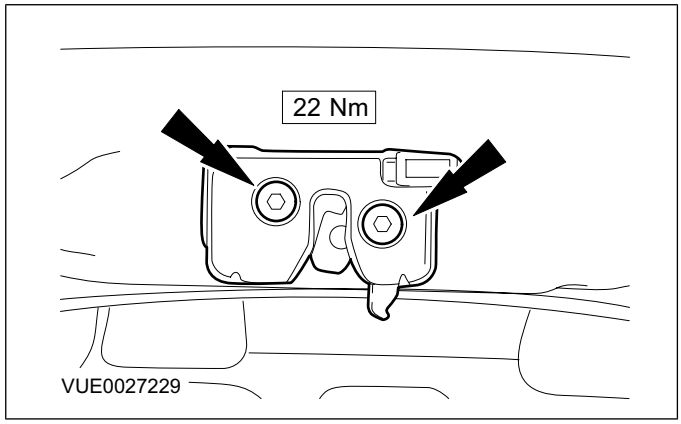


4. Disconnect the liftgate latch actuator cable from the liftgate latch actuator.

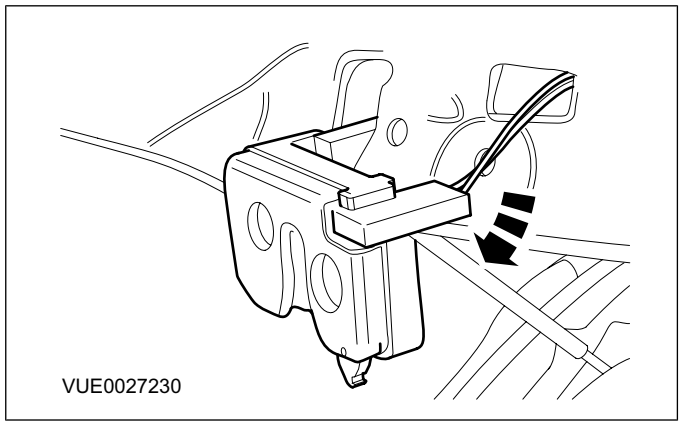
1. Push the cable from the retaining bracket.
2. Rotate the end of the cable clockwise to release it from the liftgate latch actuator.



5. Detach the liftgate latch from the liftgate.



6. Detach the liftgate ajar switch and remove the liftgate latch.



Installation

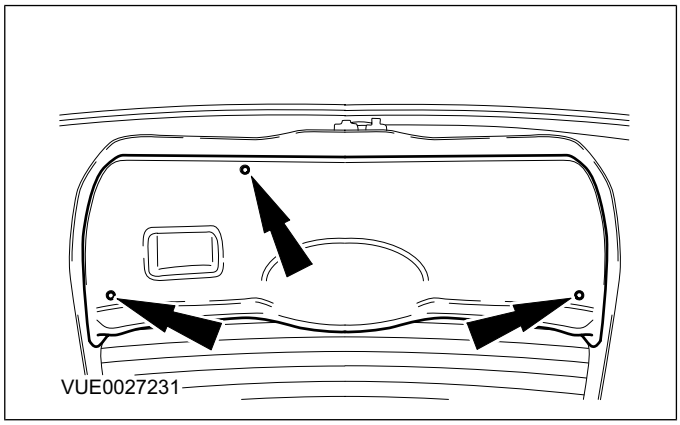
1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

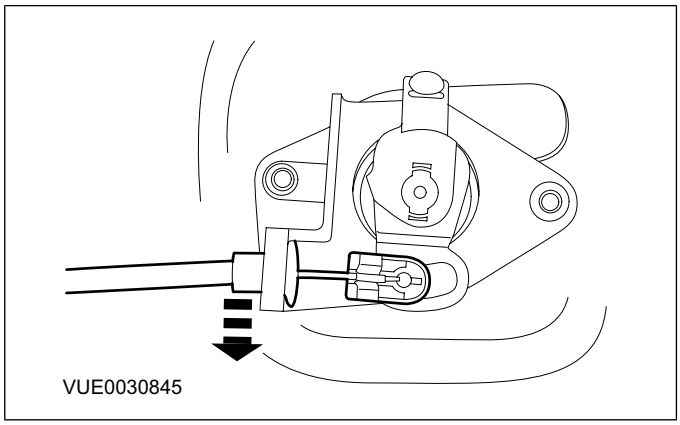
Liftgate Lock Cylinder(41 664 0)

Removal

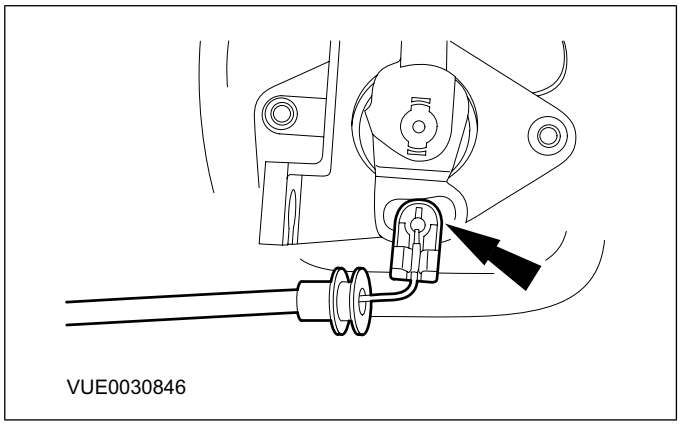
1. **Remove the liftgate trim panel.**



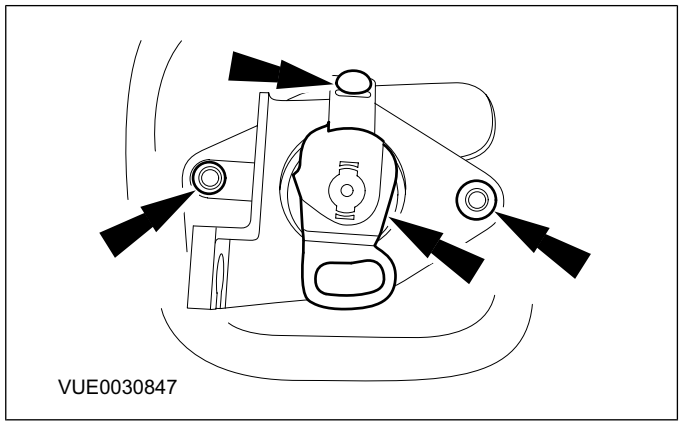
2. **Detach the liftgate latch cable from the liftgate lock cylinder retaining plate.**



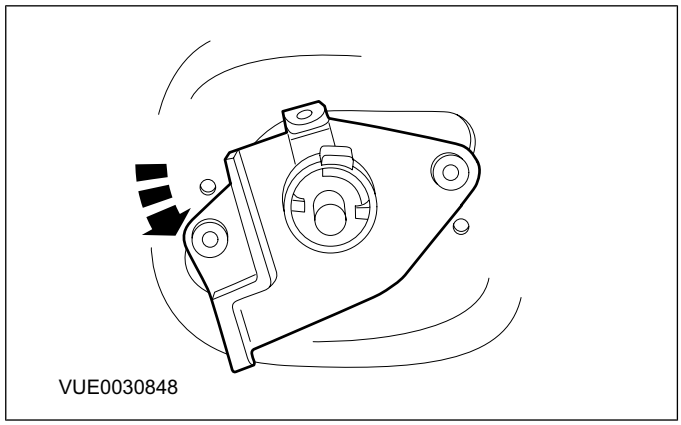
3. **Disconnect the liftgate latch cable from the liftgate lock cylinder actuator.**



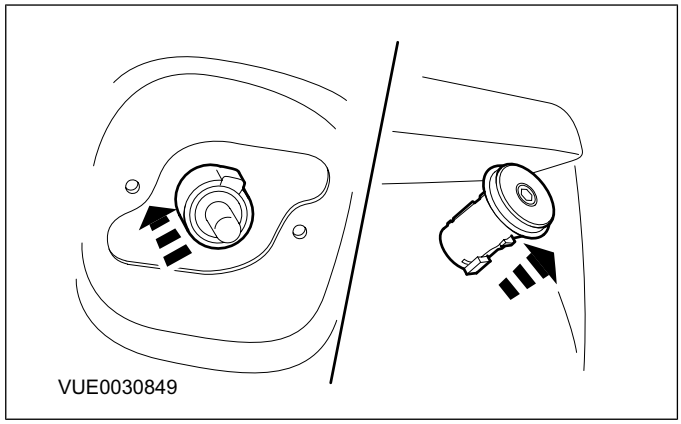
4. **Remove the liftgate lock cylinder retaining plate retaining screws and the liftgate lock cylinder actuator.**



5. **Remove the liftgate lock cylinder retaining plate.**
   - Rotate the retaining plate counterclockwise.



6. **Remove the liftgate lock cylinder.**
   - Push the liftgate lock cylinder through the liftgate.



REMOVAL AND INSTALLATION

Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

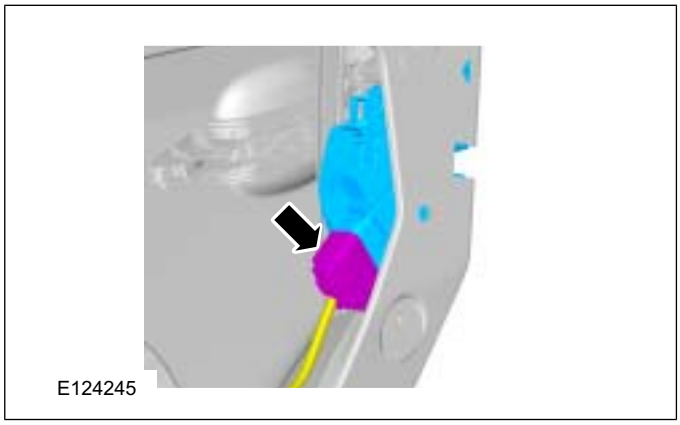
Rear Door Latch(41 352 0)

Removal

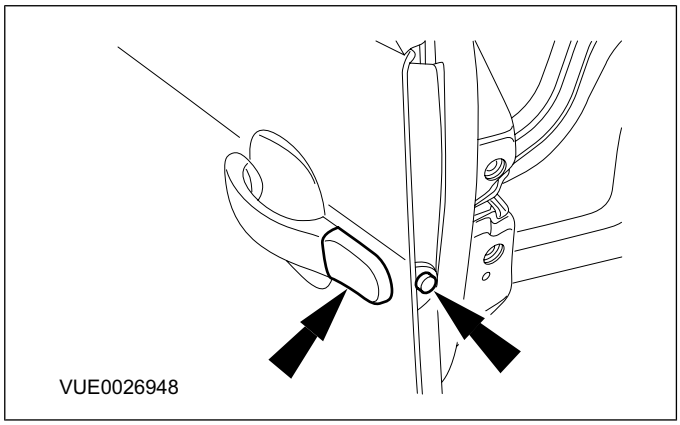
1. **Remove the rear door window glass.**

   For additional information, refer to: Rear Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

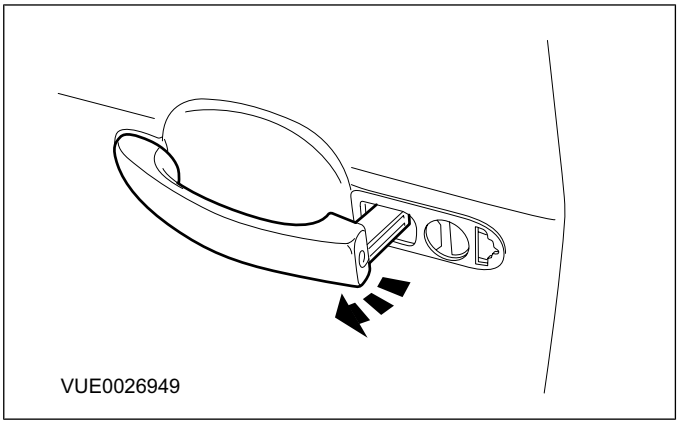
2. **Disconnect the door latch electrical connector.**



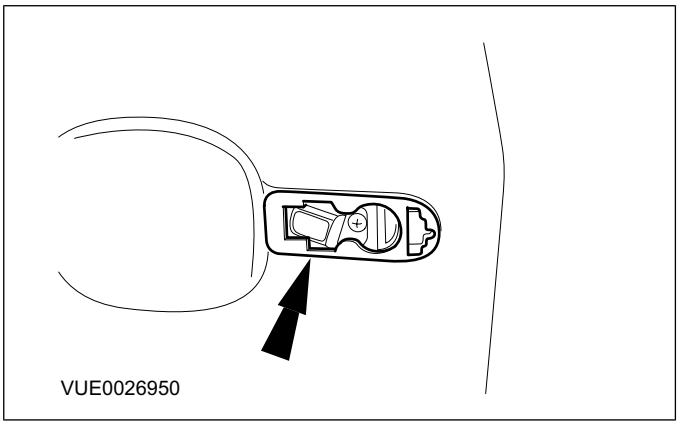
3. **Remove the exterior rear door handle cover retaining screw and the exterior rear door handle cover.**



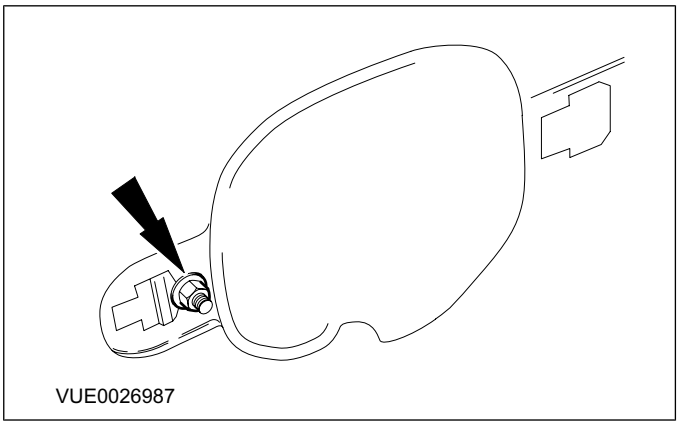
4. **Remove the exterior rear door handle.**



5. **Remove the exterior rear door handle gasket.**

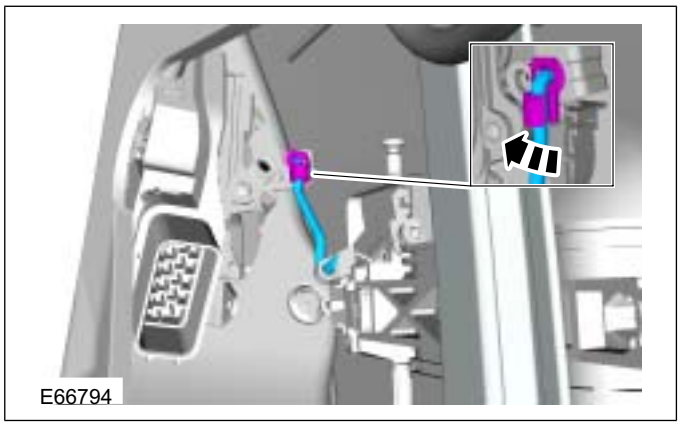


6. **Remove the exterior rear door handle reinforcement plate retaining nut.**

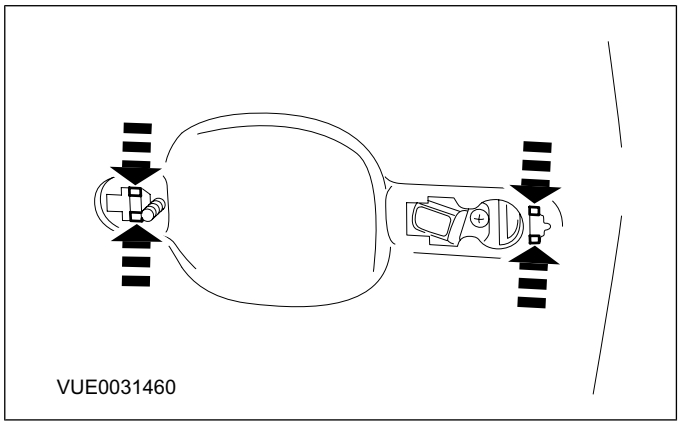


REMOVAL AND INSTALLATION

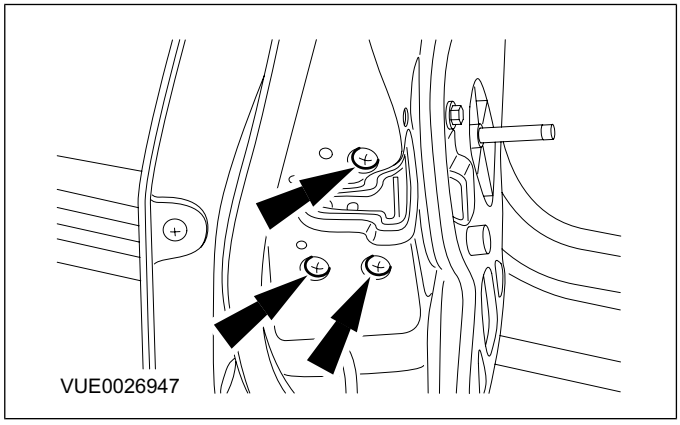
7. Detach the rear door latch connecting rod.



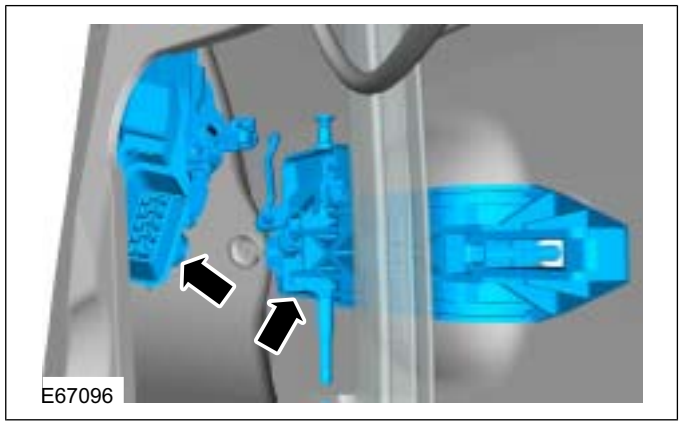
8. Push the exterior rear door handle reinforcement plate into the door by releasing the clips.



9. Remove the door latch retaining screws.



10. Remove the rear door latch and rear door handle from the rear door inner panel.



Installation

1. To install reverse the removal procedure.
2. Install the rear door window glass.

   For additional information, refer to: Rear Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

SECTION 501-16 Wipers and Washers

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Angle of wiper arms to windshield

Description	Angle
Front (RHD)	+ 5°
Rear	+ 5°

Tightening torques

Description	Nm	lb.ft	lb.in
Nut, windshield wiper arm	18	13	-
Bolts, crossbrace	20	15	-
Suspension strut top nuts	25	18	-
Bolts, windshield wiper motor unit to bulkhead	20	15	-
Bolts, windshield wiper motor	12	9	-
Nuts, windshield wiper linkage	20	15	-
Nut, rear wiper arm	15	11	-
Bolts, rear wiper motor	7	-	62

Specification

Description	Finis Code	Specification
Washer fluid	-	WSD-M8B16-AA

DESCRIPTION AND OPERATION

Wipers and Washers

Windshield wash/wipe system

The windshield wash/wipe system will only operate if the ignition switch is in **ON** position.

Four wash functions are available: "Off", "Single wipe", "Normal Speed", "High Speed" and "Intermittent".

When the intermittent wipe mode is switched on the windshield wipers operate at normal speed with the following wiper delays:

- Wiper delay 1: 1 second
- Wiper delay 2: 3.5 seconds
- Wiper delay 3: 6 seconds
- Wiper delay 4: 9,5 seconds
- Wiper delay 5: 15.5 seconds
- Wiper delay 6: 22 seconds

NOTE: In the event of a failure, or if the control resistor is not connected the default time for the wiper delay is 8 seconds.

When the windshield washer switch is operated washer fluid is sprayed onto the windshield. After a short delay designed to protect the wiper blades the wipers perform 2 or 3 wipes at low speed.

If, when the windshield washer switch is activated, the windshield wipers are switched off, then a single wipe is performed 4 seconds after the wipers have returned to the home position after performing the 2 or 3 wipes.

If, when the windshield washer switch is activated, the wipers are in intermittent mode, and if the selected wiper delay time is longer than 6 seconds, then a single wipe is performed 6 seconds after the wipers have returned to the home position after performing the 2 or 3 wipes. If the selected delay time is less than 6 seconds then no post wipe is required.

The post wipe function on the windshield ensures that any water remaining on the windshield after washing is wiped away. It is only required if the wipers are switched off or they are set to intermittent mode.

Rear window wash/wipe system

The rear window wash/wipe system will only operate if the ignition switch is in the position "II".

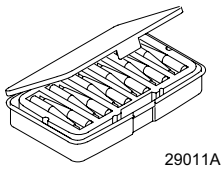
If the switch for the rear window washer is pressed, then washer fluid is sprayed onto the rear window, and the wiper operates continuously. When the switch is released the rear window wiper performs another 2-3 wipes.

DIAGNOSIS AND TESTING

Wipers and Washers

Refer to Wiring Diagrams Section 501-16, for schematic and connector information.

Special Tool(s)

 29011A	Terminal Probe Kit 29-011 A

Inspection and Checking

1. Verify the customer concern.
2. Visually check for any obvious mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Wiper blade(s) • Rotating shaft – wiper arm • Washer reservoir • Hose(s) • Nozzles	• Fuse(s) • Connectors • Wiring harness • Washer pump • Front window wiper motor • Front Wiper Module • BFC

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the concern is not visually evident, refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Wipers inoperative	• Fuse • Circuit(s) • Wash/wipe system switch • Windshield wiper motor • BFC • Central junction box (CJB) • Front Wiper Module	• GO to Pinpoint Test A.
	• Rear wiper	• GO to Pinpoint Test G6.
• Brief wipe is inoperative (slow wipe OK)	• Wash/wipe switch	• RENEW the wash/wipe switch. CHECK the operation of the system.
• Wipers permanently switched on	• Circuit(s) • Wash/wipe system switch • Windshield wiper motor • BFC • Front Wiper Module	• GO to Pinpoint Test B.
• Slow/fast wipe not working	• Circuit(s) • Wash/wipe system switch • Windshield wiper motor	• GO to Pinpoint Test C.
• Intermittent wipe mode of windshield wiper inoperative (fast/slow wipe OK)	• Circuit(s) • Wash/wipe switch • BFC • Front Wiper Module	• GO to Pinpoint Test D.

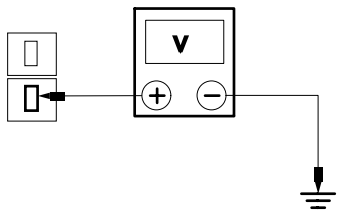
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Wash/wipe function inoperative	• Circuit(s) • Wash/wipe system switch • BFC • Front Wiper Module	• GO to Pinpoint Test E.
• Windshield wiper do not return to park position after switching off	• Circuit(s) • Wash/wipe system switch • Windshield wiper motor • BFC • Front Wiper Module	• GO to Pinpoint Test G.
• Washer pump motor inoperative	• Circuit(s) • Washer pump motor • Wash/wipe system switch	• GO to Pinpoint Test F.

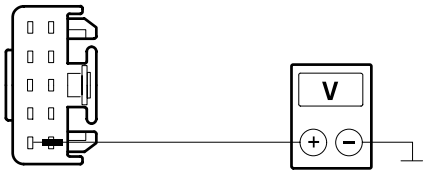
System Check

NOTE: Use a digital multimeter for all electrical measurements.

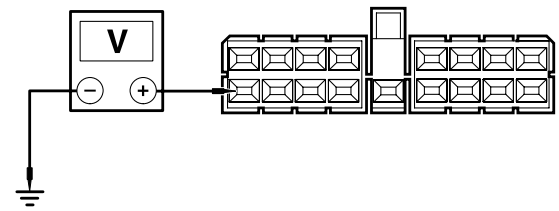
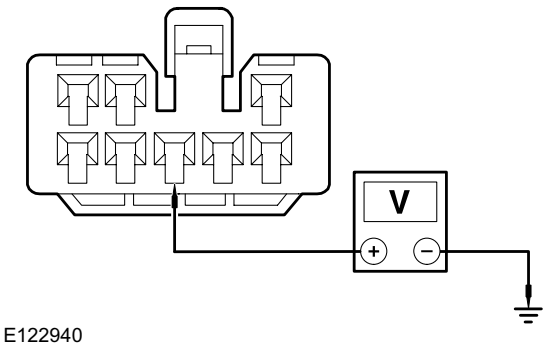
PINPOINT TEST A : WIPERS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON front wiper.
	3 SWITCH ON rear window wiper. • Are both wipers inoperative? → **Yes** Front wiper inoperative. GO to A2. Rear wiper inoperative. GO to G6.
A2: CHECK THE VOLTAGE SUPPLY TO FUSE F46 (20A) (CJB) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Connect Fuse F46 (20 A) (CJB), pin 2.
	3 Ignition switch in position II.
 E67858	4 Measure the voltage between fuse F46 (20 A) (CJB), circuit CBP46 (WH/BU) and ground. • Is battery voltage measured? → **Yes** GO to A3. → **No** LOCATE and REPAIR the circuit CDC21 (GY/BN) using the Wiring Diagrams. CHECK the operation of the system.

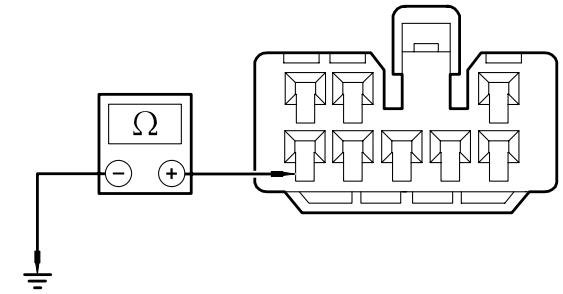
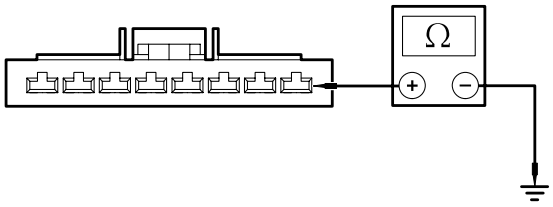
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A3: CHECK THE VOLTAGE SUPPLY TO THE WASH/WIPE SYSTEM SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.
	3 Ignition switch in position II.
 VFE0022258	4 Measure voltage between wash/wipe switch, connector C2RW08, pin 6, circuit CBP46 (WH/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the wash/wipe system switch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit CBP46 (WH/BU) between fuse F46 (CJB), splice S2BP46 and the wash/wipe system switch using the Wiring Diagrams. CHECK the operation of the system.
A4: CHECK THE WASH/WIPE SYSTEM SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. – Perform the check on the rear wiper circuit at the wash/wipe system switch. • Is the wash/wipe system switch OK? → **Yes** Vehicle with BFC GO to A5. Vehicle without BFC GO to A6. → **No** RENEW the wash/wipe system switch. CHECK the operation of the system.
A5: CHECK VOLTAGE SUPPLY TO BFC FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect BFC from connector C2AM02-B.
	3 Ignition switch in position II.

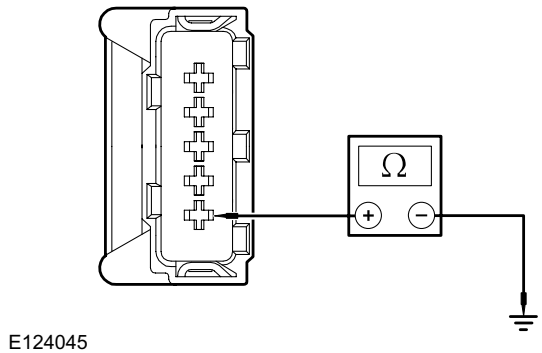
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E122938	4 Measure the voltage between the BFC, connector C2AM02-B, pin 17, circuit CBP46 (WH/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A8. → **No** LOCATE and RECTIFY the break in the circuit CBP46 (WH/BU) between the wash/wipe system switch, Splice S2BP46 and BFC using the Wiring Diagrams. CHECK the operation of the system.
A6: CHECK VOLTAGE SUPPLY TO FRONT WIPER MODULE (FWM) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E122940	
	2 Disconnect Front Wiper Module (FWM) from connector C2RW03.
	3 Ignition switch in position II.
	4 Measure the voltage between the Front Wiper Module (FWM), connector C2RW03, pin 6, circuit CBP46 (WH/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A7. → **No** LOCATE and RECTIFY the break in the circuit CBP46 (WH/BU) between the wash/wipe system switch, Splice S2BP46 and Front Wiper Module (FWM) using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A7: CHECK GROUND CONNECTION OF FRONT WIPER MODULE (FWM) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Front Wiper Module (FWM) from connector C2RW03.
 E122987	3 Measure the resistance between the Front Wiper Module (FWM) connector C2RW03, pin 4, circuit GD216 (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the Front Wiper Module (FWM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD216 (BK/VT) between the Front Wiper Module (FWM) and ground G14 using the Wiring Diagrams. CHECK the operation of the system.
A8: CHECK GROUND CONNECTION OF BFC FOR OPEN CIRCUIT	
	1 Disconnect BFC.
 E122988	2 Measure the resistance between the BFC connector C2AM02-C, pin 8, circuit GD357 (BK), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the BFC. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD357 (BK) between the BFC and ground G13 using the Wiring Diagrams. CHECK the operation of the system.
A9: CHECK THE WASH/WIPE SYSTEM SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.

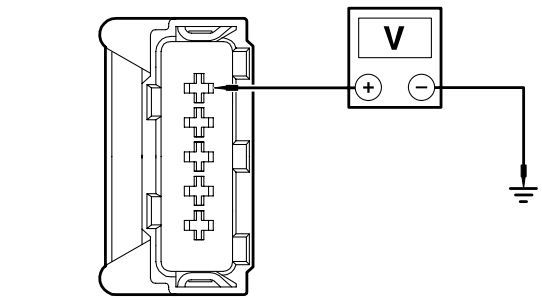
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. – Perform the check on the fast and slow front wipe circuit at the wash/wipe system switch. • Is the wash/wipe switch OK? → **Yes** GO to A10. → **No** RENEW the wash/wipe system switch. CHECK the operation of the system.
A10: CHECK THE GROUND CONNECTION OF THE FRONT WIPER MOTOR FOR OPEN CIRCUIT	
	1 Disconnect front wiper motor from connector C1RW01.
 E124045	2 Measure the resistance between the front wiper motor, connector C1RW01, pin 5, circuit GD123 (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the wiper motor. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD123 (BK/GY) between the wiper motor and ground G5 using the wiring diagrams. CHECK the operation of the system.

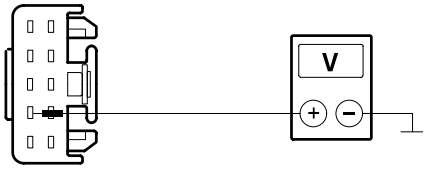
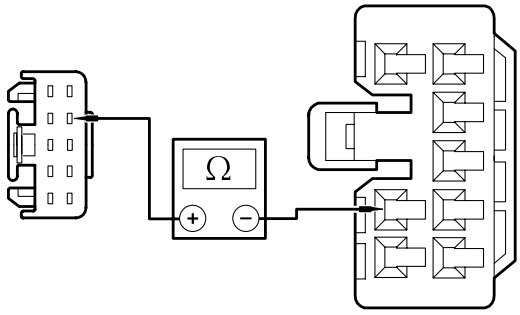
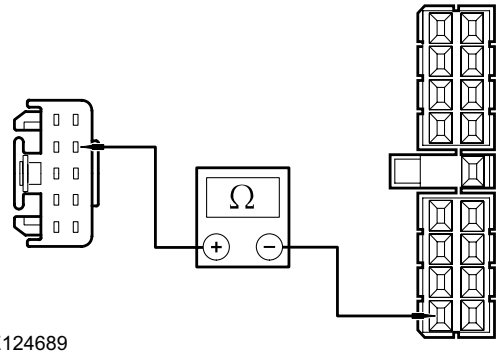
PINPOINT TEST B : WIPERS PERMANENTLY SWITCHED ON

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.
	3 Ignition switch in position II.

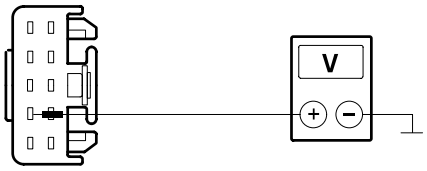
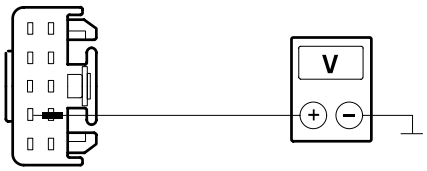
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK the front and rear wipers. • Does the rear window wiper motor run continuously? → **Yes** GO to G11. → **No** - The front wiper motor is running continually at the slow wipe speed: GO to B2. - The front wiper motor is running continually at the fast wipe speed: GO to B11. - No malfunction detected: The front wiper motor is running continuously at fast wipe speed: RENEW the wash/wipe switch. CHECK the operation of the system. - No malfunction detected: The front wiper motor is running continually in intermittent wipe mode: GO to B6.
B2: CHECK THE FRONT WIPER MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect windshield wiper motor from connector C1RW01.
	3 Ignition switch in position II.
 E122984	4 Measure the voltage between front wiper motor connector C1RW01, pin 1, circuit CRW10 (BU/GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit CRW10 (BU/GN) between the wash/wipe system switch and wiper motor using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the windshield wiper motor. CHECK the operation of the system.
B3: CHECK THE WASH/WIPE SYSTEM SWITCH.	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch.
	3 Ignition switch in position II.

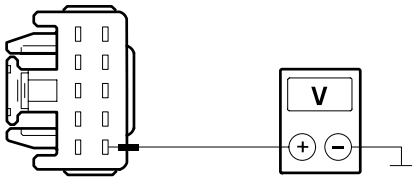
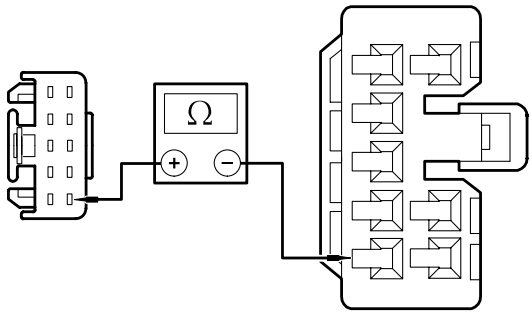
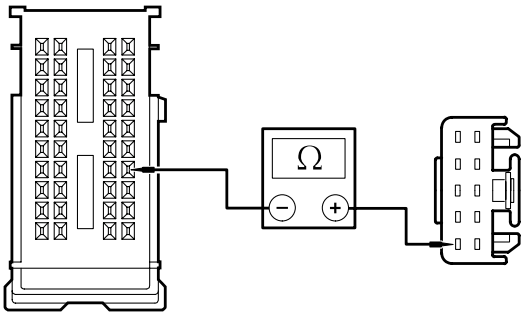
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022280	4 Measure the voltage between the wash/wipe system switch, connector C2RW08, pin 7, circuit CRW01 (WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** Vehicles with BFC GO to B6. Vehicles without BFC GO to B5. → **No** GO to B4.
B4: CHECK FOR CONTINUITY BETWEEN THE BFC/FRONT WIPER MODULE AND WASH/WIPE SYSTEM SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch and BFC/Front Wiper Module.
 E124690	
 E124689	3 Measure the resistance between the wash/wipe system switch connector C2RW08, pin 7 circuit CRW01 (WH) and – C2AM02-B, pin 8, circuit CRW01 (WH) for vehicles with BFC harness side. – C2RW03, pin 2, circuit CRW01 (WH) for vehicles with Front Wiper Module (FWM) harness side. • Is the resistance less than 2 ohms registered? → **Yes** RENEW wash/wipe system switch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and BFC using the wiring diagrams. CHECK the operation of the system.

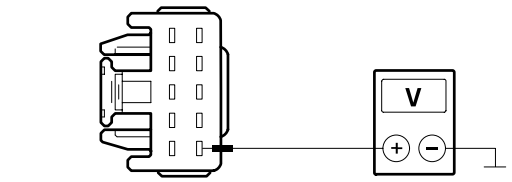
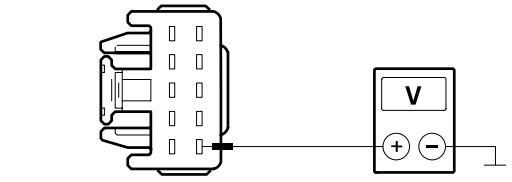
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B5: CHECK CIRCUIT CRW01 (WH) BETWEEN THE WASH/WIPE SWITCH AND THE FRONT WIPER MODULE (FWM) FOR SHORT CIRCUIT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Front Wiper Module (FWM) from connector C2RW03.
	3 Ignition switch in position II.
 VFE0022280	4 Measure the voltage between the wash/wipe system switch, connector C2RW08, pin 7, circuit CRW01 (WH), wiring harness side and ground. • Is battery voltage measured? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit CRW01 (WH) between the wash/wipe system switch and Front Wiper Module (FWM) using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the Front Wiper Module (FWM). CHECK the operation of the system.
B6: CHECK CIRCUIT CRW01 (WH) BETWEEN THE WASH/WIPE SWITCH AND THE BFC FOR SHORT CIRCUIT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect BFC from connector C2AM02-B.
	3 Ignition switch in position II.
 VFE0022280	4 Measure the voltage between the wash/wipe system switch, connector C2RW08, pin 7, circuit CRW01 (WH), wiring harness side and ground. • Is battery voltage measured? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit CRW01 (WH) between the wash/wipe system switch and BFC using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the BFC. CHECK the operation of the system.

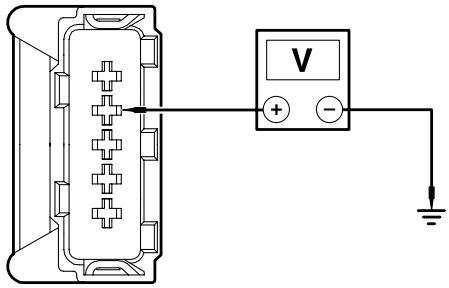
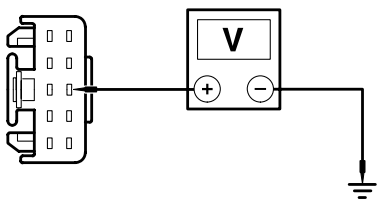
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B7: CHECK THE WASH/WIPE SYSTEM SWITCH.	
 VFE0028504	1 Measure the voltage between the wash/wipe switch, connector C2RW08, pin 10, circuit CRW17 (GN/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** Vehicles with BFC GO to B10. Vehicles without BFC GO to B9. → **No** RENEW the wash/wipe switch. CHECK the operation of the system.
B8: CHECK THE CONTINUITY BETWEEN WASHER WIPE SWITCH AND BFC/FRONT WIPER MODULE (FWM) CIRCUIT	
 E124692	
 E124691	1 Measure the resistance between the wash/wipe system switch connector C2RW08, pin 10, circuit CRW17 (GN/VT) and – C2AM02-A, pin 7, circuit CRW17 (GN/VT) for vehicles with BFC harness side. – C2RW03, pin 8, circuit CRW17 (GN/VT) for vehicles with Front Wiper Module (FWM) harness side. • Is the resistance less than 2 ohms registered? → **Yes** RENEW the washer wipe switch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit. CHECK the operation of the system.

DIAGNOSIS AND TESTING

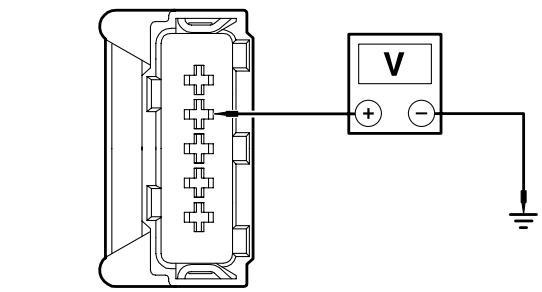
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B9: CHECK CIRCUIT CRW17 (GN/VT) BETWEEN THE WASH/WIPE SWITCH AND THE FRONT WIPER MODULE (FWM) FOR SHORT CIRCUIT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Front Wiper Module (FWM) from connector C2RW03.
	3 Ignition switch in position II.
 VFE0028504	4 Measure the voltage between the wash/wipe switch, connector C2RW08, pin 10, circuit CRW17 (GN/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit CRW17 (GN/VT) between the wash/wipe system switch and Front Wiper Module (FWM) using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the Front Wiper Module (FWM). CHECK the operation of the system.
B10: CHECK CIRCUIT CRW17 (GN/VT) BETWEEN THE WASH/WIPE SWITCH AND THE BFC FOR SHORT CIRCUIT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect BFC from connector C2AM02-A.
	3 Ignition switch in position II.
 VFE0028504	4 Measure the voltage between the wash/wipe switch, connector C2RW08, pin 10, circuit CRW17 (GN/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit CRW17 (GN/VT) between the wash/wipe system switch, Splice S2RW17 and BFC using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the BFC. CHECK the operation of the system.

DIAGNOSIS AND TESTING

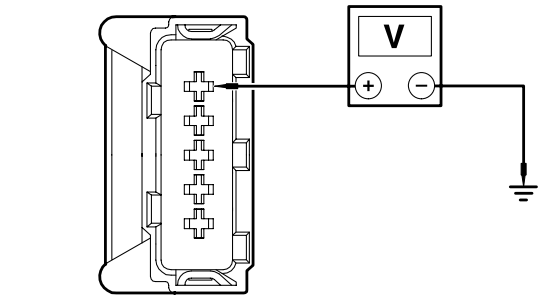
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B11: NARROW DOWN THE FAULT CONDITION	
 E122946	1 Measure the voltage between the front wiper motor, connector C1RW01, pin 2, circuit CRW08 (VT/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B12. → **No** RENEW the front wiper motor. CHECK the operation of the system.
B12: CHECK THE WASH/WIPE SYSTEM SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. – Perform the check on the fast front wipe speed circuit at the wash/wipe system switch. • Is the wash/wipe system switch OK? → **Yes** LOCATE and RECTIFY the break in circuit CRW08 (VT/OG) between the wash/wipe system switch and the front wiper motor using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the wash/wipe system switch. CHECK the operation of the system.
B13: CHECK CIRCUIT CRW08 (VT/OG) BETWEEN WASH/WIPE SWITCH AND THE FRONT WIPER MOTOR FOR SHORT CIRCUIT TO BATTERY VOLTAGE	
 E124693	1 Measure the voltage between wiper switch connector C2RW08. pin 8, circuit CRW08 (VT/OG) wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit. → **No** RENEW wash/wipe switch. CHECK the operation of the system.

DIAGNOSIS AND TESTING

PINPOINT TEST C : SLOW/FAST WIPE NOT WORKING.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON slow and fast wipe speed in succession.
	3 CHECK front wipers. • Do the wipers operate at fast speed? → **Yes** Slow wipe speed inoperative: GO to C4. → **No** GO to C2.
C2: CHECK FRONT WIPER MOTOR (FAST WIPE SPEED)	
	1 Ignition switch in position 0.
	2 Disconnect windshield wiper motor from connector C1RW01.
	3 Ignition switch in position II.
	4 SWITCH ON fast wipe speed.
 E122946	5 Measure the voltage between: – front wiper motor, connector C1RW01, pin 2, circuit CRW08 (VT/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the windshield wiper motor. CHECK the operation of the system. → **No** GO to C3.
C3: CHECK THE WASH/WIPE SYSTEM SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. – Perform the check on the fast front wipe speed circuit at the wash/wipe system switch. • Is the wash/wipe system switch OK? → **Yes** LOCATE and RECTIFY the break in circuit CRW08 (VT/OG) between the wash/wipe system switch and the front wiper motor using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the wash/wipe system switch. CHECK the operation of the system.
C4: CHECK FRONT WIPER MOTOR (SLOW WIPE SPEED)	
	1 Ignition switch in position 0.
	2 Disconnect windshield wiper motor from connector C1RW01.
	3 Ignition switch in position II.
	4 SWITCH ON slow wipe speed.
 E122984	5 Measure the voltage between: – front wiper motor, connector C1RW01, pin 1, circuit CRW10 (BU/GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the front wiper motor. CHECK the operation of the system. → **No** GO to C5.
C5: CHECK THE WASH/WIPE SYSTEM SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.

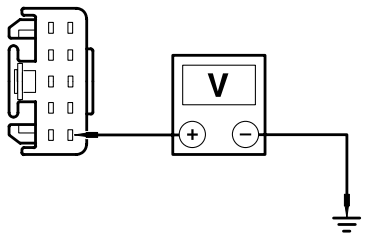
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. – Perform the check on the slow front wipe speed circuit at the wash/wipe system switch. • Is the wash/wipe system switch OK? → **Yes** LOCATE and RECTIFY the break in circuit CRW10 (BU/GN) between the wash/wipe system switch and the front wiper motor using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the wash/wipe system switch. CHECK the operation of the system.

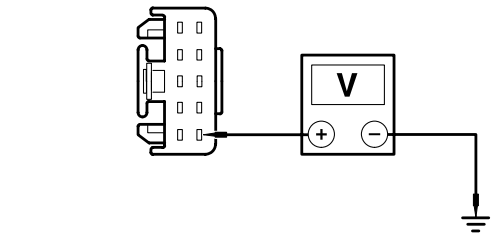
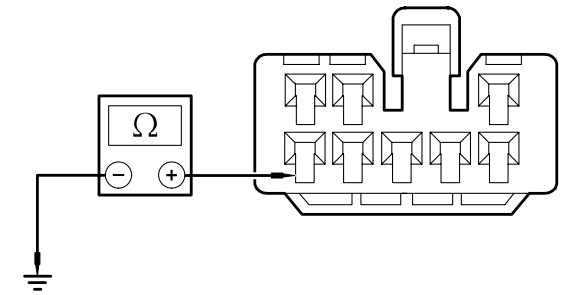
PINPOINT TEST D : INTERMITTENT WIPE MODE OF FRONT WIPER INOPERATIVE, VEHICLES WITHOUT RAIN SENSOR (FAST/SLOW WIPE OK)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: NARROW DOWN THE POSSIBLE CAUSES FOR THE FAULT	
	1 Ignition switch in position II.
	2 SWITCH slow wipe ON and OFF.
	3 CHECK front wipers. • Do the wipers return to the park position after switching them off? → **Yes** GO to D2. → **No** GO to Pinpoint Test G.
D2: NARROW DOWN THE FAULT CONDITION	
	1 SWITCH ON intermittent mode at the wash/wipe system switch.
	2 Adjust the wipe cycle at the wash/wipe system switch.
	3 CHECK front wipers. • Is intermittent mode of front wipers inoperative? → **Yes** GO to D3. → **No** Verify the customer concern.

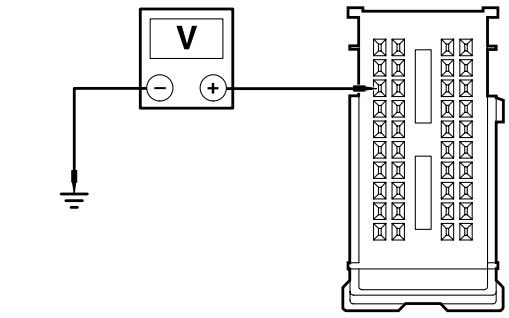
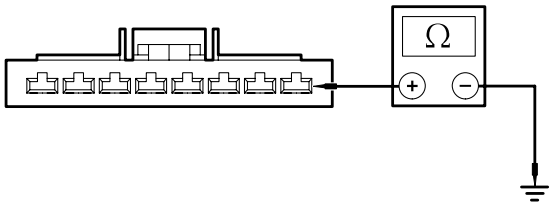
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D3: CHECK THE WASH/WIPE SYSTEM SWITCH.	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. – Perform the check on the intermittent front wipe circuit at the wash/wipe system switch. • Is the wash/wipe switch OK? → **Yes** Vehicles with BFC -GO to D5. Vehicles without BFC GO to D4. → **No** RENEW the wash/wipe switch. CHECK the operation of the system.
D4: CHECK CIRCUIT CRW17 (GN/VT) BETWEEN THE WASH/WIPE SWITCH AND THE FRONT WIPER MODULE (FWM) FOR OPEN CIRCUIT	
	1 Disconnect Front Wiper Module (FWM) from connector C2RW03.
	2 Connect Wash/wipe system switch to connector C2RW08.
	3 Ignition switch in position II.
	4 SWITCH ON intermittent wiping.
 E124694	5 Measure the voltage between the front wiper switch, connector C2RW08, pin 10, circuit CRW17 (GN/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to D6. → **No** LOCATE and RECTIFY the break in the circuit CRW17 (GN/VT) between the wash/wipe system switch and Front Wiper Module (FWM) using the Wiring Diagrams. CHECK the operation of the system.
D5: CHECK CIRCUIT CRW17 (GN/VT) BETWEEN THE WASH/WIPE SWITCH AND THE BFC FOR OPEN CIRCUIT	
	1 Connect Wash/wipe system switch to connector C2RW08.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Ignition switch in position II.
	3 SWITCH ON intermittent wiping.
 E124695	4 Measure the voltage between the front wiper switch, connector C2RW08, pin 10, circuit CRW17 (GN/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to D7. → **No** LOCATE and RECTIFY the break in the circuit CRW17 (GN/VT) between the wash/wipe system switch, Splice S2RW17 and BFC using the Wiring Diagrams. CHECK the operation of the system.
D6: CHECK GROUND CONNECTION OF FRONT WIPER MODULE (FWM) FOR OPEN CIRCUIT	
	1 SWITCH OFF the front wiper.
	2 Ignition switch in position 0.
 E122987	3 Measure the resistance between the Front Wiper Module (FWM): – Connector C2RW03, pin 4, circuit GD216 (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the Front Wiper Module (FWM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD216 (BK/VT), ground G14 between the Front Wiper Module (FWM) and ground connection using the Wiring Diagrams. CHECK the operation of the system.
D7: CHECK VOLTAGE SUPPLY TO BFC FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect BFC from connector C2AM02-A.
	3 Ignition switch in position II.

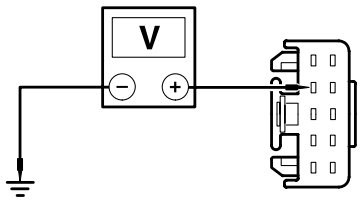
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E122953	4 Measure the voltage between the BFC: – connector C2AM02-A, pin 33, circuit CBP38 (GY/BU), wiring harness side and ground. • Is battery voltage measured? → **Yes** GO to D8. → **No** LOCATE and RECTIFY the break in the circuit CBP38 (GY/BU) between the wash/wipe system switch and the BFC using the Wiring Diagrams. CHECK the operation of the system.
D8: CHECK GROUND CONNECTION OF BFC FOR OPEN CIRCUIT	
	1 Disconnect BFC connector C2AM02-C.
 E122943	2 Measure the resistance between the BFC, – Connector C2AM02-C, pin 8, circuit GD357 (BK), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the BFC. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD357 (BK), ground G13 between the BFC using the Wiring Diagrams. CHECK the operation of the system.

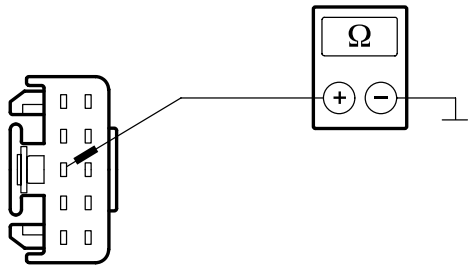
PINPOINT TEST E : WASH/WIPE FUNCTION INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON the front and rear wash/wipe functions in turn.

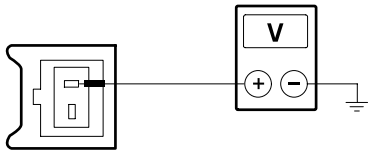
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the front and rear wash/wipe functions. • Is the wash/wipe function inoperative at the front ? → **Yes** Vehicles with and without BFC GO to E3. → **No** - Windshield wipe function inoperative (washer OK): Vehicles with and without BFC GO to E2.
E2: CHECK THE VOLTAGE AT THE FRONT WIPER SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Front wiper switch from connector C2RW08.
	3 Ignition switch in position II.
 E124696	4 Measure the voltage between the Front wiper switch, connector C2RW08, pin 2, circuit CRW07 (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the Front wiper switch. CHECK the operation of the system. → **No** Vehicles without BFC : LOCATE and RECTIFY the break in the circuit CRW07 (GY/BN) between the wash/wipe system switch, splice S2RW07 and Front Wiper Module (FWM) using the Wiring Diagrams. CHECK the operation of the system. Vehicles with BFC : LOCATE and RECTIFY the break in the circuit CRW07 (GY/BN) between the wash/wipe system switch, Splice S2RW07 and BFC using the Wiring Diagrams. CHECK the operation of the system.
E3: CHECK THE GROUND CONNECTION OF THE WASH/WIPE SYSTEM SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect wash/wipe system switch from connector C2RW08.

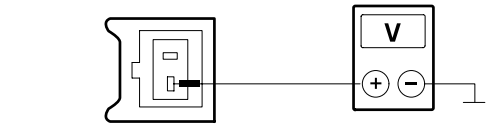
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0025221	3 Measure resistance between wash/wipe switch, connector C2RW08, pin 3, circuit GD215 (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the wash/wipe system switch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD215 (BK/GY) between the wash/wipe system switch, ground G12 and splice S2D215 using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST F : WASHER PUMP MOTOR INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK THE VOLTAGE AT THE WASHER PUMP MOTOR	
NOTE: Wash/wipe system switch in the OFF position	
	1 Ignition switch in position 0.
	2 Disconnect washer pump motor at front/rear from connector C1RW14.
	3 Ignition switch in position II.
 VFE0008568	4 Measure the voltage between the washer pump motor, connector C1RW14, pin 1, circuit CRW07 (GY/BN), wiring harness side and ground. • Is battery voltage measured? → **Yes** GO to F2. → **No** LOCATE and RECTIFY the break in the circuit CRW07 (GY/BN) between the wash/wipe system switch and washer pump motor using the Wiring Diagrams. CHECK the operation of the system.

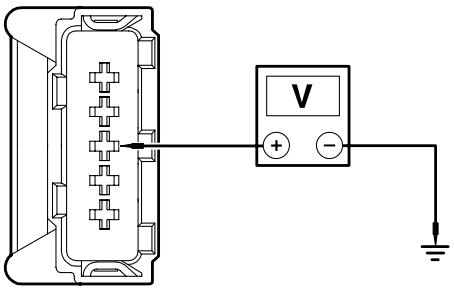
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F2: CHECK THE VOLTAGE AT THE WASHER PUMP MOTOR	
 VFE0015948	1 Measure the voltage between the washer pump motor, connector C1RW14, pin 2, circuit CRW12 (GY/OG), wiring harness side and ground. • Is battery voltage measured? → **Yes** RENEW the washer pump motor. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit CRW12 (GY/OG) between the wash/wipe system switch and washer pump motor using the Wiring Diagrams. CHECK the operation of the system.

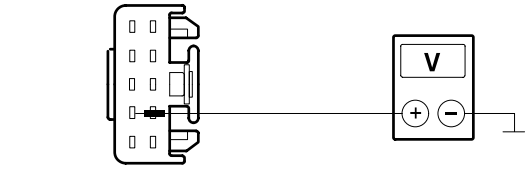
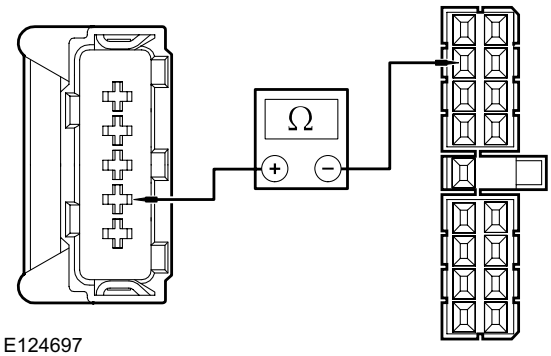
PINPOINT TEST G : WINDSHIELD WIPERS DO NOT RETURN TO PARK POSITION AFTER SWITCHING OFF

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: DETERMINE THE CAUSE OF THE FAULT	
	1 Ignition switch in position II.
	2 SWITCH the front and rear wipers ON/OFF in turn.
	3 CHECK the front and rear wipers. • Does the windscreen wiper return to the park position? → **Yes** Rear window wiper not returning to the initial position: GO to G6. → **No** GO to G2.
G2: CHECK VOLTAGE AT THE WINDSHIELD WIPER MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect windshield wiper motor from connector C1RW01.
	3 Ignition switch in position II.

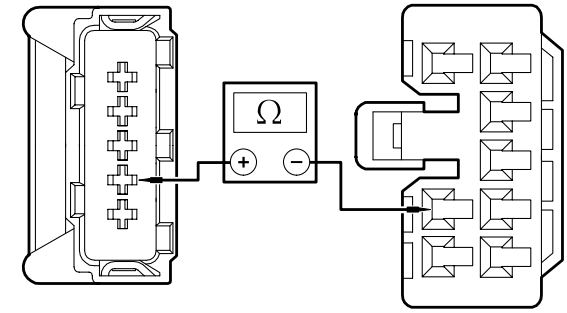
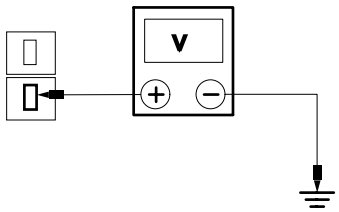
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E122999	4 Measure the voltage between: – front wiper motor, connector C1RW01, pin 3, circuit CBP46 (WH/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to G3. → **No** LOCATE and RECTIFY the break in the circuit CBP46 (WH/BU) between splice S2BP46 and wiper motor using the wiring diagrams. CHECK the operation of the system.
G3: CHECK THE WINDSHIELD WIPER MOTOR	
	1 Check the wiper motor according to the component check at the end of this section. • Is the wiper motor OK? → **Yes** GO to G4. → **No** RENEW the wiper motor. CHECK the operation of the system.
G4: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.
	2 Connect Front wiper motor to connector C1RW01.
	3 Ignition switch in position II.
	4 SWITCH ON slow wipe speed.
	5 Ignition switch in position 0.
	6 Wipers should NOT be in the parked position.
	7 Disconnect wash/wipe system switch from connector C2RW08.
	8 Ignition switch in position II.

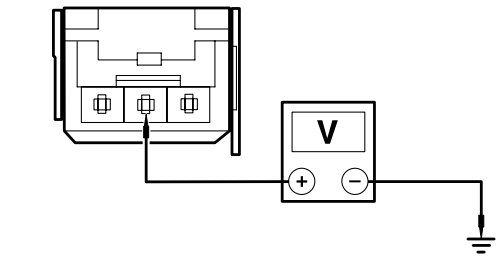
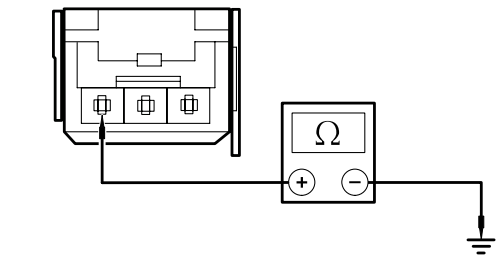
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022280	9 Measure the voltage between the wash/wipe system switch, connector C2RW08, pin 7, circuit CRW01 (WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the wash/wipe system switch. CHECK the operation of the system. → **No** Vehicles with and without BFC GO to G5.
G5: MEASURE THE CONTINUITY BETWEEN WIPER MOTOR AND FRONT WIPER MODULE (FWM)/BFC CIRCUIT CRW09 (BN/BU)	
NOTE: Wiper is still NOT in the park position	
	1 Ignition switch in position 0.
	2 Disconnect Body Function Controller/Front Wiper Module (FWM) connector C2AM02-B/C2RW03.
	3 Disconnect wiper motor connector C1RW01.
 E124697	

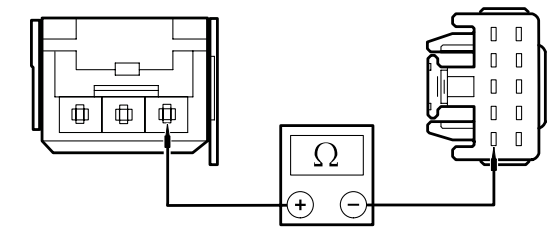
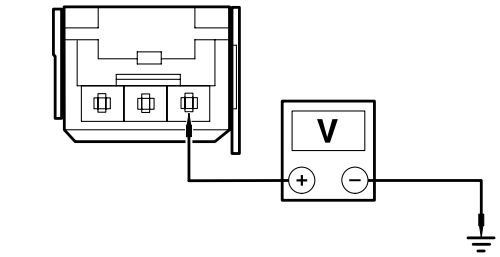
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124698	4 Measure the resistance between the wiper motor connector C1RW01, pin 4, circuit CRW09 (BN/BU) and – C2AM02-B, pin 16, circuit CRW09 (BN/BU) for vehicles with BFC harness side and ground. – C2RW03, pin 2, circuit CRW09 (BN/BU) for vehicles with Front Wiper Module (FWM) harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** Renew the Front Wiper Module (FWM)/BFC. check the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit CRW09 (BN/BU) between the Front Wiper Module (FWM)/BFC and the front wiper motor using the Wiring Diagrams. CHECK the operation of the system.
G6: CHECK THE VOLTAGE SUPPLY TO FUSE F47 (10A) (CJB) FOR OPEN CIRCUIT	
	1 Ignition switch in position II.
 E67858	2 Measure the voltage between fuse F47 (10 A) (CJB), pin 2, circuit CBP47 (GN/BU) and ground. • Is battery voltage measured? → **Yes** GO to G7. → **No** REPAIR circuit CDC21 (GY/BN) using the wiring diagram. If necessary INSTALL A NEW CJB. CHECK the operation of the system.
G7: CHECK VOLTAGE AT THE REAR WINDOW WIPER MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect rear window wiper motor from connector C4RW02.
	3 Ignition switch in position II.

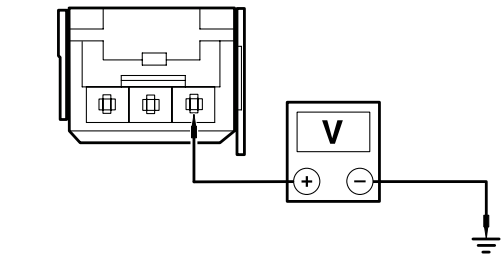
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124046	4 Measure the voltage between: – Rear wiper motor, connector C4RW02, pin 2, circuit CBP47 (GN/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to G8. → **No** LOCATE and RECTIFY the break in the circuit CBP47 (GN/BU) between fuse F47 and the rear wiper motor using the Wiring Diagrams. CHECK the operation of the system.
G8: CHECK THE GROUND CONNECTION OF THE REAR WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E124047	2 Measure the resistance between the rear wiper motor, connector C4RW02, pin 3, circuit GD326 (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the wiper motor. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit GD326 (BK/WH) between the wiper motor, ground G17 and splice S4D326-B using the wiring diagrams. CHECK the operation of the system.
G9: CHECK FOR CONTINUITY BETWEEN THE REAR WIPER SWITCH AND REAR WIPER MOTOR CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Wiper switch connector C2RW08.
	3 Disconnect rear wiper switch connector C4RW02.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124048	4 Measure the resistance between the wiper washer switch connector C2RW08, pin 5, circuit CRW13 (GN) harness side and rear wiper motor connector C4RW02, pin 1, circuit CRW13 (GN). • Is a resistance of less than 2 ohms? → **Yes** GO to G10. → **No** LOCATE and RECTIFY the break in the circuit between the wiper washer switch, circuit CRW13 (GN) and the rear wiper motor circuit CRW13 (GN) using the Wiring Diagrams. CHECK the operation of the system.
G10: CHECK VOLTAGE AT THE REAR WINDOW WIPER MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect rear window wiper motor from connector C4RW02.
	3 Ignition switch in position II.
	4 Switch ON the rear wiper.
 E124699	5 Measure the volatge between the rear window wiper motor, connector C4RW02, pin 1, circuit CRW13 (GN), wiring harness side and ground. • Is the battery voltage measured? → **Yes** RENEW the rear wiper motor. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit.
G11: REAR WIPER MOTOR RUNNING CONTINOUSLY	
	1 Ignition switch in position 0.
	2 Disconnect rear window wiper motor from connector C4RW02.
	3 Disconnect wiper washer switch connector C2RW08.
	4 Ignition switch in position II.

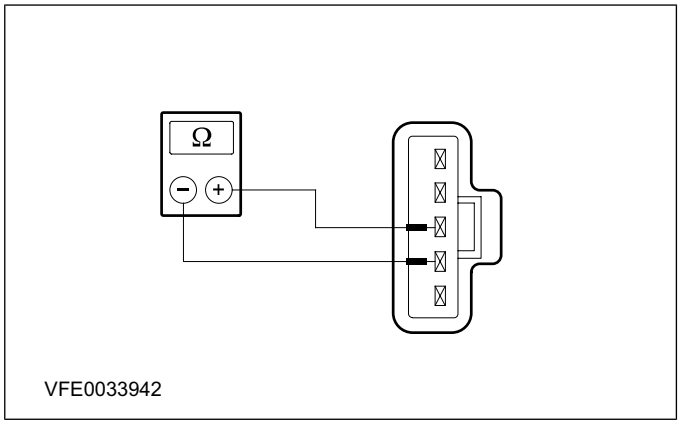
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E124699	5 Measure the voltage between the rear wiper motor connector C4RW02, pin 1, circuit CRW13 (GN), wiring harness side and ground. • Is the battery voltage measured? → **Yes** LOCATE and RECTIFY the break in the circuit CRW13 (GN) between wiper washer switch and wiper motor. → **No** RENEW the wiper washer switch. CHECK the operation of the system.

Component testing, RHD:

Front wiper motor

1. CHECK the front wiper motor in the park position:
   - Measure the resistance at the front wiper motor, between pin 3 and pin 4.
   - Is a resistance of less than 2 ohms registered?
     - If yes, go to 2.
     - If not, RENEW the front wiper motor.



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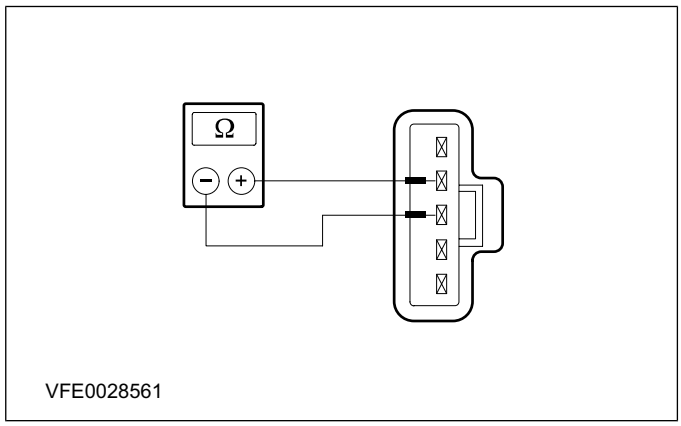
2. CHECK the front wiper motor outside the park position:
   1. Measure the resistance at the front wiper motor, between pin 2 and pin 3.
   2. Is a resistance of less than 2 ohms registered?
      - If yes then the front wiper motor is OK.
      - If not, RENEW the front wiper motor.



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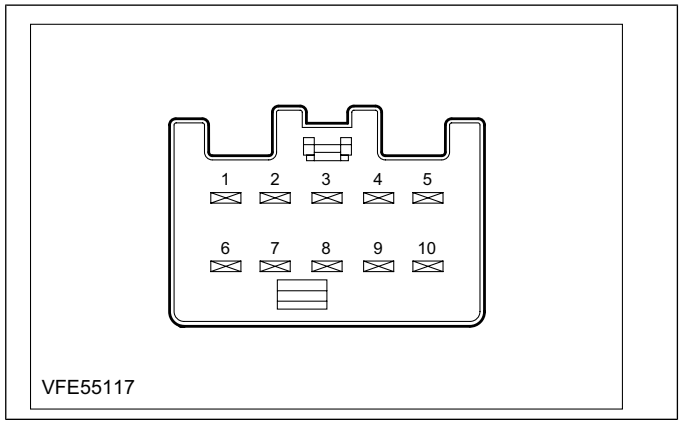
Wash/wipe switch

Pin assignment:



VFE55117

Circuit to test	Connect a digital multimeter with the following connections	Set the switch to the following position	Switch is OK when the following test readings are seen
Variable wipe times	1 and 10	1	0.5 - 4 kOhm

DIAGNOSIS AND TESTING

Circuit to test	Connect a digital multimeter with the following connections	Set the switch to the following position	Switch is OK when the following test readings are seen
		2	4 -14 kOhm
		3	14 -24 kOhm
		4	24 -34 kOhm
		5	34 -43 kOhm
		6	43 -57 kOhm
Flick wipe, front wiper	6 and 9	Flick wipe	Circuit closed
		Off	Circuit open
		Intermittent	Circuit open
		Slow	Circuit closed
		Fast	Circuit open
Intermittent, front wiper	6 and 10	Flick wipe	Circuit open
		Off	Circuit open
		Intermittent	Circuit closed
		Slow	Circuit open
		Fast	Circuit open
	7 and 9	Flick wipe	Circuit open
		Off	Circuit closed
		Intermittent	Circuit closed
		Slow	Circuit open
		Fast	Circuit open
Slow wipe, front wiper	6 and 9	Flick wipe	Circuit closed
		Off	Circuit open
		Intermittent	Circuit open
		Slow	Circuit closed
		Fast	Circuit open
Fast wipe, front wiper	6 and 8	Flick wipe	Circuit open
		Off	Circuit open
		Intermittent	Circuit open
		Slow	Circuit open
		Fast	Circuit closed
Front washer system	6 and 2	Off	Circuit closed
		Front washer system on	Circuit open
	2 and 3	Off	Circuit open
		Front washer system on	Circuit closed

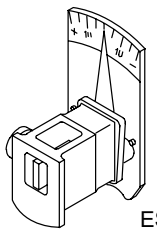
DIAGNOSIS AND TESTING

Circuit to test	Connect a digital multimeter with the following connections	Set the switch to the following position	Switch is OK when the following test readings are seen
	3 and 4	Off	Circuit open
Rear window washer	6 and 5	Off	Circuit open
		Rear wiper on	Circuit closed
		Rear washer system on	Circuit closed
	3 and 4	Off	Circuit open
		Rear wiper on	Circuit open
		Rear washer system on	Circuit closed
Rear wiper	5 and 3	Off	Circuit closed
		Rear wiper on	Circuit open
		Rear washer system on	Circuit open
	4 and 6	Off	Circuit closed
		Rear wiper on	Circuit closed
		Rear washer system on	Circuit open
	5 and 6	Off	Circuit open
		Rear wiper on	Circuit closed
		Rear washer system on	Circuit closed

GENERAL PROCEDURES

Wiper Blade and Pivot Arm Adjustment(32 591 0)

Special Tool(s)

 ES32006	Aligner, Wiper Arm 501-027 (32-006)

General Equipment

Aero-Wiper Measuring and Adjusting Tools AWPE 02 (Order No. 511 5124 001 00)

Vehicles without beam blade wipers

1. **CAUTION: Make sure that the wiper motor is in the park position.**

   Remove the wiper blade.

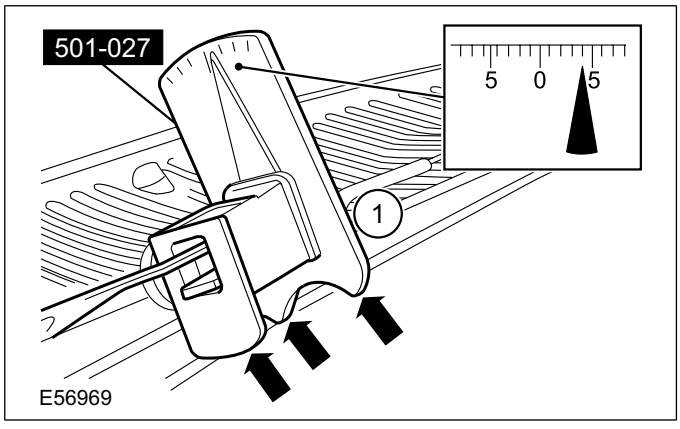
2. **Insert the wiper arm in the special tool and place the special tool on the windshield.**

3. **NOTE: All three support points of the special tool must be in contact with the glass.**

NOTE: The angle of the wiper on the scale must point from the zero center line to the center of the windshield/rear window. Ignore the sign (+/-) on the alignment tool.

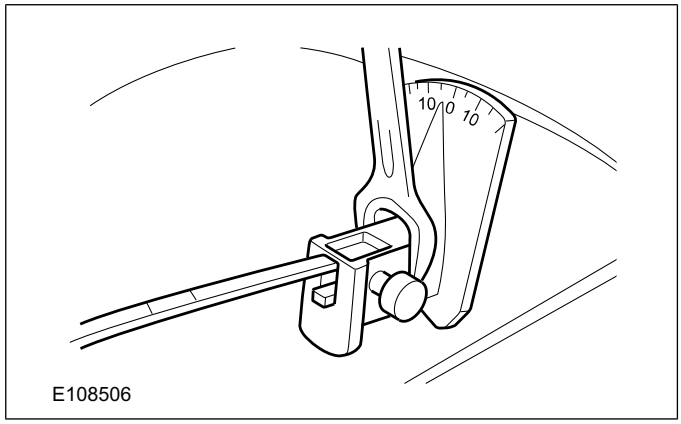
Using the special tool, read off the angle between the wiper arm and the windshield.

1. Center of windshield



4. **NOTE: Lift the special tool away from the glass when correcting the angle, in order to prevent damage.**

Using an open-ended wrench on the special tool, adjust the wiper arm. For additional information, refer to Specifications.

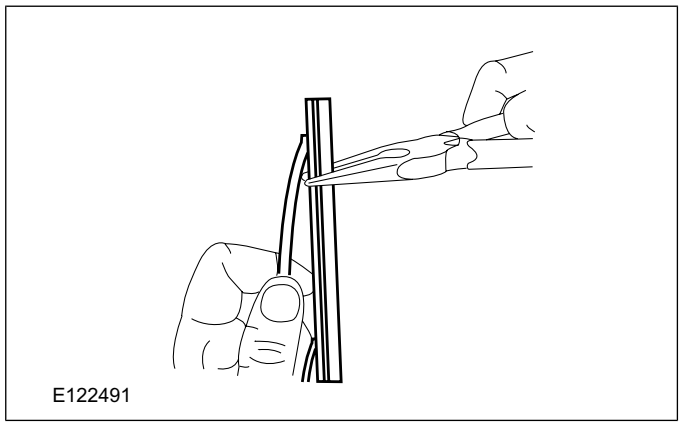


5. **Remove the special tool.**
6. **Install the wiper blade.**

Wiper Rubber Replacement Procedure

Removal

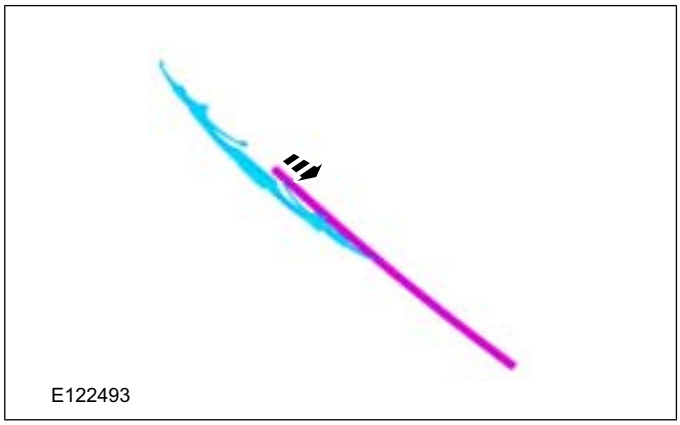
1. **Remove the wiper blade from Wiper Arm.**
2. **Hold the wiper blade firmly on your left hand closer to the notch side as shown in the picture.**



3. **Use a nose plier to press and pull out the old wiper refill from wiper blade. While removing the blade refill ensure that the metallic holding claws are not damaged.**

GENERAL PROCEDURES

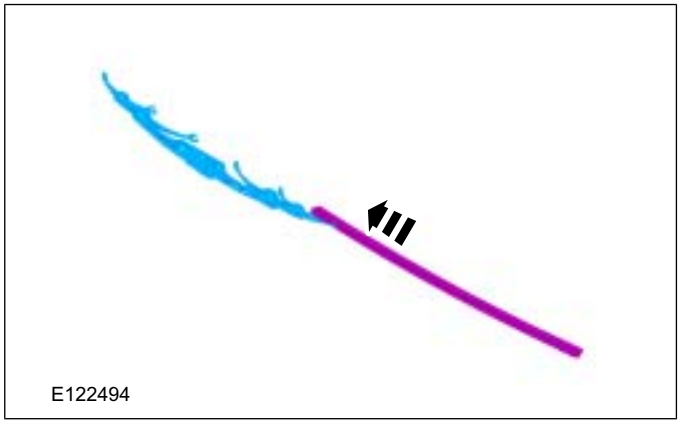
4. **Pull out the entire rubber element with steel strips from wiper blade.**



5. **After removal of the steel strips, inspect them for any damage or bend. If found to be damaged do not reuse them.**
6. **Check the condition of metallic claws present in the wiper blade.**
7. **Carefully dispose the removed rubber elements from wiper blade.**

Installation

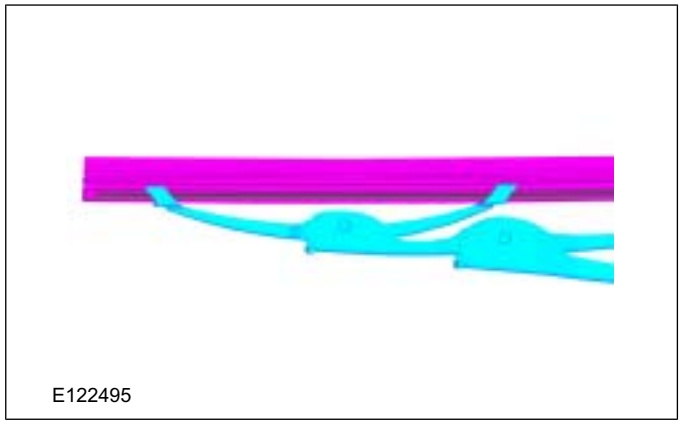
8. **Hold the wiper blade firmly on your left hand. Hold the Non-notch side of the new refill with metal strips on your other hand.**
9. **Insert the non-notch side of the wiper refill in between the metallic claws.**



10. **Insert the refill in all the claws one by one up to the last claw.**
11. **Stop after inserting the refill into the last claw of the wiper blade. Refill should be seated perfectly in between the metallic claws.**
12. **NOTE: Gently try to pull the rubber refill. The notch present in the steel strip should immediately stop the pulling of rubber refill.**

NOTE: Starting from inserting the refill into first claw, the entire inserting operation should experience free sliding movement of rubber element on wiper blade.

Hold the wiper blade assembly firmly on your left hand and push the refill with metal strip. Till the notch of the steel strip is locked in between the claws the refill should be pushed.



Do's & Don'ts

Do's

1. **Always's use Ford's genuine screen wash concentrate to clean your vehicles windscreen.**
2. **Use washer fluid to wash the windscreen before every first operation of wipers.**
3. **Clean the wiper rubber lip with pure water and lint free cloth often.**

Don'ts

4. **Never attempt to clean your windscreen using any other cleanser which is not recommended by Ford.**
5. **Never operate wipers without washer solution spray.**
6. **Never attempt to lift the passenger's side wiper blade standing from driver side and vice versa.**

REMOVAL AND INSTALLATION

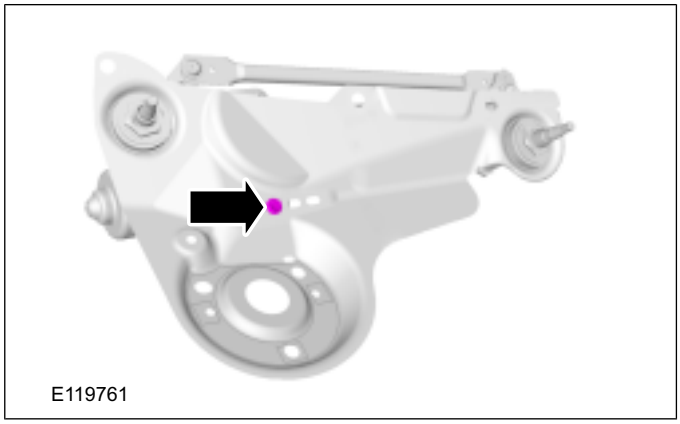
Mounting Arm and Pivot Shaft(32 554 0)

Removal

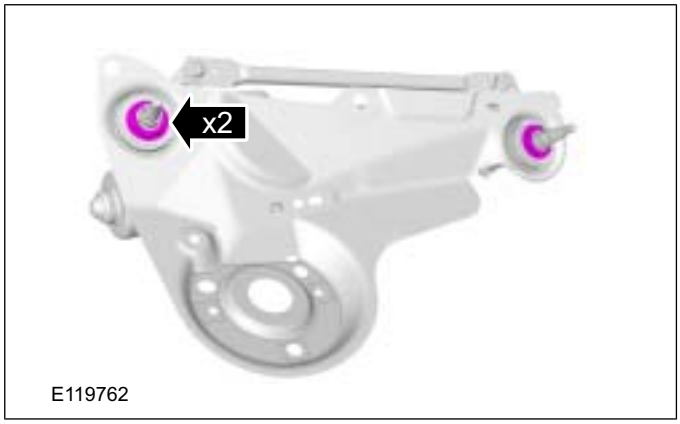
1. **Remove windshield wiper motor.**

   For additional information, refer to: Windshield Wiper Motor (501-16 Wipers and Washers, Removal and Installation).

2. **Remove the bolt.**

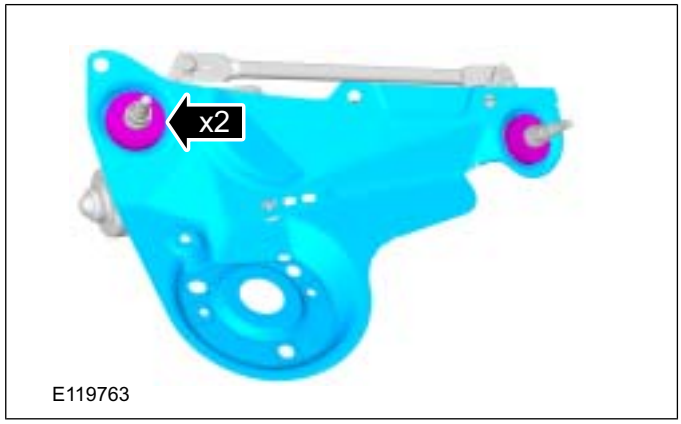


3. **Unscrew and remove the nuts from the windshield wiper linkage.**



4. **Remove the windshield wiper mounting arm bracket.**

- Remove the upper rubber bushes.



Installation

1. **Install the components in the reverse order.**

REMOVAL AND INSTALLATION

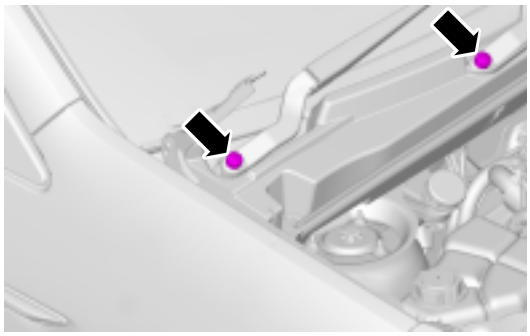
Windshield Wiper Motor(32 524 0)

Removal

1. Remove the hood.

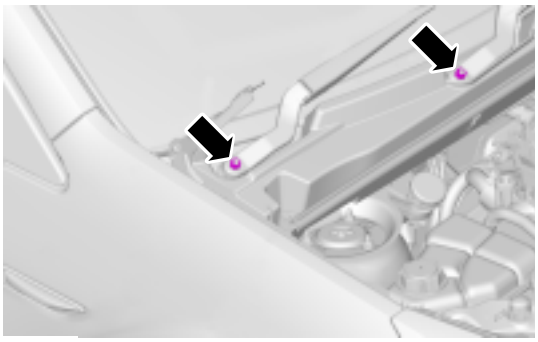
For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

2. Remove the wiper arm covers on both sides.



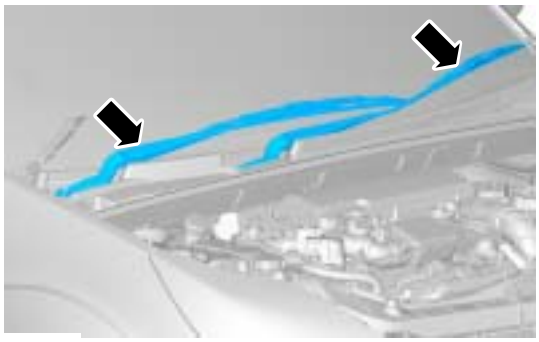
E119634

3. Remove the wiper arm nuts on both sides.



E119635

4. Remove the wiper arms both sides.



E119636

5. Remove the cowl panel grill.

1. Remove the clips on both sides.

E119637

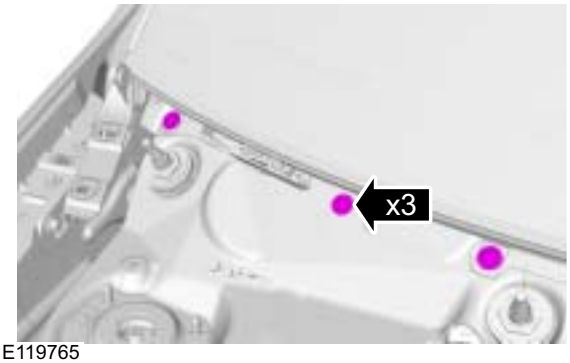
6. ⚠CAUTION: Do not raise the vehicle.

Remove the suspension strut nuts.

1. Discard the retaining nuts.

E119764

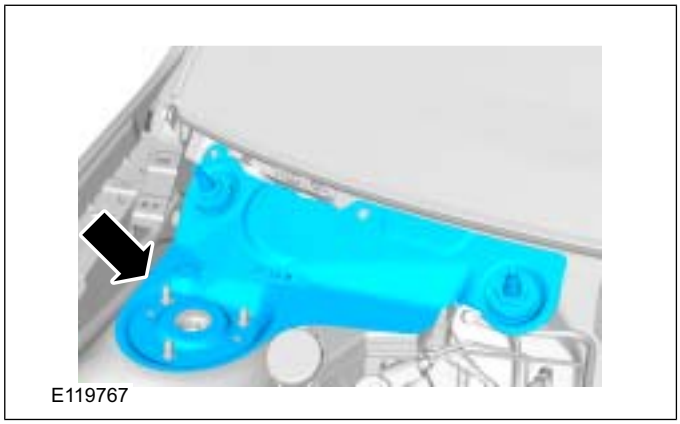
7. Remove the bolts from the bracket for the windshield wiper motor assembly.



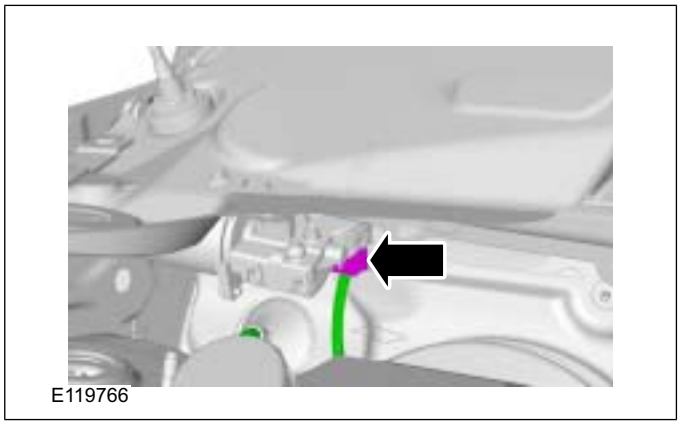
E119765

REMOVAL AND INSTALLATION

8. Detach the windshield wiper motor assembly.



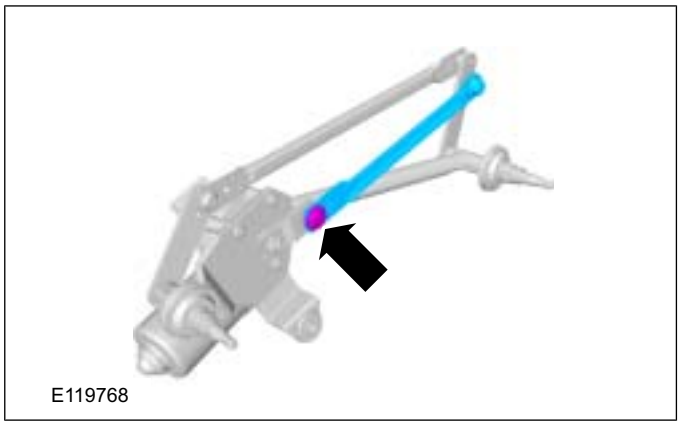
9. Disconnect the windshield wiper motor electrical connector.



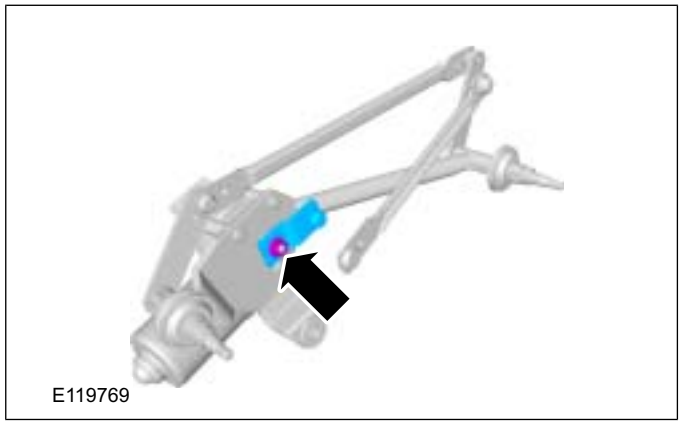
10. Remove the mounting arm and pivot shaft.

    For additional information, refer to: Mounting Arm and Pivot Shaft (501-16 Wipers and Washers, Removal and Installation).

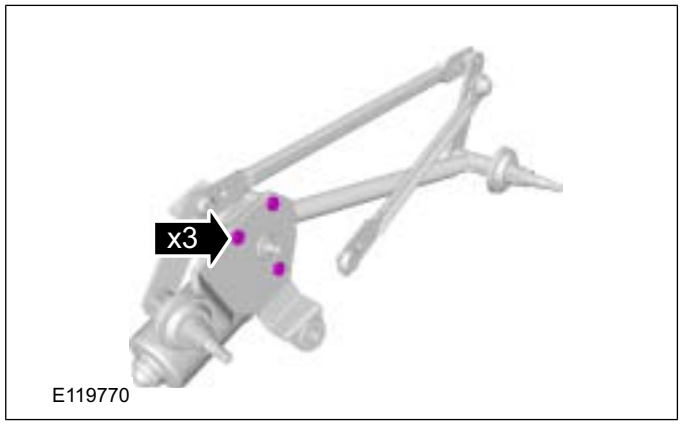
11. Detach the windshield wiper linkage from the windshield wiper motor lever arm.



12. Detach the windshield wiper motor nut.



13. Remove the windshield wiper motor by removing the screws.



Installation

1. **CAUTION: Move the windshield wiper motor to park position before installing the wiper arms.**

NOTE: Install new suspension strut nuts.

Install the components in the reverse order.

REMOVAL AND INSTALLATION

Windshield Washer Pump(32 624 0)

Removal

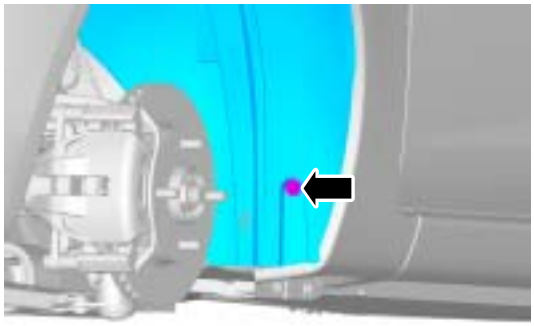
1. Raise and support the vehicle.

   For additional information, refer to: Jacking (100-02 Jacking and Lifting, Description and Operation) / Lifting (100-02 Jacking and Lifting, Description and Operation).

2. Remove the wheels.

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

3. Remove the fender splash shield.



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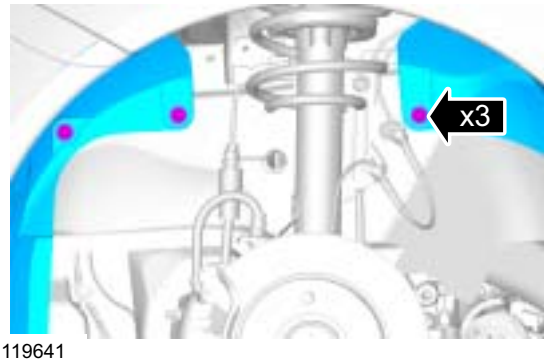

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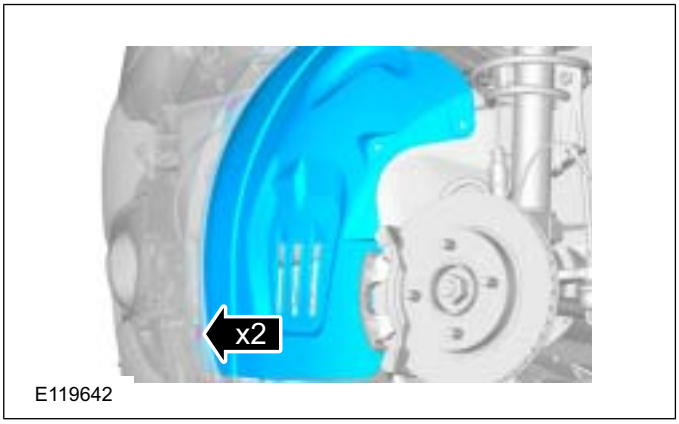
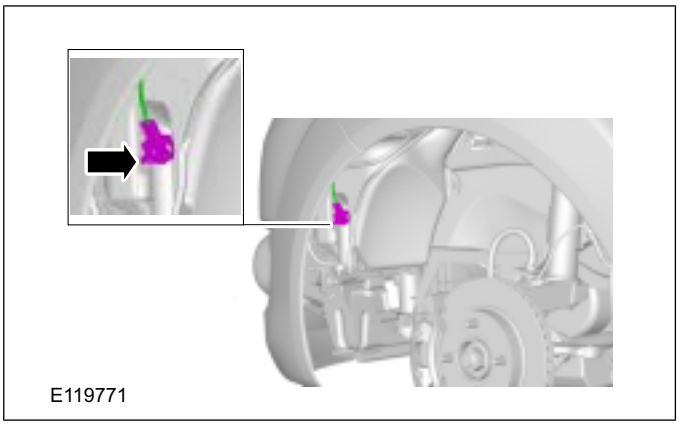


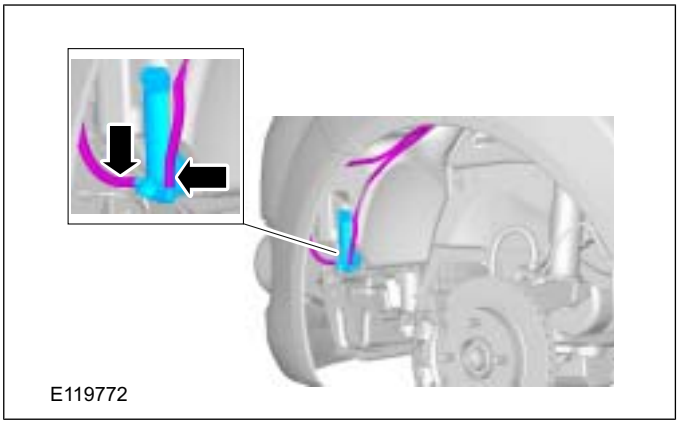
E119642

4. Disconnect the windshield washer pump connector.



E119771

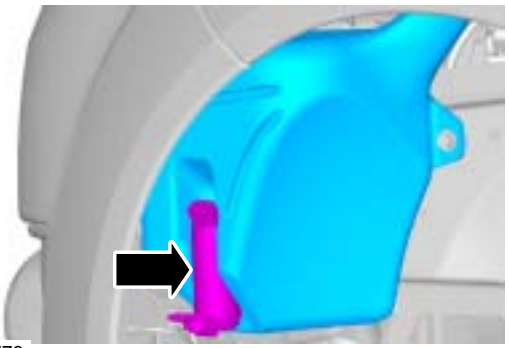
5. Disconnect the hoses from the windshield washer fluid reservoir.



E119772

REMOVAL AND INSTALLATION

6. **Remove the windshield washer pump.**



E119773

Installation

1. **NOTE: Coat the rubber seal on the windshield washer pump with soap prior to installation.**

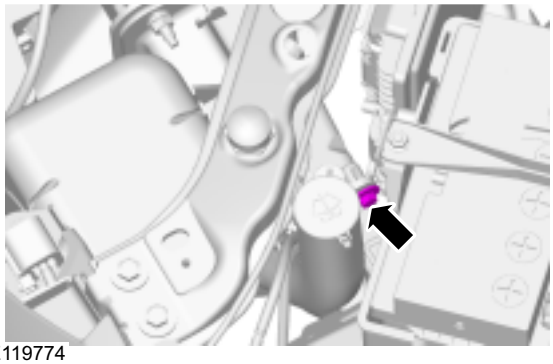
   Install the components in reverse order.

REMOVAL AND INSTALLATION

Windshield Washer Reservoir(32 622 0)

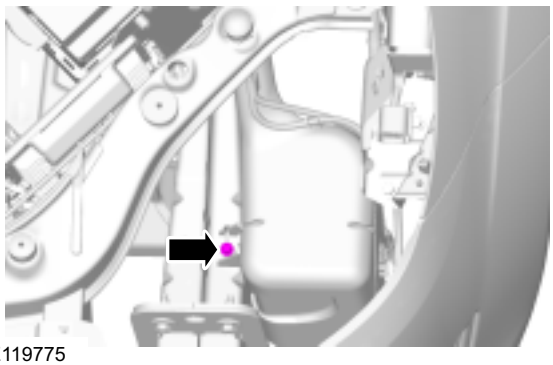
Removal

1. **Remove the upper bolt on the windshield washer fluid reservoir.**



E119774

2. **Remove the centre bolt on the windshield washer fluid reservoir.**



E119775

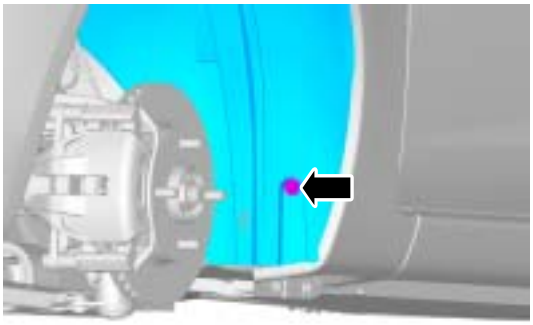
3. **Raise and support the vehicle.**

   For additional information, refer to: Jacking (100-02 Jacking and Lifting, Description and Operation) / Lifting (100-02 Jacking and Lifting, Description and Operation).

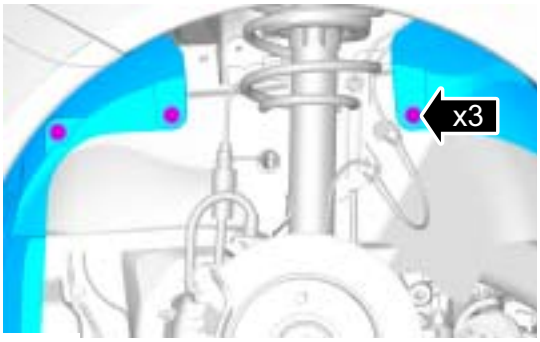
4. **Remove the wheels.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

5. **Remove the fender splash shield.**



E119640



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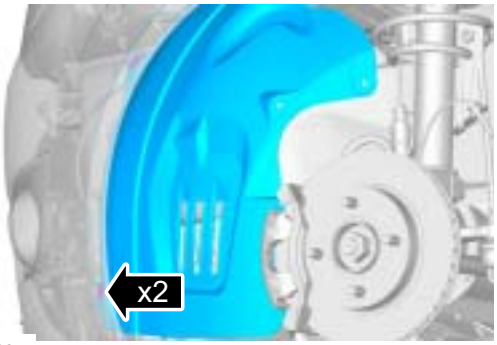
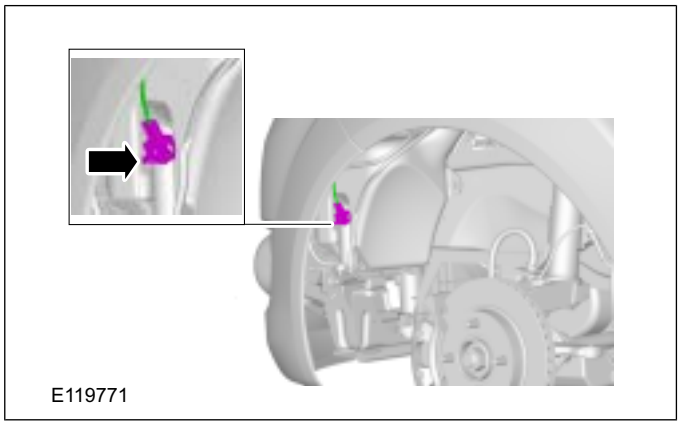


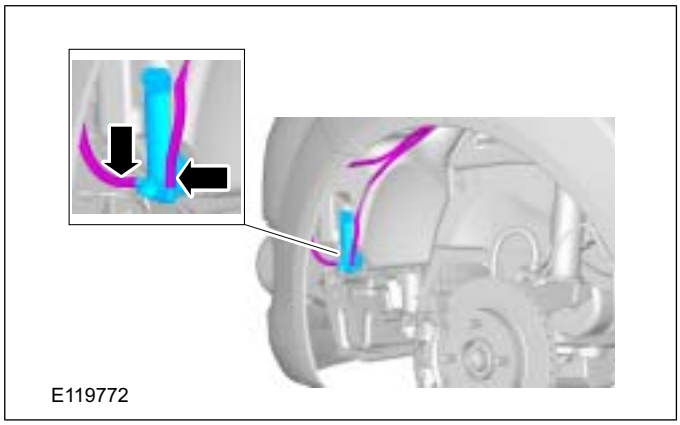
E119642

REMOVAL AND INSTALLATION

6. **Disconnect the windshield washer pump connector.**

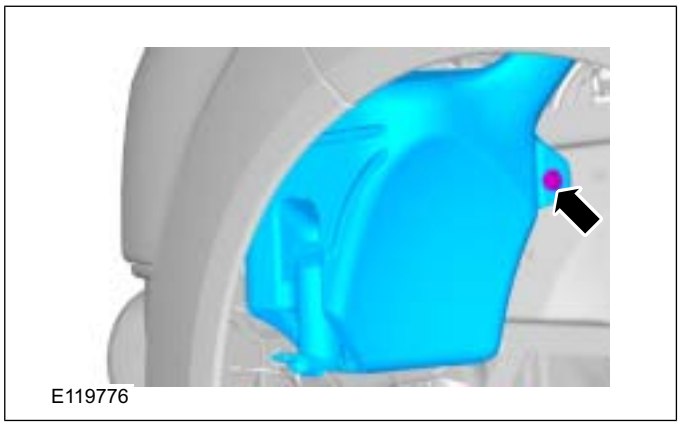


7. **Disconnect the hoses from the windshield washer fluid reservoir.**



8. **Remove the washer reservoir.**

   Remove the windshield washer fluid washer bolt.



Installation

1. **Install the components in reverse order.**

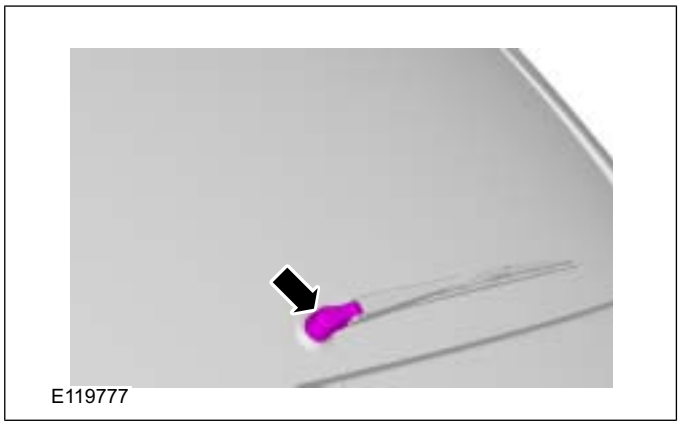
REMOVAL AND INSTALLATION

Rear Window Wiper Motor(32 530 0)

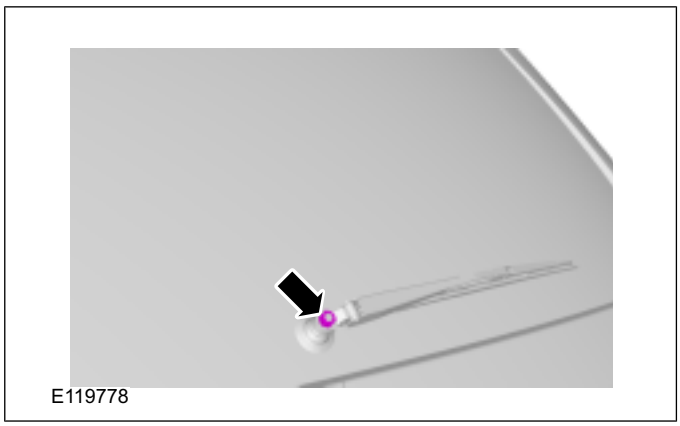
Removal

1. **CAUTION: Check that the wiper motor is in the parked position.**

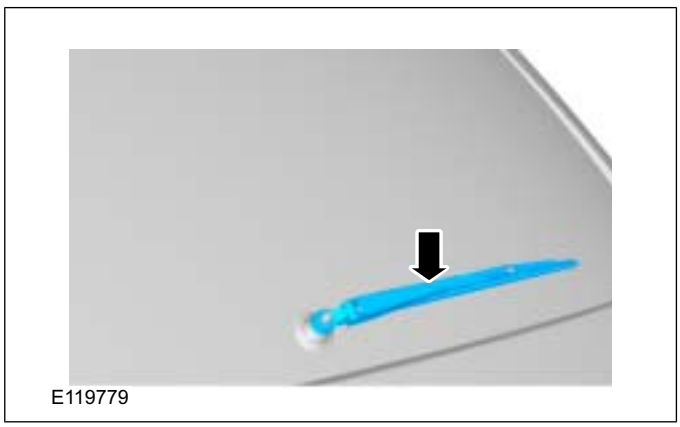
   Remove the rear wiper arm cover.


E119777

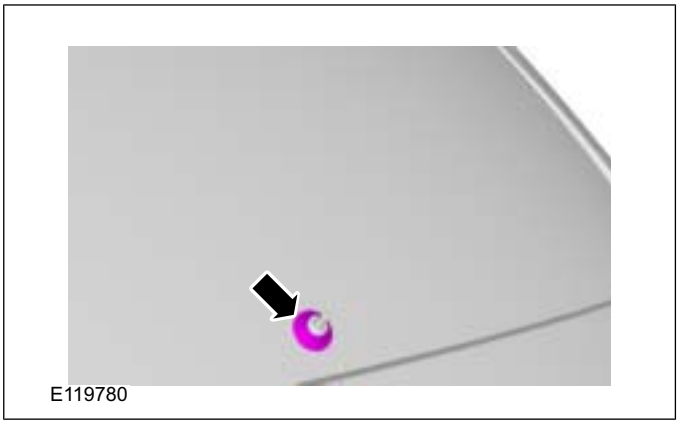
2. **Remove the rear wiper arm nut.**


E119778

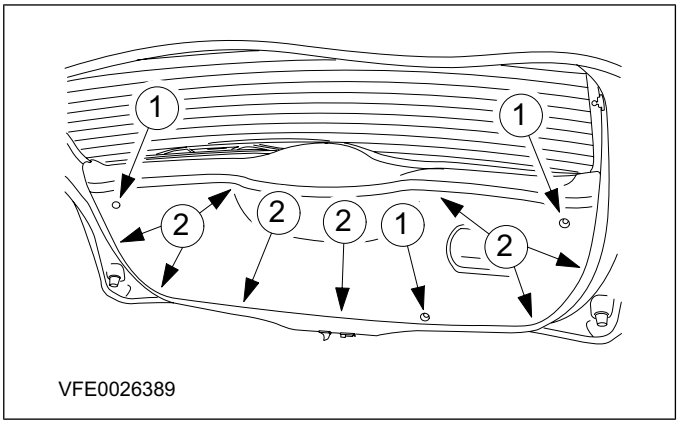
3. **Remove the rear wiper arm.**


E119779

4. **Remove the rear wiper arm rubber bush.**

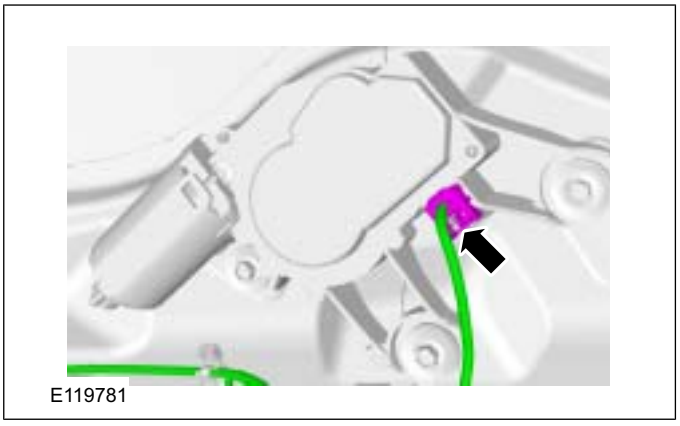

E119780

5. **Remove the tailgate trim panel.**
   1. Unscrew the bolts.
   2. Disengage the clips.



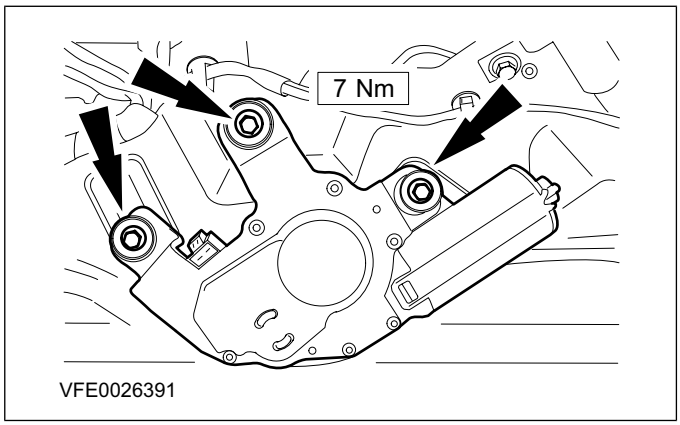
VFE0026389

6. **Disconnect the rear wiper motor electrical connector.**


E119781

REMOVAL AND INSTALLATION

7. Remove the rear wiper motor.



Installation

1. **CAUTION: Move the wiper motor to the parked position before installing the wiper arm.**

   Install the components in reverse order.

SECTION 501-19 Bumpers

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Torque Specifications

Item	Nm	lb-ft	lb-in
Front bumper retaining bolts	25	18	-
Front bumper side screws securing	3	-	-
Front bumper centre screws securing	11	-	-
Radiator grille opening panel reinforcement retaining bolts	10	7	-
Fender splash shield retaining screws	5	-	-
Bumper cover to fender retaining screws	5	-	-
Radiator support panel retaining bolts	20	15	-

REMOVAL AND INSTALLATION

Front Bumper(43 423 0)

General Equipment

Transmission jack
Wooden block

Removal

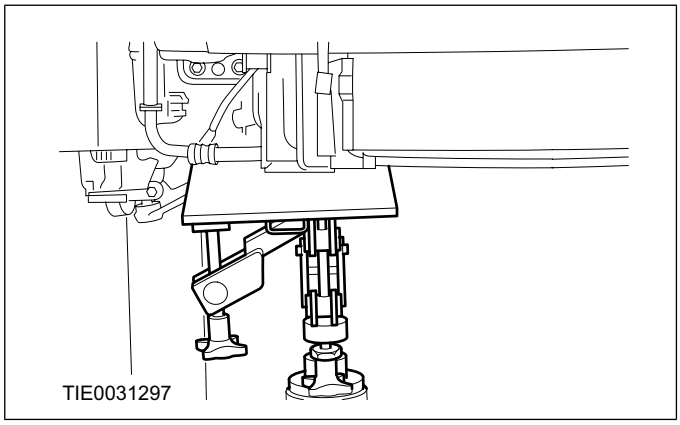
1. **Remove the front bumper cover.**

   For additional information, refer to: Front Bumper Cover (501-19 Bumpers, Removal and Installation).

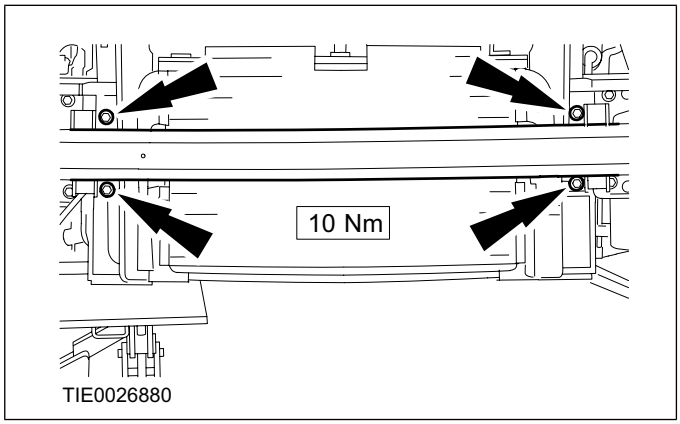
2. **Remove the headlight assy.**

   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

3. **Using a suitable transmission jack and wooden block, support the radiator.**

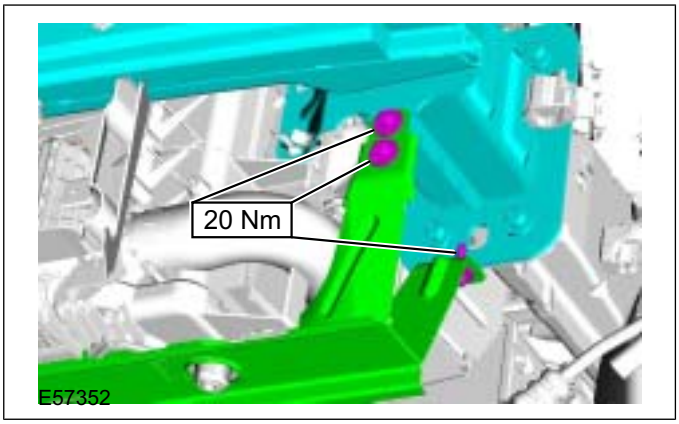


4. **Detach the bumper from the radiator grille opening panel reinforcement.**

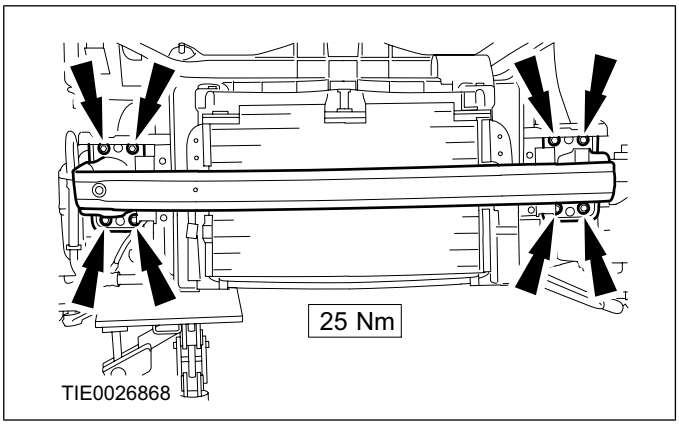


5. **Remove the radiator support panel (if equipped).**

- Remove the radiator support panel retaining bolts on both sides.



6. **Remove the bumper.**



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Front Bumper Cover(43 427 0)

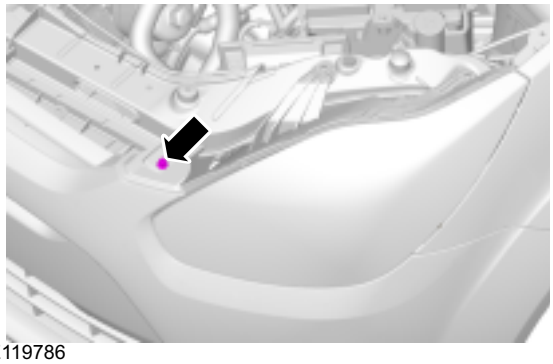
Removal

All vehicles

1. **Raise and support the vehicle. For additional information, refer to: (100-02 Jacking and Lifting)**

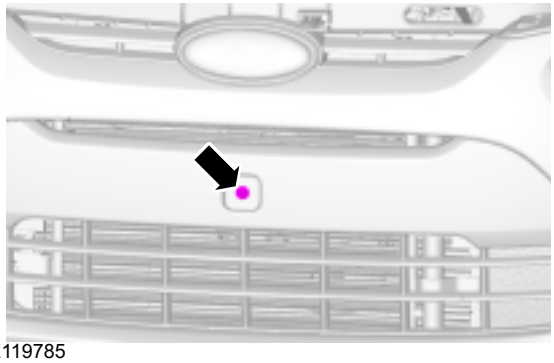
   Jacking (Description and Operation), Lifting (Description and Operation).

2. **Remove the clip on both sides.**



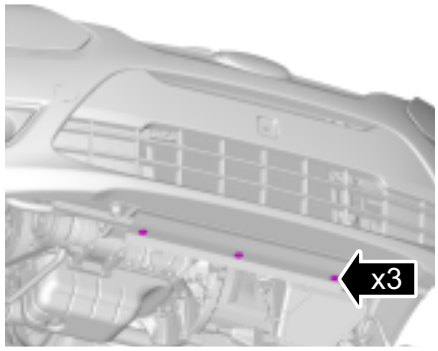
E119786

3. **Remove the front bumper center bolt.**



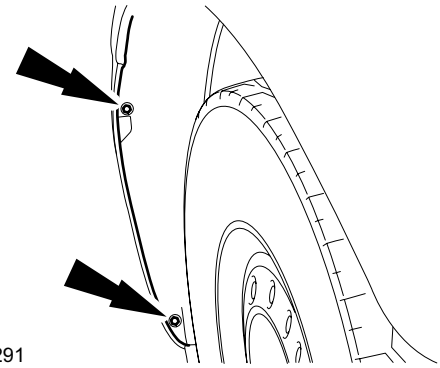
E119785

4. **Remove the front bumper bottom bolts.**



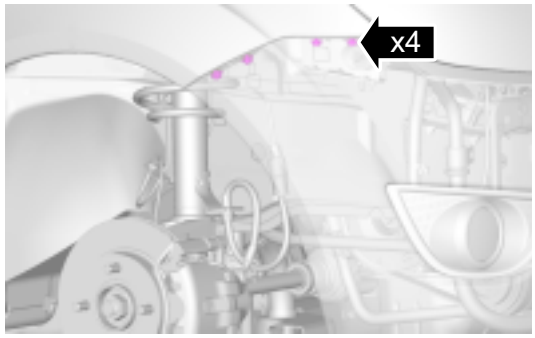
E119787

5. **Detach the fender splash shield from the bumper cover on both sides.**



TIE0031291

6. **Remove the front bumper fender bolts on both sides.**



E119788

7. **Remove both the fog lamps (if equipped).**

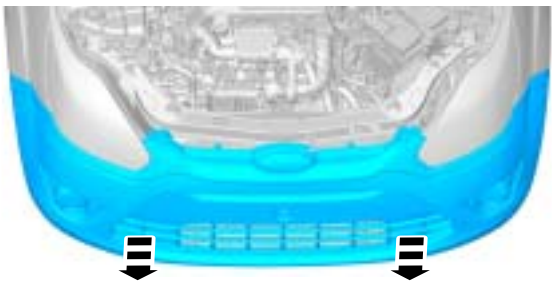
   For additional information, refer to: Front Fog Lamp (417-01 Exterior Lighting, Removal and Installation).

REMOVAL AND INSTALLATION

All vehicles

8. **NOTE: Vehicle without front fog lamps view shown.**

   Remove the bumper cover.



E119789

Installation

All vehicles

1. **To install reverse the removal procedure.**

All vehicles

2. **Lower the vehicle.**

REMOVAL AND INSTALLATION

Rear Bumper Cover(43 447 0)

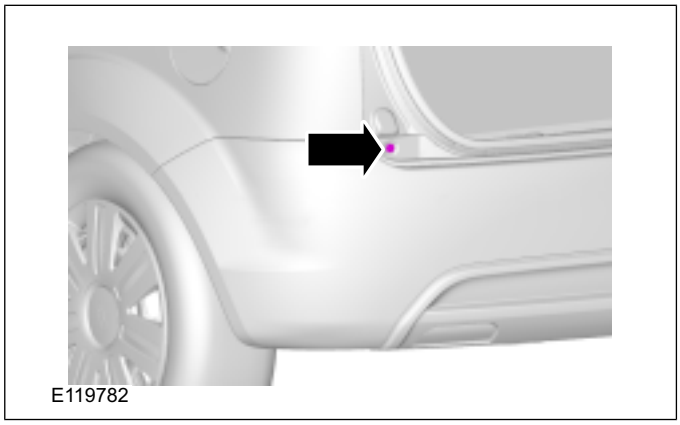
Removal

All vehicles

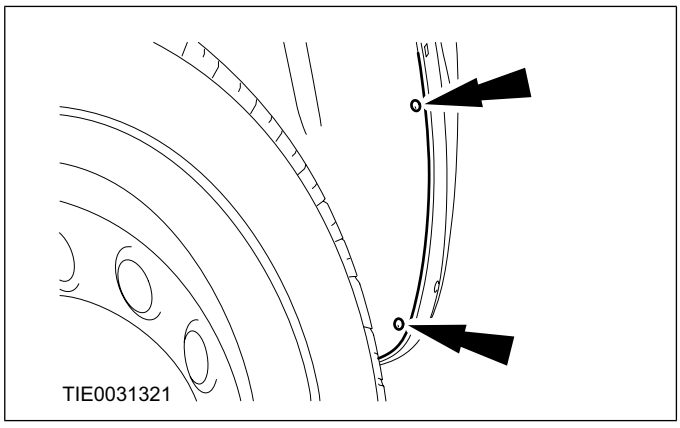
1. **Raise and support the vehicle. For additional information, refer to: (100-02 Jacking and Lifting)**

   Jacking (Description and Operation), Lifting (Description and Operation).

2. **Remove the screws on both sides of the bumper.**

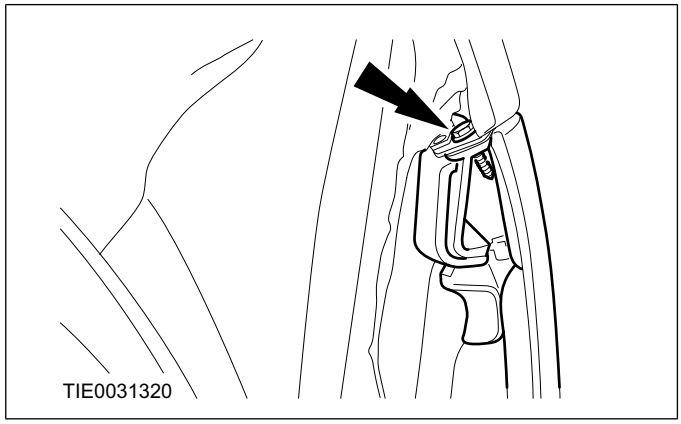


3. **Detach the bumper cover from the fender splash shield on both sides.**

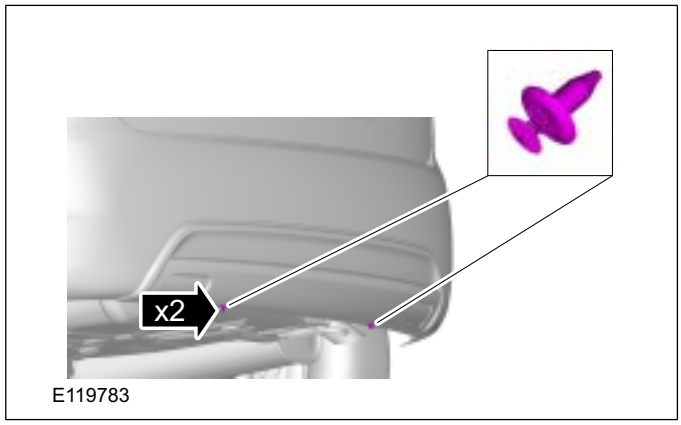


4. **Detach the bumper cover from the fender.**

- Remove the retaining screw on both sides.

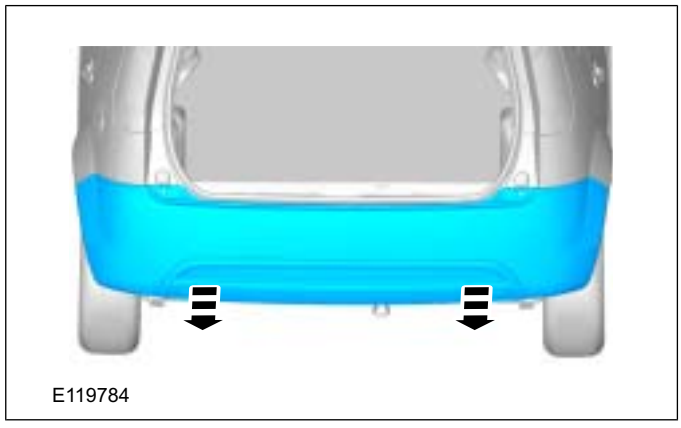


5. **Remove the pushpin retainers.**



All vehicles

6. **Remove the bumper cover.**



Installation

All vehicles

1. **To install reverse the removal procedure.**

REMOVAL AND INSTALLATION

All vehicles

2. Lower the vehicle.

SECTION 501-20A Safety Belt System

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Torque Specifications

Item	Nm	lb-ft	lb-in
Safety belt upper anchor retaining bolts	40	30	-
Safety belt lower anchor retaining bolts	40	30	-
Front safety belt retractor retaining bolts	35	26	-
Safety belt buckle retaining bolt	47	35	-
Safety belt buckle and pretensioner retaining bolt	47	35	-
Rear safety belt buckle retaining bolts	55	41	-
Rear seat backrest latch bracket retaining nuts	23	17	-
Rear safety belt retractor retaining bolts	40	30	-
Rear center safety belt retaining nuts	47	35	-

DIAGNOSIS AND TESTING

Safety Belt System

Principles of Operation

WARNING: All safety belt components including retractors, buckles, front safety belt buckle support assemblies, child safety seat leather brackets and attaching hardware in use during a collision must be removed and new components must be installed. New safety belt components should also to be installed where safety belts not in use during a collision, are inspected and found to be damaged or operate incorrectly. Failure to follow these instructions may result in personal injury.

Rear seat safety belt are equipped with a conventional retractor.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical and electrical damage.

Visual Inspection Chart

Mechanical
• Safety belt retractor • Safety belt buckle

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Component Test

Test Method 1 (braking)

WARNING: It is important that during this test, the driver and passenger allow the safety belts to provide the restraint and do not attempt to anticipate the sudden deceleration. The steering wheel should not be used as a brace. However, both driver and passenger should prepare themselves for the possibility that the safety belt will not lock. The passenger should hold their hands in front of them, just clear of the instrument panel or front seat backrest, depending on which safety belt is being tested. Failure to follow these instructions may result in personal injury.

- Select for this test a quiet or private stretch of road. Make sure that the road is clear and that full visibility is maintained at all times.
- Both driver and passenger should adopt a normal, comfortable seating position. Both occupants should wear the safety belts and the safety belt webbing must be correctly adjusted, with no slack.
- Proceed at a speed of 10 km/h (6 mph). Do not exceed 10 km/h (6 mph) for this test.
- Apply the foot brake sharply to stop the vehicle. If the vehicle motion sensitive lock mechanism is operating correctly, the safety belt webbing will lock and restrain the wearer.
- Conduct the test twice in each front and rear passenger seat position.
- Any safety belt retractor which does not restrain the wearer during this test must not be reused. A new safety belt must be installed.

Test Method 2 (turning circle)

This method requires a flat open area of private road, sufficient for the vehicle to be driven in a continuous circle on full steering lock.

- The driver should wear the safety belt provided and the belt webbing must be correctly adjusted, with no slack.
- The passenger should occupy a rear seat with the safety belt correctly adjusted, with no slack.
- Start the engine and, with the steering on full right-hand lock, drive the vehicle in a continuous circle at 16 km/h (10mph). Do not exceed 16 km/h (10 mph) for this test.
- When the speed is stable, the passenger should attempt to slowly extract the safety belt webbing from each safety belt retractor in turn. If the vehicle motion sensitive lock mechanism is operating correctly, it will not be possible to extract the webbing.
- Any safety belt retractor from which it is possible to extract the webbing during this test must not be used. A new safety belt must be installed.

DIAGNOSIS AND TESTING

Static Test

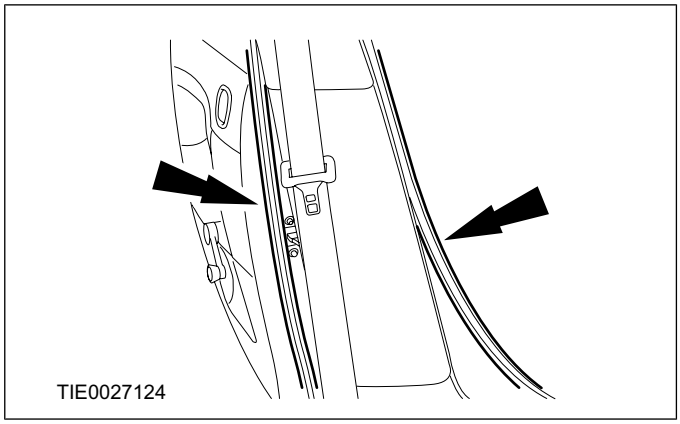
With the vehicle stationary and on level ground take firm hold of the safety belt webbing (on the tongue side of the upper safety belt anchor) and pull out quickly. The retractor should lock within 0.25 meter (10 inches), preventing further webbing payout. Any safety belt retractor from which it is possible to extract further webbing must not be used. A new safety belt must be installed.

REMOVAL AND INSTALLATION

Front Safety Belt Retractor(40 222 0)

Removal

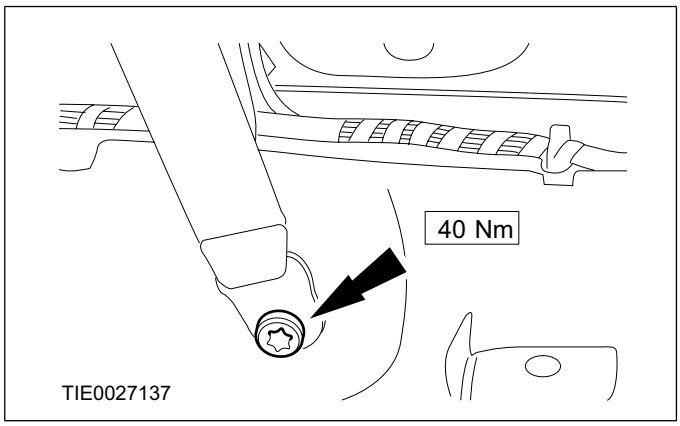
1. **Detach the door opening weatherstrips from the B-pillar.**



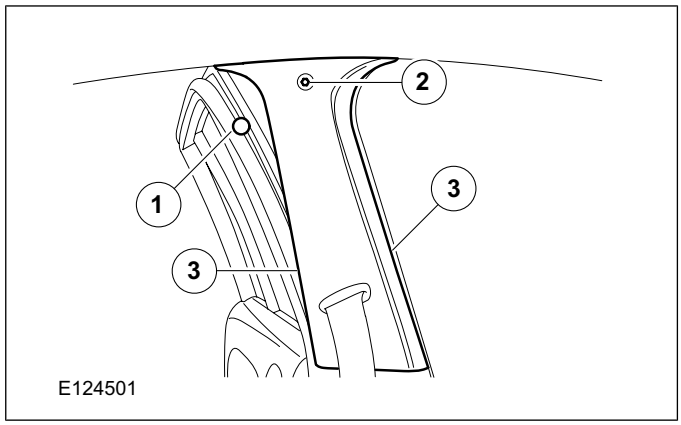
2. **NOTE: Hold the safety belt webbing when detaching the safety belt lower anchor from the floor panel.**

   Detach the safety belt lower anchor from the floor panel.

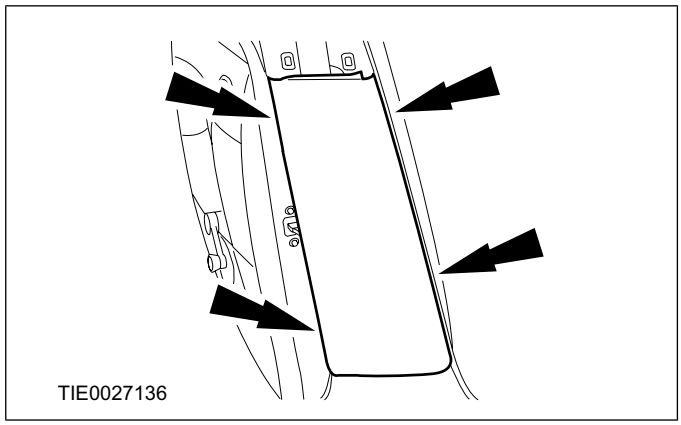
   - Remove the retaining bolt and spacer from the anchor plate.



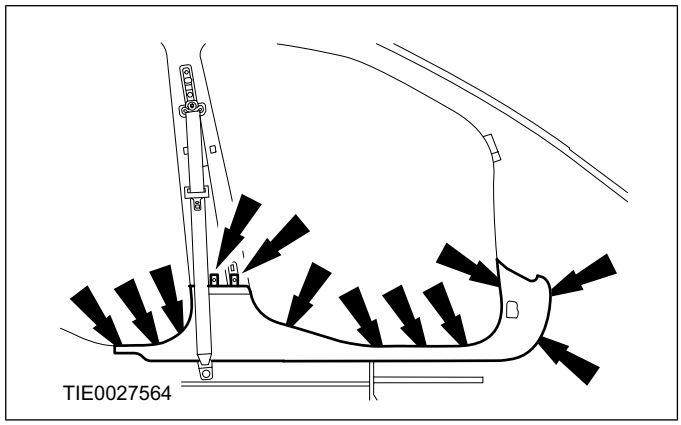
3. **Remove the B-pillar upper trim panel.**
   1. Remove the screw cover.
   2. Remove the retaining screw.
   3. Detach the retaining clips from the B-pillar.
   - Feed the safety belt webbing through the B-pillar upper trim panel.



4. **Remove the B-pillar lower trim panel.**
   - Detach the retaining clips.



5. **Remove the front door scuff panel.**
   - Detach the retaining clips.

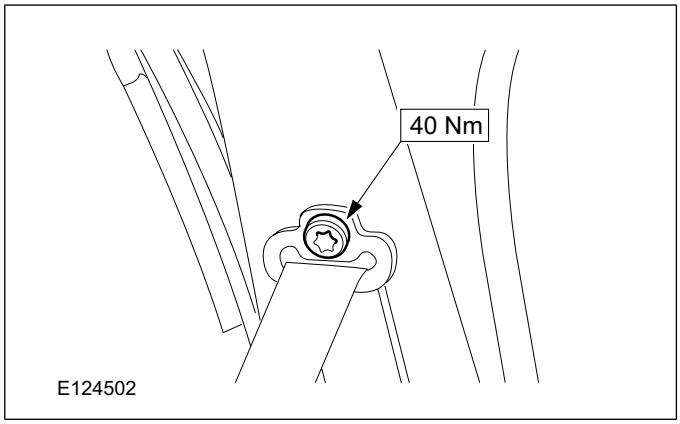


6. **CAUTION: The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt anchor at all**

REMOVAL AND INSTALLATION

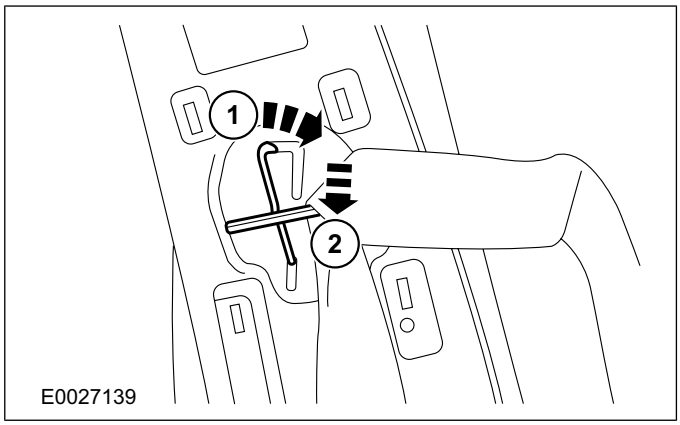
times when the safety belt is detached or removed.

Detach the safety belt upper anchor bolt.



7. Detach the guide loop from the B-pillar.

1. Rotate the guide clockwise.
2. Slide the guide downwards.

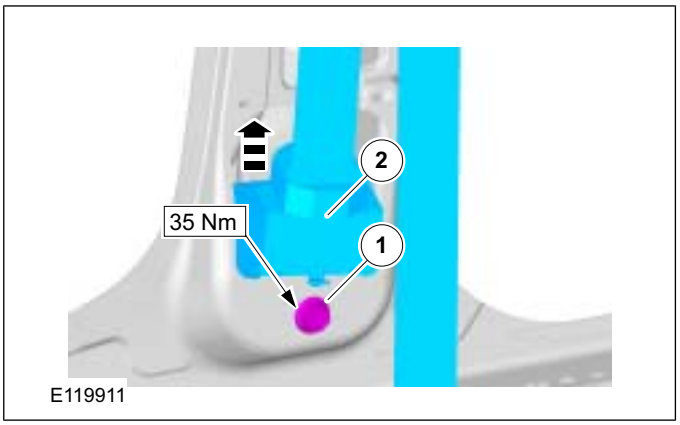


8. CAUTION: The safety belt retractor retaining bolt must only be used five times.

NOTE: After removal, stamp the safety belt retractor retaining bolt with a center punch to indicate usage.

Remove the front safety belt retractor.

1. Remove the bolt.
2. Lift the retractor to detach the locating tang.



Installation

1. CAUTIONS:

Make sure the safety belt retractor locating tang is correctly located.

The safety belt retractor retaining bolt must only be used five times, inspect the markings on the retaining bolt and install a new retaining bolt if necessary.

To install, reverse the removal procedure.

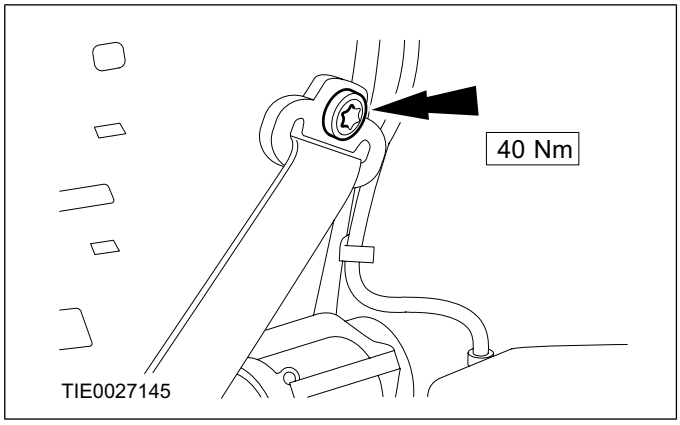
REMOVAL AND INSTALLATION

Rear Safety Belt Retractor — 5-Door(40 248 0)

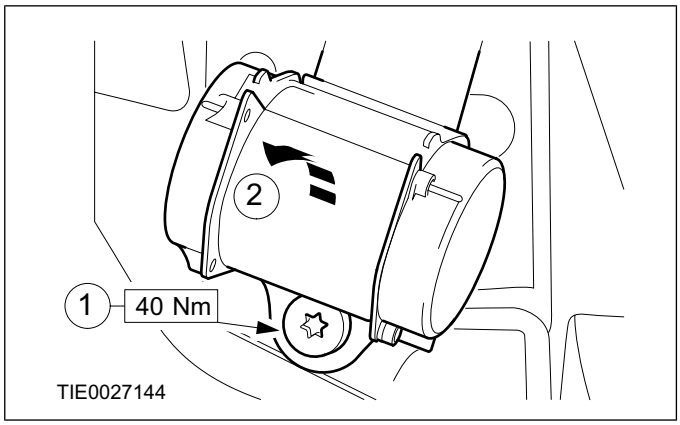
Removal

1. **Remove the C-pillar trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **CAUTION: The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt anchor at all times when the safety belt is detached or removed.**

   Detach the safety belt upper anchor from the D-pillar.



3. **Remove the rear safety belt retractor.**
   1. Remove the retaining bolt.
   2. Lift the retractor to detach the locating tangs.



Installation

1. **CAUTION: Make sure the safety belt retractor locating tangs are correctly located.**

   To install, reverse the removal procedure.

SECTION 501-20B Supplemental Restraint System

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Special Tool Usage

Description	Simulator	Test and Deployment Lead (Part of Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt [418-S055])
Driver air bag module	501-073A	418-141
Passenger air bag module	501-073A	418-141
Simulator, Occupant Restraint Systems	501-092	

Torque Specifications

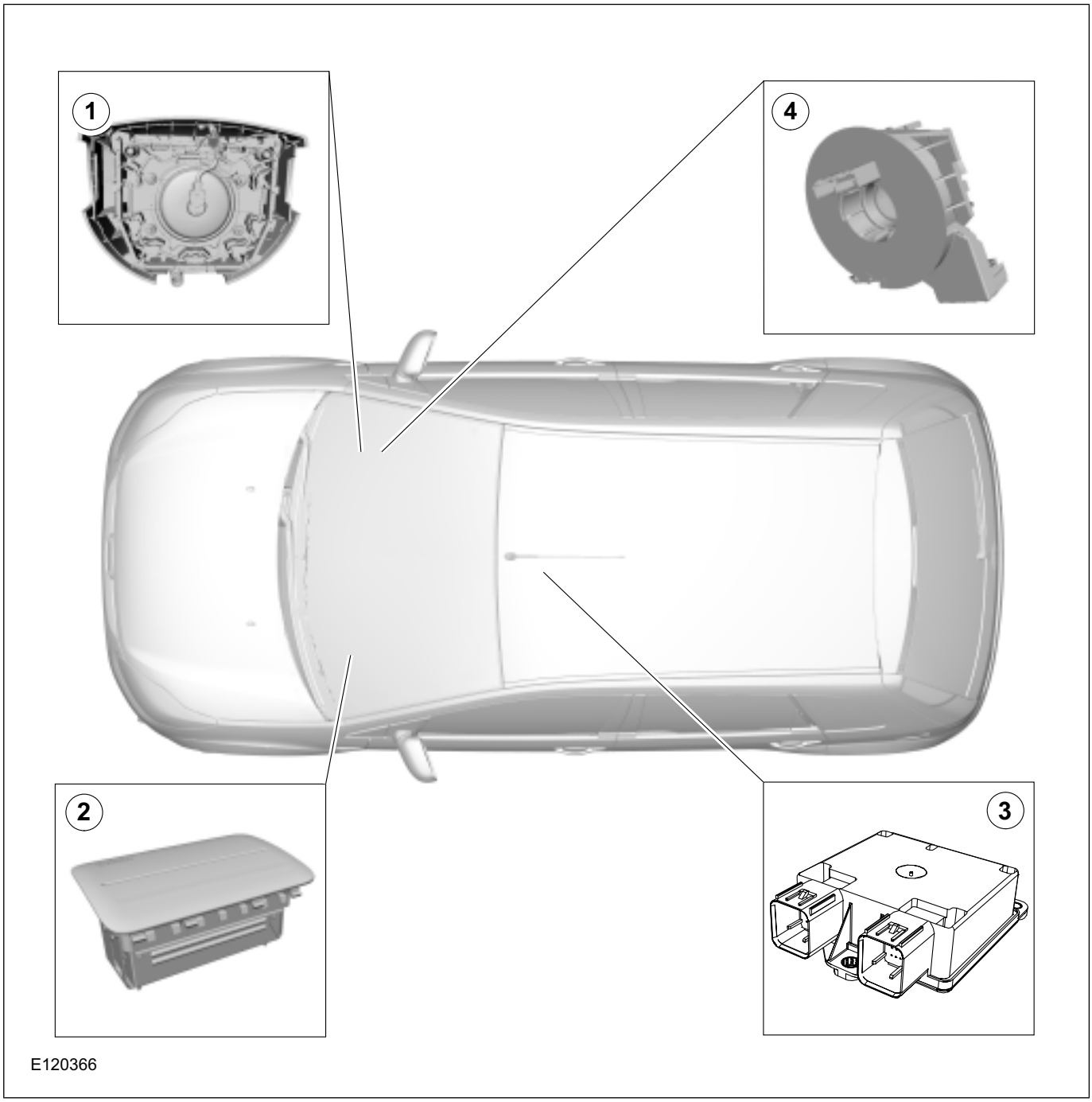
Item	Nm	lb-ft	lb-in
Air bag control module retaining nuts	9	-	80
Passenger air bag module bracket to cross-vehicle beam retaining bolts	10	-	89

DESCRIPTION AND OPERATION

Air Bag Supplemental Restraint System (SRS)

Supplemental Restraint System (SRS)

System overview (5-door shown)



Item	Description
1	Driver air bag module
2	Passenger air bag module

Item	Description
3	Air bag module
4	Clockspring

DESCRIPTION AND OPERATION

System structure

The following components form part of the supplemental restraint system (SRS):

- Air bag control module
- Driver and passenger air bag modules
- Clockspring
- Air bag warning indicator

Air Bag Control Module

E124162

The air bag control module is located under the floor console, near to the gearshift lever. The installation marks on the air bag control module are to make sure it is aligned correctly.

A micro mechanical sensor is incorporated into the air bag control module; this measures the acceleration/deceleration in the event of a collision. The calculated value is evaluated by the air bag control module to determine the severity of the impact.

The air bag control module compares the values it receives from the micro mechanical sensor. If the deceleration due to a frontal impact exceeds a stored value then the air bag control module triggers the air bags.

If the vehicle battery is destroyed in the collision, a voltage hold circuit in the air bag control module will still enable the air bags to be triggered up to 150 ms after the start of the impact.

If a system fault is detected by the air bag control module, the air bag warning indicator is illuminated. The fault can be located by carrying out a diagnostic check using the Ford approved diagnostic tool.

The air bag control module can be used again after a collision for up to 5 times, provided that the air bag control module is not physically damaged and that it passes a self-test.

Driver and Passenger Air Bag Modules

E55577

The driver air bag module is fitted to the steering wheel, the cover forming the outer surface of the steering wheel boss. The cover has invisible 'split lines' moulded in its surface allowing the air bag to easily exit through the cover when the system deploys. A new driver air bag module and driver air bag module wiring harness must be installed following deployment.

E55578

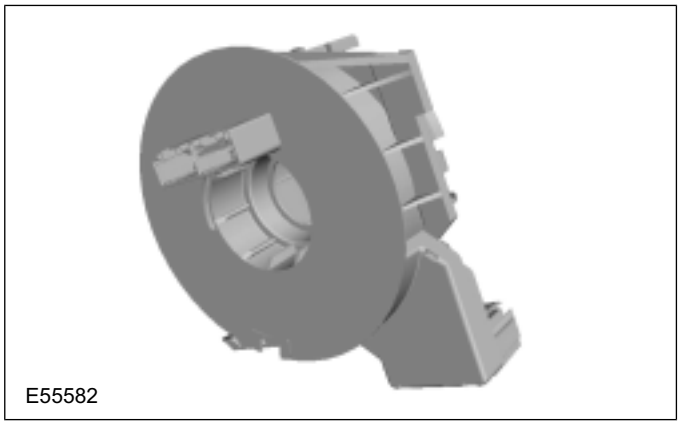
The passenger air bag module is located above the glove compartment and is secured to the in-vehicle crossbeam and the instrument panel. The cover is integrated into the instrument panel to provide an unobtrusive appearance. The cover has invisible 'split lines' moulded in its surface allowing the air bag to easily exit through the cover when the system deploys.

The passenger air bag is deployed simultaneously with the driver air bag.

A new passenger air bag module must be installed following deployment.

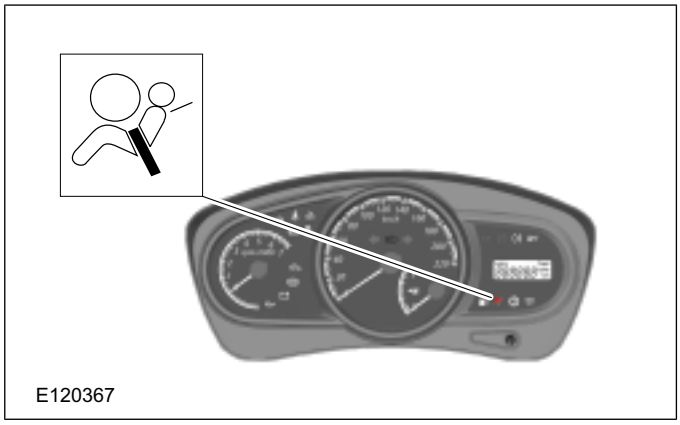
DESCRIPTION AND OPERATION

Clockspring


E55582

The clockspring is designed to carry signals between the air bag control module and the driver air bag module. The clockspring is installed on the steering column and consists of fixed and moving parts connected by a coiled Mylar tape with internal conducting tracks. The Mylar tape is able to 'wind up' and 'unwind' as the steering wheel is rotated, maintaining electrical contact at all times between the air bag control module and the driver air bag module.

Air Bag Warning Indicator


E120367

The air bag warning indicator is located in the instrument cluster. In the event of a fault being detected by the air bag control module, the air bag warning indicator flashes at a rate of 5Hz or remains illuminated. The corresponding Diagnostic Trouble Code (DTC) can be read out with the aid of Ford approved diagnostic tool.

The air bag warning indicator illuminates for three seconds at key ON. If the system self-tests OK the air bag warning indicator extinguishes, if a fault is detected the air bag warning indicator will flash after five seconds, illuminate continually from key ON or not illuminate at all, depending on the nature of the fault.

The automatic detach circuit is designed to illuminate the air bag warning indicator continuously, if the air bag control module circuit is broken, either by:

- Loss of the air bag control module circuit power supply.
- Loss of the air bag control module circuit ground circuit.
- Disconnection of the air bag control module electrical connector.

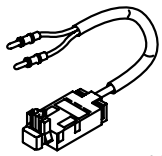
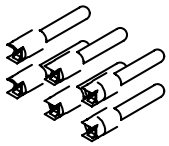
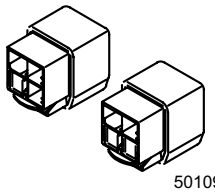
Diagnostic evaluation of the SRS can be made through the DLC and Ford approved diagnostic tool to establish the nature of the concern.

DIAGNOSIS AND TESTING

Air Bag Supplemental Restraint System (SRS)

Refer to Wiring Diagrams Section 501-20B, for schematic and connector information.

Special Tool(s)

 418141	Test and Deployment Lead, Driver, Passenger Module 418-141
 501073	Simulator, Driver and Passenger Air Bags 501-073A
 501092	Simulator, Occupant Restraint Systems 501-092

General Equipment

Ford Approved Diagnostic tool
Driver air bag module wiring harness

Diagnosing Customer Concerns Without Hard DTCs

WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS), or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

NOTE: Following the pinpoint tests when a diagnostic trouble code/lamp fault code (DTC) is not present, or the air bag warning indicator is not permanently illuminated, will result in needless replacement of air bag system components and repeat repairs.

Speak with the customer to determine if a particular set of conditions must be met in order for a fault to occur. If a LFC is reported by the customer but is not present when the vehicle comes in for repair, pinpoint test diagnostics cannot be used. Instruct the customer on how to count a LFC.

Diagnosing Customer Concerns with Hard DTCs

WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

Most air bag system diagnostic procedures require the use of system deactivation and system reactivation procedures. These procedures require the air bag module(s) to be disconnected from the SRS, thereby removing the risk of an air bag deployment while diagnostics are carried out.

Air bag simulators are required to carry out diagnosis and testing of the air bag system. The simulator contains a resistor, used to simulate an air bag module connection to the system. It is not acceptable to short-circuit the air bag module connections with a 0 ohm jumper wire. If a 0 ohm jumper wire is used to short-circuit the air bag module connections, a LFC will be displayed and a DTC logged by the air bag control module.

Deactivation

WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

1. Disconnect the battery ground cable.

DIAGNOSIS AND TESTING

2. Wait at least one minute for the backup power supply in the air bag control module to deplete its stored energy.

WARNING: Place the air bag module on a ground wired bench, with the trim cover facing up to avoid accidental deployment. Failure to follow this instruction may result in personal injury.

3. Remove the driver air bag module from the vehicle.

   REFER to: Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

4. **NOTE: REFER to FordEcat for a compatible driver air bag module wiring harness to use as a test lead.**

   Connect a test driver air bag module wiring harness to the clockspring.

5. Connect the driver air bag simulator to the driver air bag module wiring harness in place of the driver air bag module at the top of the steering column.
6. Disconnect the passenger air bag module electrical connector.

   REFER to: Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

7. Connect the passenger air bag simulator to the wiring harness in place of the passenger air bag module.
8. Connect the battery ground cable.

   REFER to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

Reactivation

WARNING: The air bag simulators must be removed and the air bag modules reconnected when reactivated to avoid non-deployment in a collision. Failure to follow this instruction may result in personal injury.

1. Disconnect the battery ground cable.

   REFER to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Wait at least one minute for the backup power supply in the air bag control module to deplete its stored energy.
3. **NOTE: If a new driver air bag module wiring harness has been used for testing the wiring harness should be retained for future test use only.**

   Remove the driver air bag simulator from the driver air bag module wiring harness at the top of the steering column.

4. Remove the driver air bag module wiring harness from the clockspring.
5. Connect and install the driver air bag module.

   REFER to: Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

6. Remove the passenger air bag simulator from the passenger air bag module harness.
7. Connect and install the passenger air bag module.

   REFER to: Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

8. Connect the battery ground cable.

   REFER to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

9. Prove out the system.

Glossary

Air Bag Simulator

Air bag simulators are used to simulate air bag module connections to the system.

Deactivate The System

Deactivate the system means to carry out deactivation. REFER to Deactivation in this procedure.

Prove Out The System

The air bag warning indicator will illuminate for three seconds.

Reactivate The System

Reactivate the system means to carry out reactivation. REFER to Reactivation in this procedure.

Principles of Operation

SRS Operation

The SRS is DC fired.

DIAGNOSIS AND TESTING

In the event of a severe frontal or three-quarter frontal impact, in excess of a predetermined limit, the driver and passenger (if equipped) front air bag(s) will deploy.

In the event of a severe full side impact, in excess of a predetermined limit, either the driver or passenger side air bags (if equipped) and side air curtains (if equipped) will deploy.

Air bag deployment will only occur, in the event of a severe collision when the ignition key is in the RUN position. The passenger air bag deactivation (PAD) switch (if equipped) will deactivate the passenger air bag in the event of a severe frontal or side impact; it will not deactivate the passenger side air bag.

Air Bag Control Module

The air bag control module is mounted horizontally to the floor pan beneath the floor console, to facilitate impact sensing along the longitudinal axis. The air bag control module retains full control of the whole system, providing continual system checks and full diagnostic capabilities. The non-volatile memory stores the fault codes, which are down loaded through the data link connector (DLC) to Ford approved diagnostic tool. A visual air bag warning indicator housed within the instrument cluster, is illuminated when the ignition is switched ON for approximately three seconds and then goes out. If a fault occurs, after five seconds the air bag warning indicator either begins to flash or illuminates continuously depending on the nature of the fault.

In the event of a failure in the vehicle power supply during an accident, the air bag control module provides an auxiliary power supply, sufficient to deploy the front air bag(s) for a minimum of 150 ms. The auxiliary power supply is discharged by the air bag control module within 60 seconds of the battery ground cable being disconnected. Thus making sure that the SRS remains operational.

The air bag control module contains a micro-controller to evaluate and process impact data. In the event of a frontal impact, in excess of a predetermined limit, the air bag control module will evaluate the signal received from the internal crash sensor against stored data and deploy the frontal air bags.

Air Bag Warning Indicator

The air bag warning indicator is incorporated into the instrument cluster, together with the automatic detach detect circuit. The air bag warning indicator illuminates for three seconds at key ON. If the system self-tests OK the air bag warning indicator extinguishes, if a fault is detected the air bag warning indicator will flash after five seconds, illuminate continually from key ON or not illuminate at all, depending on the nature of the fault.

The automatic detach detect circuit is designed to illuminate the air bag warning indicator continuously, if the air bag control module circuit is broken, either by:

- Loss of the air bag control module circuit power supply.
- Loss of the air bag control module circuit ground circuit.
- Disconnection of the air bag control module electrical connector.

Diagnostic evaluation of the SRS can be made through the DLC and Ford approved diagnostic tool to establish the nature of the concern.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Electrical
• Fuse(s) • Loose or corroded connector(s) • Air bag module(s) • Circuit(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, connect Ford approved diagnostic tool to the DLC and select the vehicle to be tested from the Ford approved diagnostic tool menu.
5. Retrieve the DTCs and refer to the Symptom Chart.

Symptom Chart

NOTE: It is only allowed to repair circuits between connectors. If damage has occurred within a connector a connector replacement kit, if available, must be installed. If a connector replacement kit is not available a new wiring harness must be installed. Connectors must not be disassembled.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• No communication with the module	• DLC. • Air bag control module. • Circuit(s).	• GO to Pinpoint Test A.
• DTC B1317: Battery voltage high	• Charging system.	• CHECK the charging system. Repeat the self-test, CLEAR the DTCs. -
• DTC B1318: Battery voltage low	• Battery. • Charging system. • Circuit(s).	• GO to Pinpoint Test B.
• DTC B1342: Air bag control module is defective	• Air bag control module.	• INSTALL a new air bag control module. REPEAT the self-test, CLEAR the DTCs. REFER to: Air Bag Control Module (501-20 Supplemental Restraint System, Removal and Installation).
• DTC B1868: Air bag warning indicator open circuit or short to ground	• Instrument cluster.	• CHECK the instrument cluster.
• DTC B1916: Driver air bag short to battery	• Clockspring. • Circuit(s).	• GO to Pinpoint Test C.
• DTC B1925: Passenger air bag short to battery	• Circuit(s).	• GO to Pinpoint Test D.
• DTC B1932: Driver air bag open circuit	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test E.
• DTC B1933: Passenger air bag open circuit	• Passenger air bag module. • Circuit(s).	• GO to Pinpoint Test F.
• DTC B1934: Driver air bag circuit low resistance	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test G.
• DTC B1935: Passenger air bag circuit low resistance	• Passenger air bag module. • Circuit(s).	• GO to Pinpoint Test H.
• DTC B1936: Driver air bag circuit short to ground	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test I.
• DTC B1938: Passenger air bag circuit short to ground	• Passenger air bag module. • Circuit(s).	• GO to Pinpoint Test J.

DIAGNOSIS AND TESTING

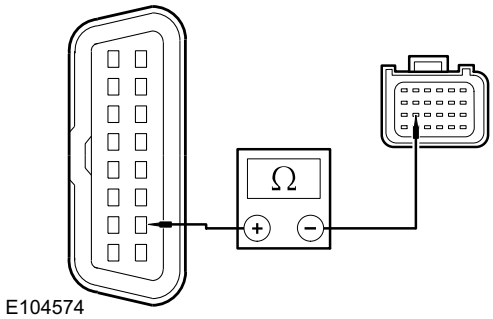
Symptom	Possible Sources	Action
• DTC B2477: Air bag control module configuration failure	• Air bag control module.	• CONFIGURE the air bag control module. REFER to Ford approved diagnostic tool. REPEAT the self-test, CLEAR the DTCs.
• DTC B2792: Cross link between firing circuits	• Circuit(s).	• GO to Pinpoint Test K.
• DTC P1796: CAN controller circuit (BUS off)	• Circuit(s).	• GO to Pinpoint Test L.
• Air bag control module disconnected or inoperative	• Air bag control module. • Circuit(s).	• GO to Pinpoint Test M.

Pinpoint Tests

PINPOINT TEST A : NO COMMUNICATION WITH THE MODULE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK THAT FORD APPROVED DIAGNOSTIC TOOL IS COMMUNICATING THROUGH THE DLC	
	1 Select an alternative system to check the DLC. • Is Ford approved diagnostic tool able to communicate with the selected system? → **Yes** GO to A2. → **No** CHECK the DLC. For additional information, REFER to the Wiring Diagrams. REPEAT the self-test, CLEAR the DTCs.
A2: CHECK THE AIR BAG WARNING INDICATOR	
	1 Ignition switch in position II.

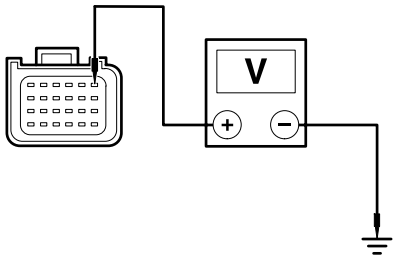
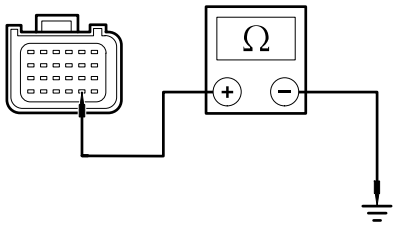
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 The air bag warning indicator should illuminate when the ignition is in the ON position for three seconds and then go out. If a fault is present, the air bag warning light will then begin to flash. • Is the warning indicator operating? → **Yes** GO to A3. → **No** CHECK the instrument cluster.
A3: CHECK THE DLC CIRCUIT	
	1 Ignition switch in position 0.
	2 Deactivate the SRS.
	3 Disconnect Air Bag Control Module C3R114-A.
 E104574	4 Measure the resistance between the DLC C2DB04 pin 7, circuit VDB10 (GY) and the air bag control module C3R114-A pin 17, circuit VDB10 (GY), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new air bag control module. REFER to: Air Bag Control Module (501-20 Supplemental Restraint System, Removal and Installation). . REACTIVATE the system. If the air bag warning indicator is flashing, count the lamp flash code and REFER to the Symptom Chart in this section. → **No** REPAIR circuit VDB10 (GY). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST B : DTC B1318: BATTERY VOLTAGE LOW

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s)	

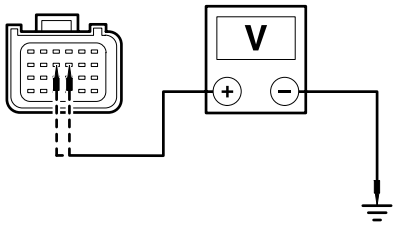
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK THE IGNITION SUPPLY CIRCUIT FOR AN OPEN CIRCUIT	
	1 Disconnect Air Bag Control Module C3R114-A.
	2 Ignition switch in position II.
 TIE0030178	3 Measure the voltage between the air bag control module C3R114-A pin 1, circuit CBP39 (VT/WH), harness side and ground. • Is the voltage between 9 and 16 volts? → **Yes** GO to B2. → **No** REPAIR circuit CBP39 (VT/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
B2: CHECK THE AIR BAG CONTROL MODULE GROUND CIRCUIT	
	1 Ignition switch in position 0.
 TIE0030179	2 Measure the resistance between the air bag control module C3R114-A pin 20, circuit GD374 (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new air bag control module. REFER to: Air Bag Control Module (501-20 Supplemental Restraint System, Removal and Installation). .REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit GD374 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

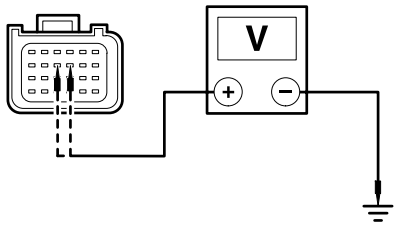
PINPOINT TEST C : DTC B1916: DRIVER AIR BAG SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s)	

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
C1: CHECK THE DRIVER AIR BAG WIRING HARNESS FOR A SHORT TO BATTERY OR IGNITION	
	1 Deactivate the SRS.
	2 Disconnect Driver Air Bag Module Simulator.
	3 Disconnect Air Bag Control Module C3R114-A.
	4 Ignition switch in position II.
 TIE0030191	5 Measure the voltage between the: • Air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side and ground. • Air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side and ground. • Is any voltage present? → **Yes** GO to C2. → **No** CONNECT the driver air bag module simulator and the air bag control module C3R114-A. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
C2: CHECK THE CLOCKSPRING FOR A SHORT TO BATTERY OR IGNITION	
	1 Ignition switch in position 0.
	2 Disconnect Clockspring C2R115.
	3 Ignition switch in position II.

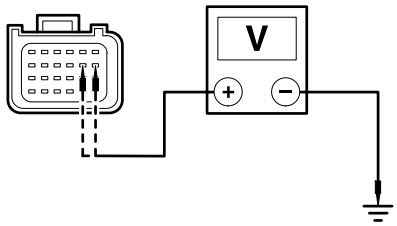
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030191	4 Measure the voltage between the: • Air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side and ground. • Air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit CR101 (VT/BN) and circuit RR101 (YE/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new clockspring. REFER to: Clockspring (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST D : DTC B1925: PASSENGER AIR BAG SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
D1: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR A SHORT TO BATTERY OR IGNITION	
	1 Deactivate the SRS.
	2 Disconnect Passenger Air Bag Module Simulator.
	3 Disconnect Air Bag Control Module C3R114-A.
	4 Ignition switch in position II.

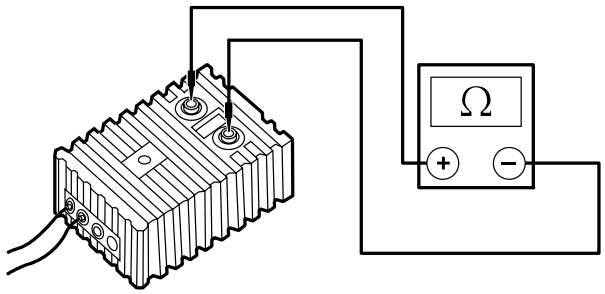
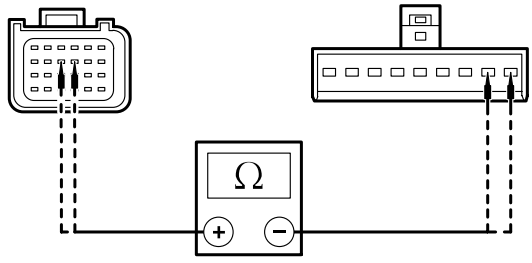
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030192	5 Measure the voltage between the: • Air bag control module C3R114-A pin 7, circuit CR103 (GN/WH), harness side and ground. • Air bag control module C3R114-A pin 8, circuit RR103 (BK/WH), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit CR103 (GN/WH) or circuit RR103 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** CONNECT the passenger air bag module simulator and the air bag control module C3R114-A. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST E : DTC B1932: DRIVER AIR BAG OPEN CIRCUIT

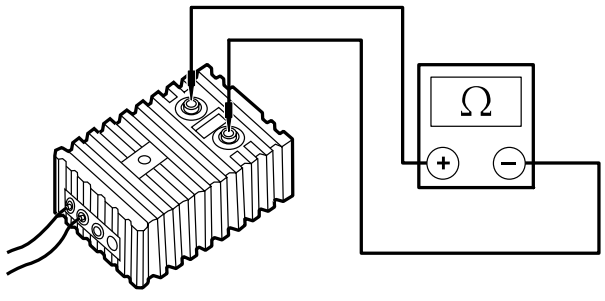
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
E1: CHECK THE DRIVER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to E2. → **No** GO to E3.
E2: CHECK THE DRIVER AIR BAG MODULE SQUIB RESISTANCE	
WARNING: Do not proceed with this test unless using Ford approved diagnostic tool. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver air bag module.
	2 Select DMM specific on Ford approved diagnostic tool.

DIAGNOSIS AND TESTING

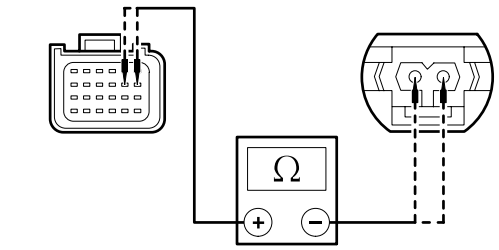
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect the Test and Deployment Lead to Ford approved diagnostic tool.
 TIE39388	4 Measure the resistance of the driver air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver air bag module. REFER to: Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
E3: CHECK THE CLOCKSPRING FOR OPEN CIRCUIT OR HIGH RESISTANCE - VEHICLES WITHOUT STABILITY ASSIST	
	1 Ignition switch in position 0.
	2 Disconnect Air Bag Control Module C3R114-A.
	3 Disconnect Clockspring C2R115.
 E65047	4 Measure the resistance between the: • Air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side and the Clockspring C2R115 pin 2, circuit RR101 (YE/GN), harness side. • Air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side and the Clockspring C2R115 pin 1, circuit CR101 (VT/BN), harness side. • Are the resistances less than 5 ohms? → **Yes** INSTALL a new clockspring. REFER to: Clockspring (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR101 (VT/BN) or circuit RR101 (YE/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST F : DTC B1933: PASSENGER AIR BAG OPEN CIRCUIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
F1: CHECK THE PASSENGER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to F2. → **No** GO to F3.
F2: CHECK THE PASSENGER AIR BAG MODULE SQUIB RESISTANCE	
WARNING: Do not proceed with this test unless using Ford approved diagnostic tool. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger air bag module.
	2 Select DMM specific on Ford approved diagnostic tool.
	3 Connect the Test and Deployment Lead to Ford approved diagnostic tool.
 TIE39388	4 Measure the resistance of the passenger air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger air bag module. REFER to: Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

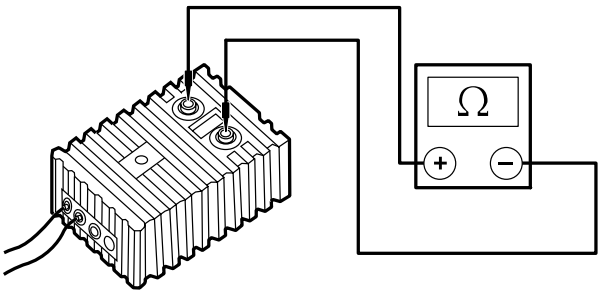
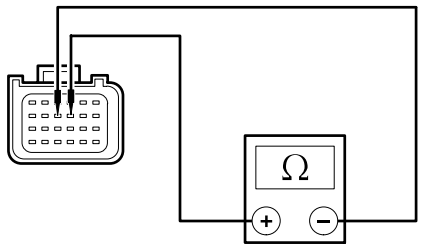
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F3: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect Air Bag Control Module C3R114-A.
	3 Disconnect Passenger Air Bag Module Simulator.
 TIE0030194	4 Measure the resistance between the: • Air bag control module C3R114-A pin 7, circuit CR103 (GN/WH), harness side and the passenger air bag module C2R103 pin 1, circuit CR103 (GN/WH), harness side. • Air bag control module C3R114-A pin 8, circuit RR103 (BK/WH), harness side and the passenger air bag module C2R103 pin 2, circuit RR103 (BK/WH), harness side. • Are the resistances less than 5 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR103 (GN/WH) and circuit RR103 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST G : DTC B1934: DRIVER AIR BAG CIRCUIT LOW RESISTANCE

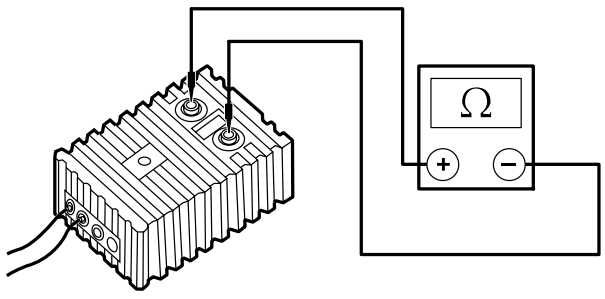
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
G1: CHECK THE DRIVER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to G2. → **No** GO to G3.

DIAGNOSIS AND TESTING

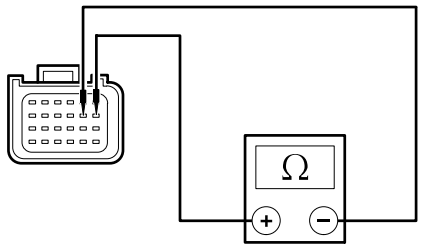
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G2: CHECK THE DRIVER AIR BAG MODULE SQUIB RESISTANCE	
WARNING: Do not proceed with this test unless using Ford approved diagnostic tool. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver air bag module.
	2 Select DMM specific on Ford approved diagnostic tool.
	3 Connect the Test and Deployment Lead to Ford approved diagnostic tool.
 TIE39388	4 Measure the resistance of the driver air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver air bag module. REFER to: Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
G3: CHECK THE CLOCKSPRING FOR LOW RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect Clockspring C2R115.
	3 Disconnect Air Bag Control Module C3R114-A.
 TIE0030195	4 Measure the resistance between the air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side and the air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** INSTALL a new clockspring. REFER to: Clockspring (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR101 (VT/BN) and circuit RR101 (YE/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST H : DTC B1935: PASSENGER AIR BAG CIRCUIT LOW RESISTANCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
H1: CHECK THE PASSENGER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to H2. → **No** GO to H3.
H2: CHECK THE PASSENGER AIR BAG MODULE SQUIB RESISTANCE	
	1 Connect the Test and Deployment Lead to the passenger air bag module.
	2 Select DMM specific on Ford approved diagnostic tool.
	3 Connect the Test and Deployment Lead to Ford approved diagnostic tool.
 TIE39388	4 Measure the resistance of the passenger air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger air bag module. REFER to: Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
H3: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR LOW RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Air Bag Simulator.

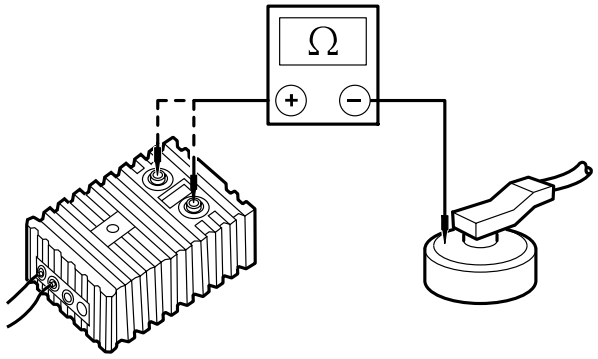
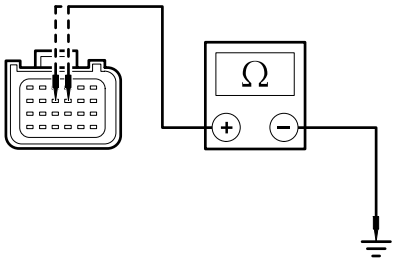
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Disconnect Air Bag Control Module C3R114-A.
 TIE0030196	4 Measure the resistance between the air bag control module C3R114-A pin 7, circuit CR103 (GN/WH), harness side and the air bag control module C3R114-A pin 8, circuit RR103 (BK/WH), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR103 (GN/WH) and circuit RR103 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

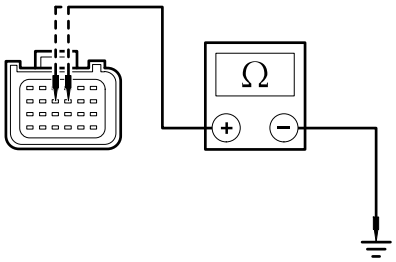
PINPOINT TEST I : DTC B1936: DRIVER AIR BAG CIRCUIT SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
I1: CHECK THE DRIVER AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to I2. → **No** GO to I3.
I2: CHECK THE DRIVER AIR BAG MODULE	
WARNING: Do not proceed with this test unless using Ford approved diagnostic tool. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver air bag module.
	2 Select DMM specific on Ford approved diagnostic tool.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect the Test and Deployment Lead to Ford approved diagnostic tool.
 E39389	4 Measure the resistance between each of the terminals and the driver air bag module casing. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver air bag module. REFER to: Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
I3: CHECK THE DRIVER AIR BAG WIRING HARNESS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Air Bag Control Module C3R114-A.
	3 Disconnect Driver Air Bag Module Simulator.
 TIE0030197	4 Measure the resistance, while turning the steering wheel from lock to lock, between the: • Air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side and ground. • Air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to I4.
I4: CHECK THE CLOCKSPRING FOR A SHORT TO GROUND	
	1 Disconnect Clockspring C2R115.

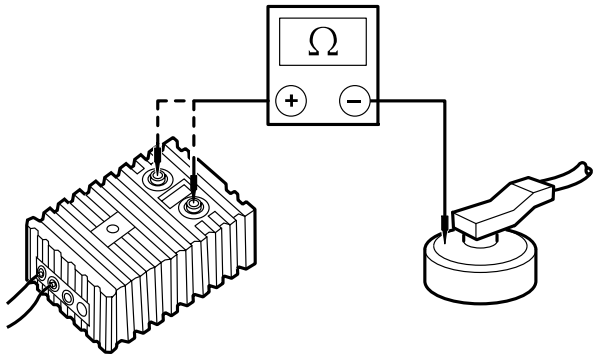
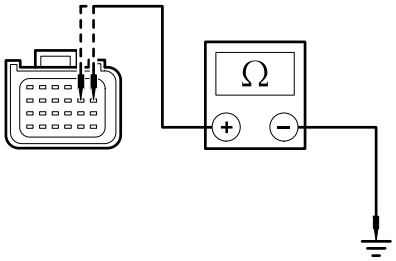
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030197	2 Measure the resistance, while turning the steering wheel from lock to lock, between the: • Air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side and ground. • Air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** INSTALL a new clockspring. REFER to: Clockspring (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR101 (VT/BN) or circuit RR101 (YE/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST J : DTC B1938: PASSENGER AIR BAG CIRCUIT SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
J1: CHECK THE PASSENGER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to J2. → **No** GO to J3.
J2: CHECK THE PASSENGER AIR BAG MODULE	
WARNING: Do not proceed with this test unless using Ford approved diagnostic tool. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger air bag module.

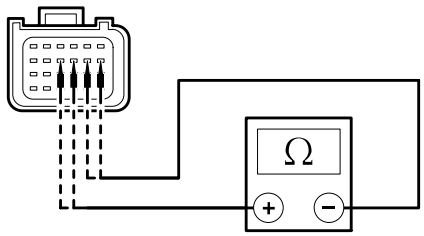
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Select DMM specific on Ford approved diagnostic tool.
	3 Connect the Test and Deployment Lead to Ford approved diagnostic tool.
 E39389	4 Measure the resistance between each of the terminals and the passenger air bag module casing. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger air bag module. REFER to: Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
J3: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Air Bag Control Module C3R114-A.
	3 Disconnect Passenger Air Bag Module Simulator.
 TIE0030198	4 Measure the resistance between the: • Air bag control module C3R114-A pin 7, circuit CR103 (GN/WH), harness side and ground. • Air bag control module C3R114-A pin 8, circuit RR103 (BK/WH), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR103 (GN/WH) or circuit RR103 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST K : DTC B2792: CROSS LINK BETWEEN FIRING CIRCUITS

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s)	

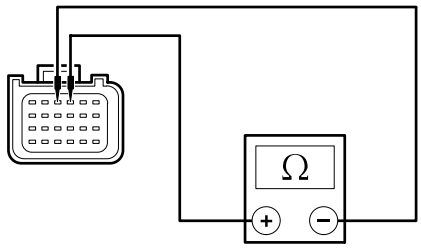
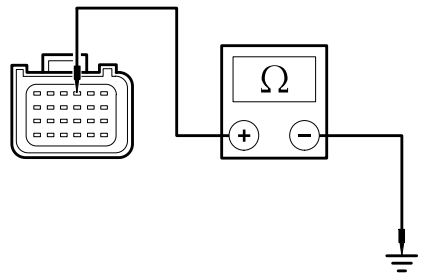
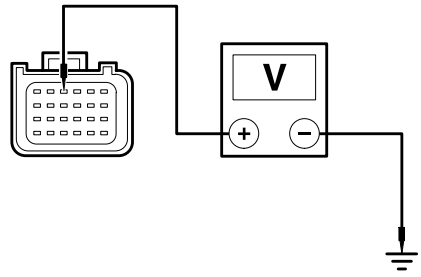
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
NOTE: CHECK for signs of damage or signs of foreign material in the air bag control module connector.	
K1: CHECK THE DRIVER AIR BAG CIRCUIT FOR A CROSS LINK TO THE PASSENGER AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Disconnect Air Bag Control Module C3R114-A.
	3 Disconnect Driver Air Bag Simulator.
	4 Disconnect Passenger Air Bag Simulator.
 E65421	5 Measure the resistance between the: • Air bag control module C3R114-A pin 8, circuit RR103 (BK/WH), harness side and the air bag control module C3R114-A pin 9, circuit RR101 (YE/GN), harness side. • Air bag control module C3R114-A pin 7, circuit CR103 (GN/WH), harness side and the air bag control module C3R114-A pin 10, circuit CR101 (VT/BN), harness side. • Are the resistances greater than 10,000 ohms? → **Yes** VERIFY the customer concern. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR101 (VT/BN) and circuit CR103 (GN/WH) or circuit RR101 (YE/GN) and circuit RR103 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST L : DTC P1796: CAN CONTROLLER CIRCUIT (BUS OFF)

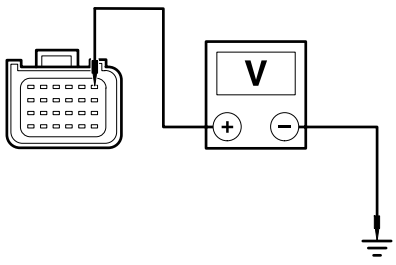
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
L1: CHECK THE CAN CONTROLLER CIRCUIT FOR LOW RESISTANCE	
	1 Deactivate the SRS.

DIAGNOSIS AND TESTING

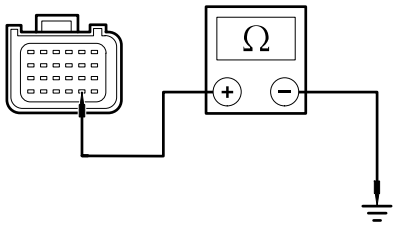
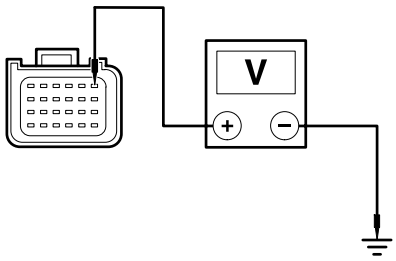
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Air Bag Control Module C3R114-A.
 TIE0020915	3 Measure the resistance between the air bag control module C3R114-A pin 3, circuit VDB06 (GY/OG), harness side and the air bag control module C3R114-A pin 4, circuit VDB07 (VT/OG), harness side. • Is the resistance less than 5 ohms? → **Yes** REPAIR circuit VDB06 (GY/OG) and circuit VDB07 (VT/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to L2.
L2: CHECK THE CAN CONTROLLER CIRCUIT FOR A SHORT TO GROUND	
 E65426	1 Measure the resistance between the air bag control module C3R114-A pin 3, circuit VDB06 (GY/OG), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** REPAIR circuit VDB06 (GY/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to L3.
L3: CHECK THE CAN CONTROLLER CIRCUIT FOR A SHORT TO BATTERY	
	1 Ignition switch in position II.
 E65427	2 Measure the voltage between the air bag control module C3R114-A pin 4, circuit VDB07 (VT/OG), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit VDB07 (VT/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** VERIFY the customer concern. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST M : AIR BAG CONTROL MODULE DISCONNECTED OR INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING: To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the SRS, or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
M1: CHECK THE AIR BAG CONTROL MODULE ELECTRICAL CONNECTORS	
	1 Deactivate the SRS.
	2 Check the air bag control module electrical connectors. • Are the air bag control module electrical connectors fully engaged? → **Yes** GO to M2. → **No** CONNECT the air bag control module electrical connectors. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
M2: CHECK THE IGNITION SUPPLY CIRCUIT FOR AN OPEN CIRCUIT	
	1 Disconnect Air Bag Control Module C3R114-A.
	2 Ignition switch in position II.
 TIE0030178	3 Measure the voltage between the air bag control module C3R114-A pin 1, circuit CBP39 (VT/WH), harness side and ground. • Is the voltage between 9 and 16 volts? → **Yes** GO to M3. → **No** GO to M4.
M3: CHECK THE AIR BAG CONTROL MODULE GROUND CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030179	2 Measure the resistance between the air bag control module C3R114-A pin 20, circuit GD374 (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new air bag control module. REFER to: Air Bag Control Module (501-20 Supplemental Restraint System, Removal and Installation). . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit GD374 (BK/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
M4: CHECK THE IGNITION SUPPLY CIRCUIT	
 TIE0030178	1 Measure the voltage between the air bag control module C3R114-A pin 1, circuit CBP39 (VT/WH), harness side and ground. • Is any voltage present? → **Yes** CHECK the charging circuit. . REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CBP39 (VT/WH). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

GENERAL PROCEDURES

Clockspring Adjustment

General Equipment

Adhesive tape

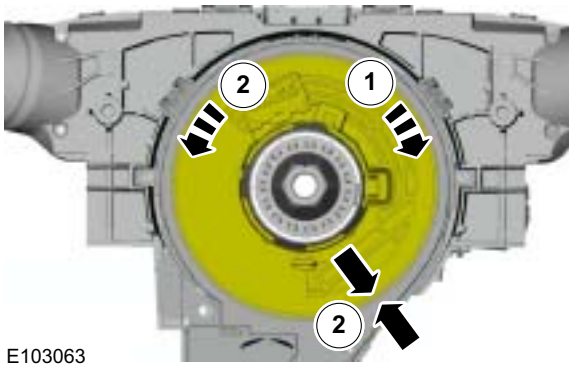
WARNINGS:

If there is a break between installing the clockspring and steering wheel rotation sensor assembly and installing the steering wheel, the centralizing of the clockspring must be repeated.

If the centralization of the clockspring is in doubt, the centralizing of the clockspring must be repeated.

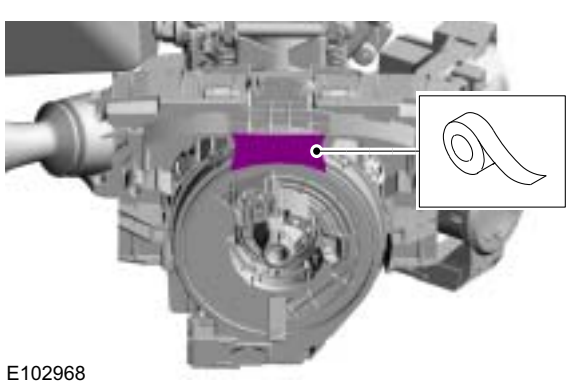
NOTE: Make sure that the road wheels are in the straight ahead position.

1. 1. Turn the clockspring in a clockwise direction until a resistance is felt.
2. Turn the clockspring in a counterclockwise direction 2.5 revolutions, until the arrow marked on the rotor of the clockspring aligns with the raised 'V' section on the outer cover of the clockspring.



2. **CAUTION: Make sure that the clockspring rotor does not rotate.**

General Equipment: Adhesive tape



GENERAL PROCEDURES

Deployed Air Bag Disposal

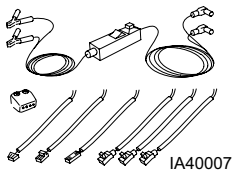
WARNING: After deployment, the air bag module surface may contain deposits of sodium hydroxide, a product of the gas generate combustion, that is irritating to the skin. Use protective gloves when handling any deployed air bag module. Failure to follow this instruction may result in personal injury.

1. **Remove the deployed air bag module(s). For additional information, refer to the relevant procedure in this section.**
2. **Seal the deployed air bag module(s) in the packaging from the new air bag module(s) or a suitable polythene bag, and then dispose of in accordance with local contaminated waste regulations.**

GENERAL PROCEDURES

Scrapped Vehicle Undeployed Air Bag Disposal

Special Tool(s)

 IA40007	Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt 418-S055 (40-007A)

General Equipment

12 volt battery

All vehicles

WARNINGS:

To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded. Failure to follow this instruction may result in personal injury.

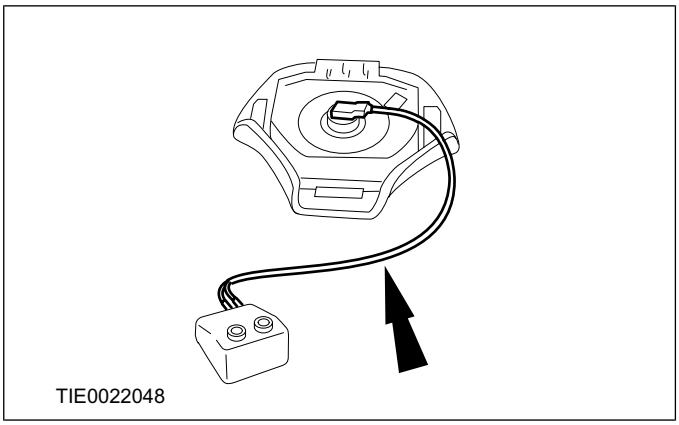
1. **Disconnect the battery ground cable.**

   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. **Remove the air bag module(s) to be deployed. For additional information, refer to the relevant procedure(s) in this section.**

Single stage air bag modules

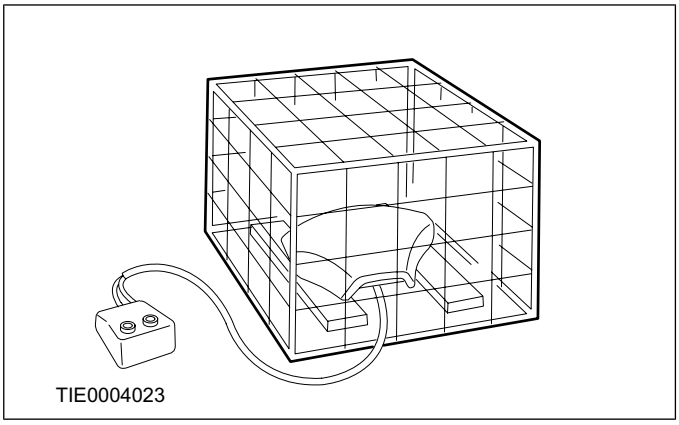
3. **Connect the test lead to the air bag module and the adapter (driver air bag module shown).**



All air bag modules

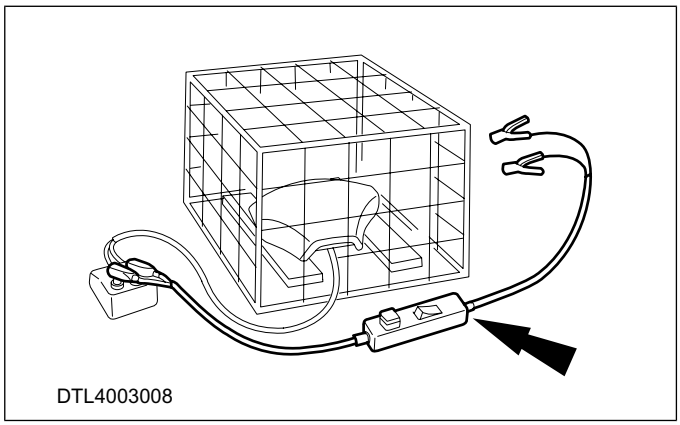
4. **CAUTION: To protect the test lead electrical connector(s) from damage during deployment, raise the air bag module off the ground on two wooden blocks.**

   Place the air bag module inside a suitable rigid wire cage with the air bag module cover uppermost.

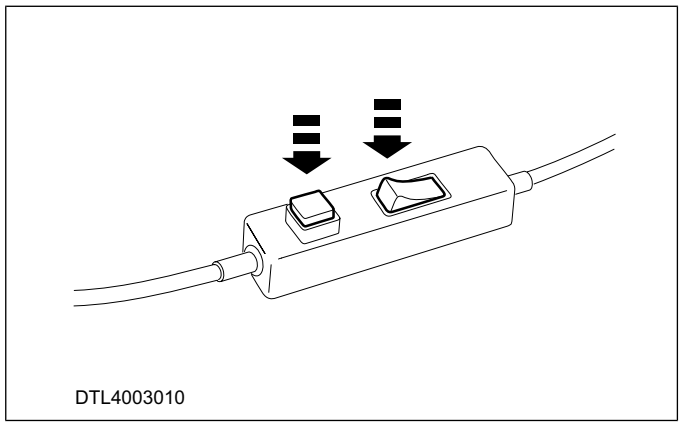


GENERAL PROCEDURES

5. **Connect the deployment lead to the adapter.**

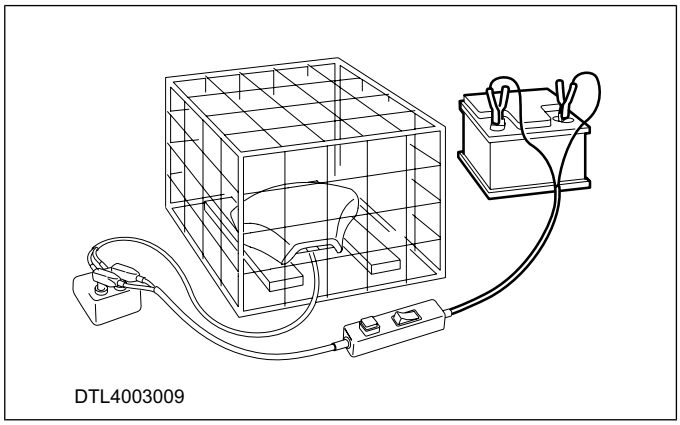

DTL4003008

Depress both switches to deploy the air bag.


DTL4003010

6. **WARNING: Before proceeding make sure that all personnel in the vicinity are aware that a loud noise (bang) is about to occur. Do not let anybody approach closer than six meters. Failure to follow this instruction may result in personal injury.**

   Move as far away as possible from the air bag module and connect the deployment lead to the battery.


DTL4003009

7. **CAUTIONS:**

   The air bag module should not be handled immediately following deployment as the air bag module will be very hot.

   After deployment, the air bag module surface may contain deposits of sodium hydroxide, a product of the gas generate combustion, that is irritating to the skin. Use protective gloves when handling any deployed air bag module.

All air bag modules

8. **Deployed air bag module(s) should be sealed in a suitable bag and then disposed of in accordance with local contaminated waste regulations.**

GENERAL PROCEDURES

Unserviceable Air Bag Disposal

1. **WARNINGS:**

   To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

   To prevent premature deployment, live air bag modules must only be placed on work benches which have been ground bonded. Failure to follow this instruction may result in personal injury.

   NOTE: All unserviceable air bag modules have been placed on the Mandatory Return List. All discolored or damaged air bag modules should be treated the same as any unserviceable live air bag module being returned.

   Remove the unserviceable air bag module. For additional information, refer to the relevant procedure in this section.

2. **WARNING: Under no circumstances is an unserviceable air bag module(s) to be returned through the local mailing system. Failure to follow this instruction may result in personal injury.**

   Seal the unserviceable air bag module(s) in the packaging from the new air bag module(s) and address to the appropriate manufacturer. The package should then be forwarded to the Exchange Plan Center (as appointed through the national sales company) who will arrange forwarding to the manufacturer.

3. **NOTE: Autoliv air bag modules and seat belt pretensioners.**

   Autoliv Gmbh, Theodor Heuss Strasse 2, 85221, Dachau, Germany.

4. **NOTE: TRW air bag modules.**

   TRW Occupant Restraint Systems, FAO Rene Getto, Industriestr 20, 73551, Aldorf, Germany.

5. **NOTE: TRW seat belt pretensioners.**

   TRW Occupant Restraint Systems, FAO Helmut Goss, Industriestr 20, 73551, Aldorf, Germany.

6. **NOTE: Takata Petri air bag modules.**

   Takata Petri AG, Grossostheimer Strasse 223, D-63741 Aschaffenburg, (Supplier Code P790M) Germany.

REMOVAL AND INSTALLATION

Air Bag Control Module(33 650 0)

General Equipment

Ford Approved Diagnostic Tool

Removal

WARNINGS:

To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS), or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

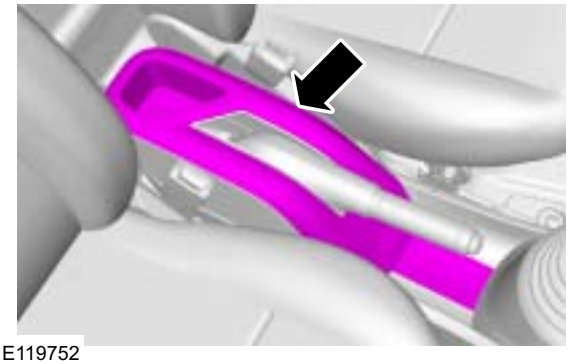
To minimize the possibility of premature deployment, do not use radio key code savers when working on the supplemental restraint system. Failure to follow this instruction may result in personal injury.

Never probe the electrical connectors of air bag modules or any other supplemental restraint system component. Failure to follow this instruction may result in personal injury.

1. **Disconnect the battery ground cable.**

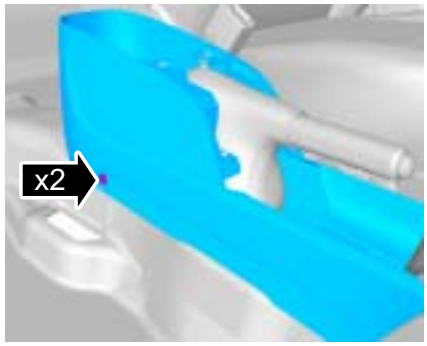
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. **Raise the parking brake control lever.**
3. **Remove the parking brake control lever trim panel.**



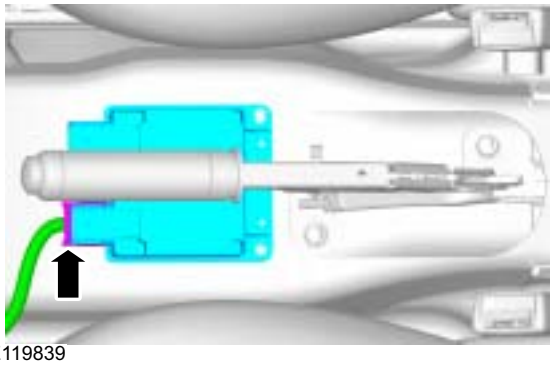
E119752

4. **Detach the console panel by removing the screws on both sides.**



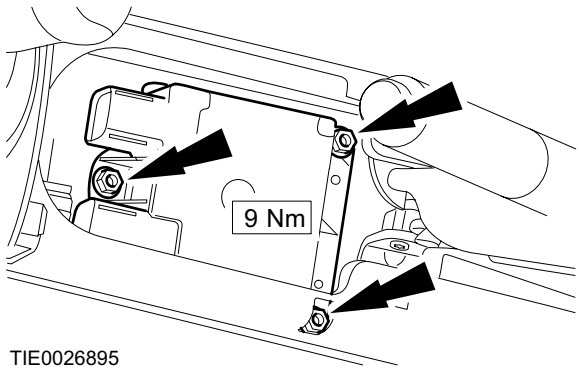
E119753

5. **Disconnect the air bag control module electrical connectors.**



E119839

6. **Remove the air bag control module.**



TIE0026895

Installation

WARNING: Never probe the electrical connectors of air bag modules or any other supplemental restraint system component.

REMOVAL AND INSTALLATION

Failure to follow this instruction may result in personal injury.

1. **To install, reverse the removal procedure.**
2. **WARNING: New air bag control modules must be configured following installation. Failure to follow this instruction may result in personal injury.**

   If installing a new air bag control module, configure the air bag control module using Ford Approved Diagnostic Tool.

REMOVAL AND INSTALLATION

Clockspring

General Equipment

Ford Approved Diagnostic Tool

Removal

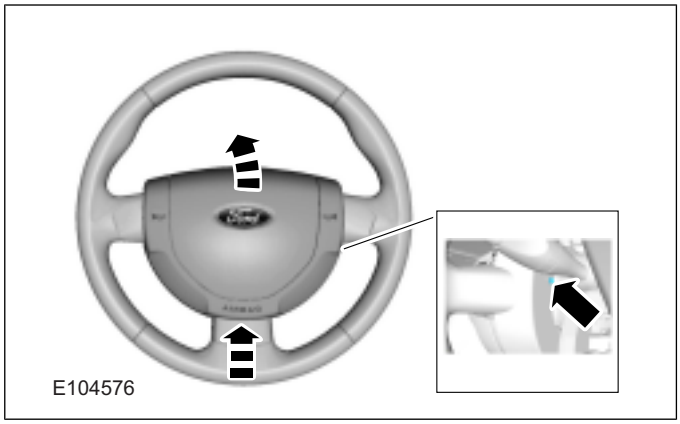
WARNINGS:

To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS). Failure to follow these instructions may result in personal injury.

To minimize the possibility of premature deployment, do not use radio key code savers when working on the supplemental restraint system. Failure to follow this instruction may result in personal injury.

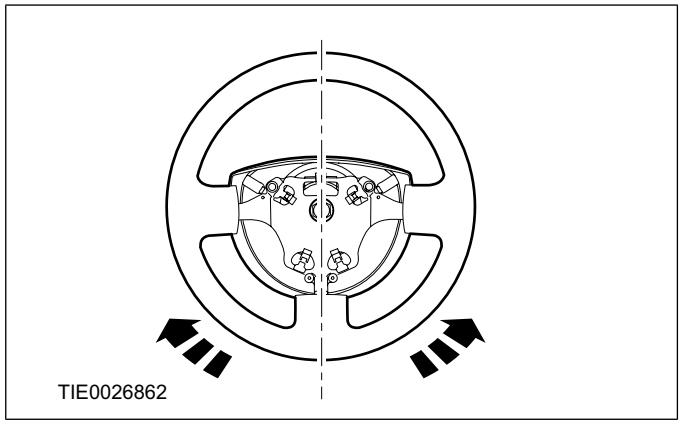
Never probe the electrical connectors of air bag modules or any other supplemental restraint system component. Failure to follow this instruction may result in personal injury.

1. **Detach the driver air bag module from the steering wheel.**
   1. Pull the top of the air bag module away from the steering wheel.
   2. Push the air bag module upwards to detach the lower retaining clips.

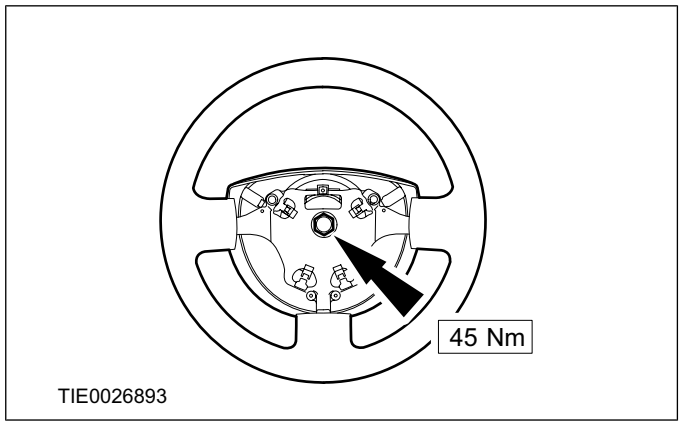


2. **NOTE: Make sure that the road wheels are in the straight ahead position.**

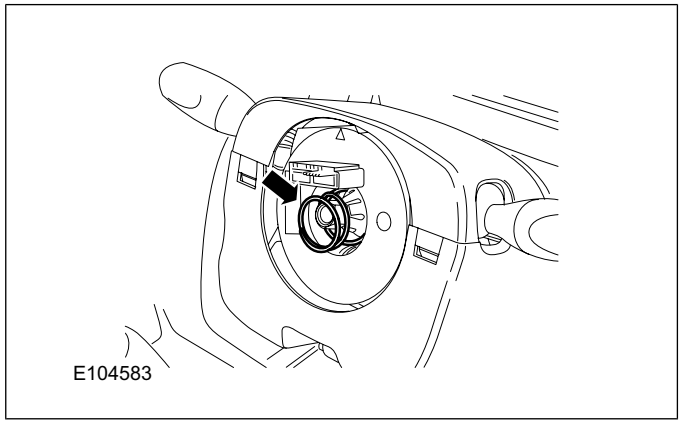
Centralize the steering and lock it in position.



3. **Remove the steering wheel.**



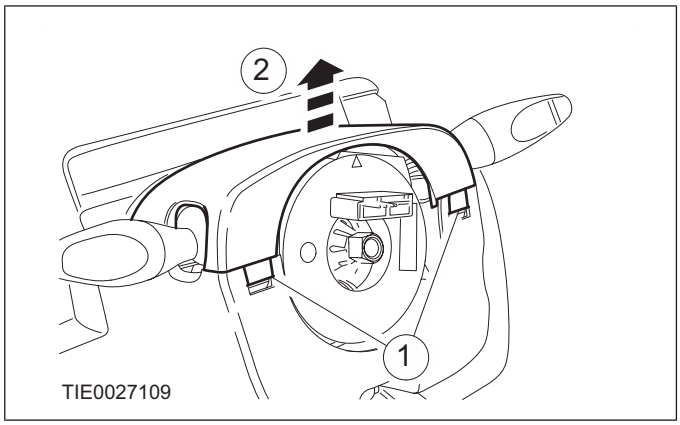
4. **Remove the spring.**



5. **Detach the steering column upper shroud from the lower shroud.**
   1. Using a thin bladed screwdriver, release the two clips (one each side).

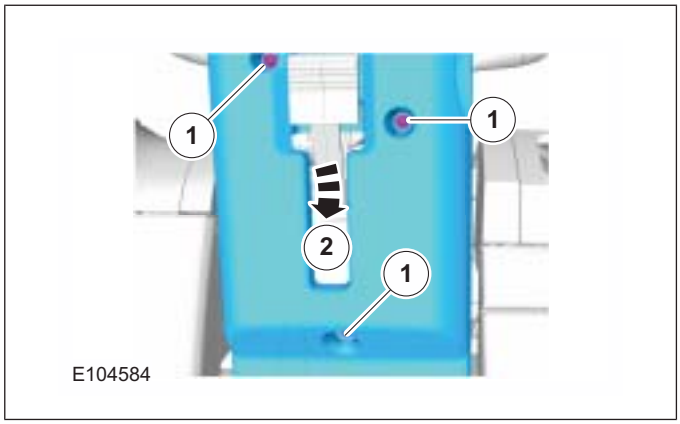
REMOVAL AND INSTALLATION

2. Detach the shroud.



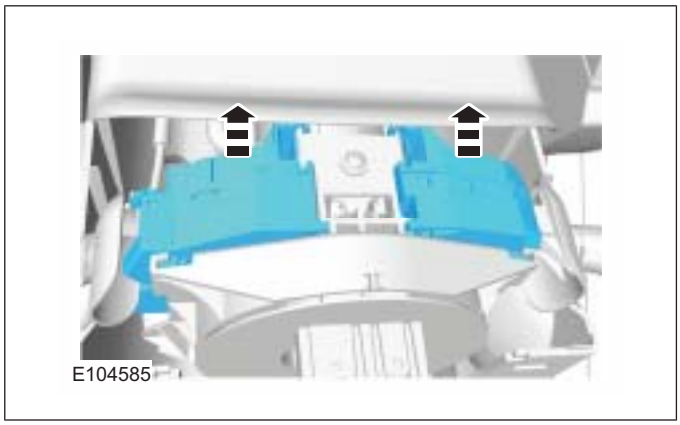
6. Remove the steering column lower shroud.

1. Remove the retaining screws.
2. Release the steering column locking lever (If equipped).

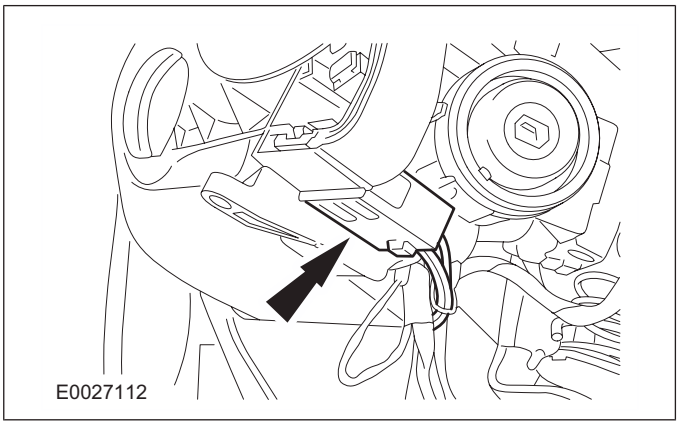


7. Detach the multifunction switches from the clockspring and position them to one side.

- Depress each locking tang in turn and slide each switch upwards.



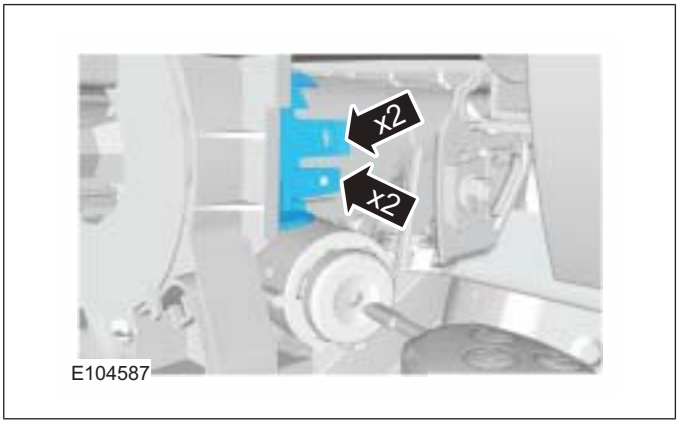
8. Disconnect the clockspring electrical connector.



9. Remove the clockspring retaining screw.

10. Remove the clockspring.

- Release the locking tangs from the steering column.



Installation

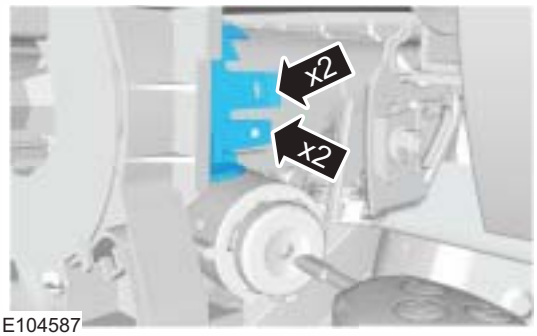
All vehicles

WARNING: Never probe the electrical connectors of air bag modules or any other supplemental restraint system component.

REMOVAL AND INSTALLATION

Failure to follow this instruction may result in personal injury.

1. **Install the clockspring.**
   - Make sure the retaining tangs lock into position on the steering column.

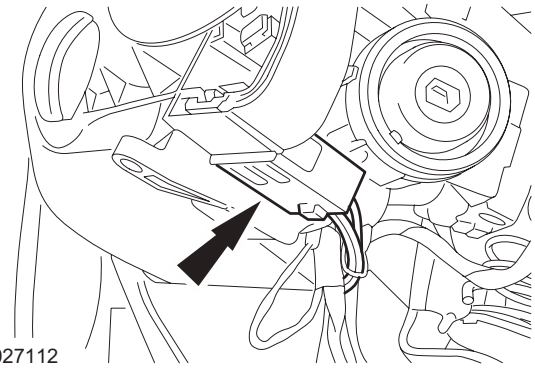


E104587

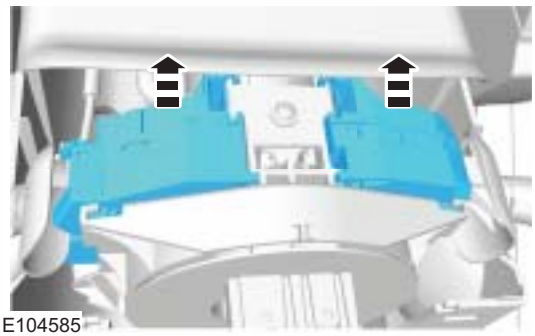
2. **Install the clockspring retaining screw.**


E104586

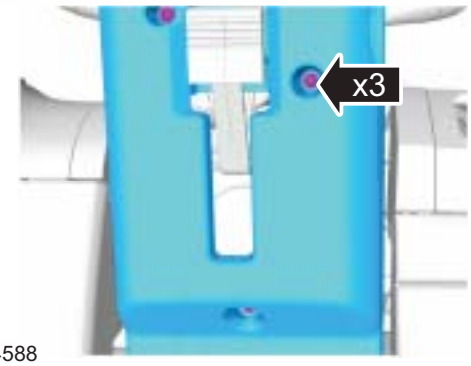
3. **Connect the clockspring electrical connector.**


E0027112

4. **Attach the multifunction switches to the clockspring.**

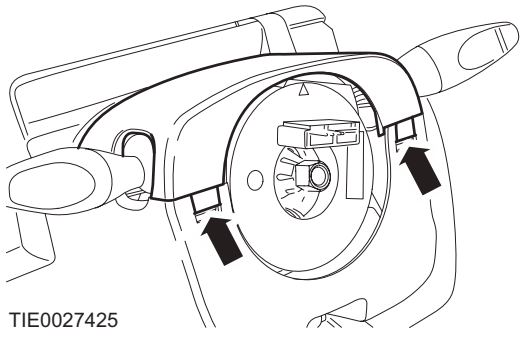

E104585

5. **Install the steering column lower shroud.**
   - Lock the steering column locking lever (If equipped).



E104588

6. **Attach the steering column upper shroud to the lower shroud.**


TIE0027425

All vehicles

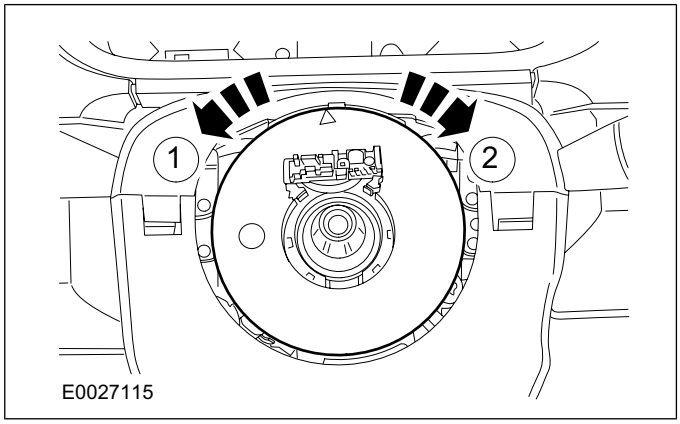
7. **WARNING: Incorrect centralization may result in premature component failure. If in doubt when centralizing the clockspring, repeat the centralizing procedure. Failure to**

REMOVAL AND INSTALLATION

follow this instruction may result in personal injury.

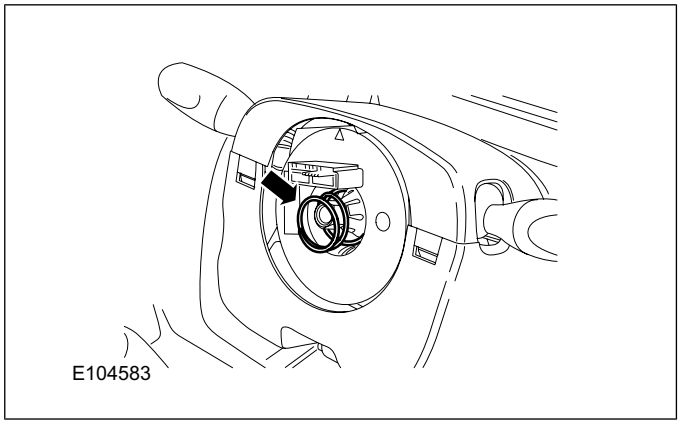
Centralize the clockspring.

1. Turn the clockspring in a counterclockwise direction until resistance is felt (approximately two and one half turns).
2. Turn the clockspring in a clockwise direction, until the arrow marked on the rotor of the clockspring aligns with the raised 'V' section at the 12 o'clock position on the outer cover of the clockspring (approximately two and one half turns).



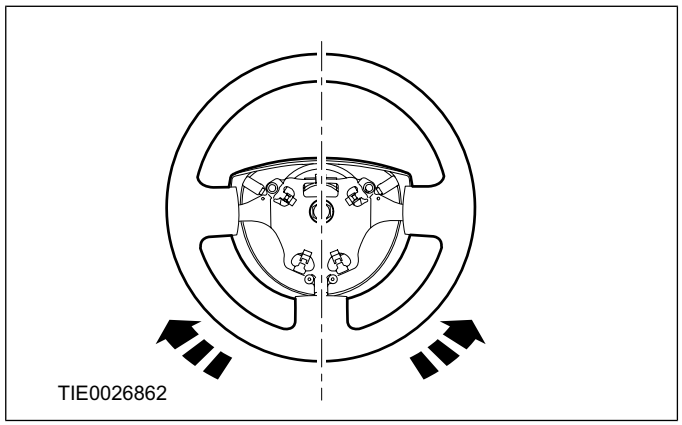
All vehicles

8. Install the spring.



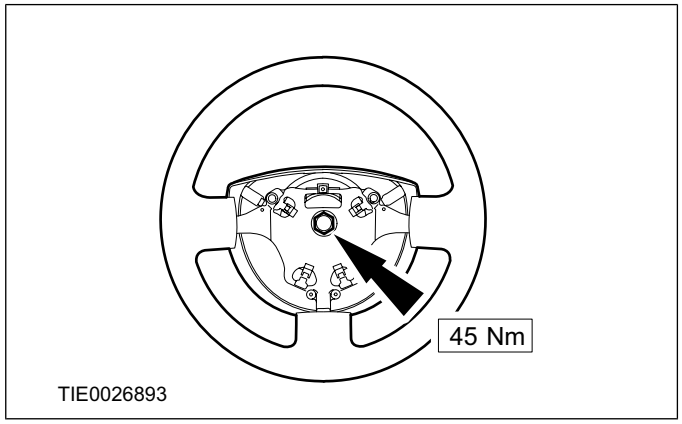
9. NOTE: Make sure that the road wheels are in the straight ahead position.

Centralize the steering and lock it in position.



10. CAUTION: If there is any break between centralizing the clockspring and installing the steering wheel, or the vehicle is left unattended by the technician, the centralizing procedure MUST be repeated.

Install the steering wheel nut.



11. Attach the driver air bag module to the steering wheel.

REMOVAL AND INSTALLATION

Driver Air Bag Module(40 700 0)

Removal

WARNINGS:

To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS), or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, do not use radio key code savers when working on the supplemental restraint system. Failure to follow this instruction may result in personal injury.

To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded and with the trim cover facing up. Failure to follow these instructions may result in personal injury.

Never probe the electrical connectors of air bag modules or any other supplemental restraint system component. Failure to follow this instruction may result in personal injury.

Painting over the driver air bag module trim cover or instrument panel could lead to deterioration of the trim cover and air bag modules. Do not for any reason attempt to paint discolored or damaged air bag module trim covers or instrument panel. Install a new component. Failure to follow this instruction may result in personal injury.

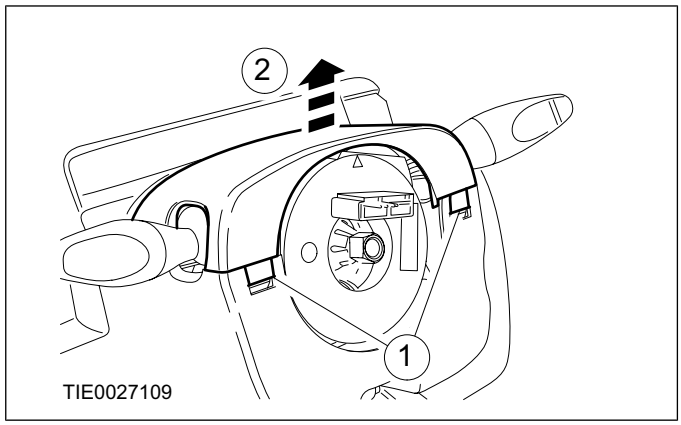
1. **Disconnect the battery ground cable.**

   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. **NOTE: Turn the steering wheel to access the steering column upper shroud retaining clips.**

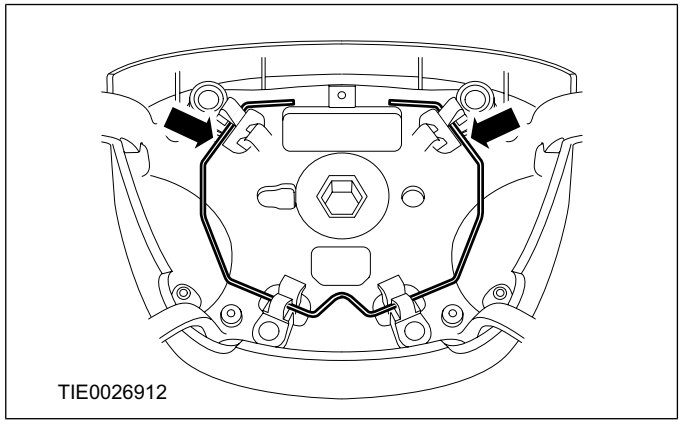
   Detach the steering column upper shroud from the steering column lower shroud (steering wheel removed for clarity).

   1. Using a thin bladed screwdriver, release the two clips (one each side).
   2. Detach the shroud.



3. **NOTE: Turn the steering wheel to access the air bag module retaining clips.**

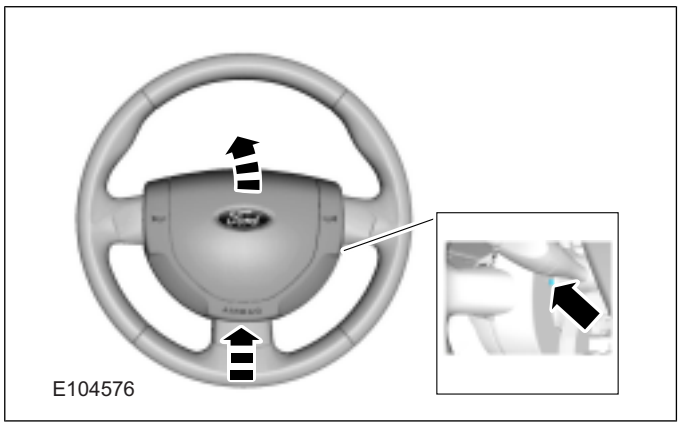
   Using a thin bladed screwdriver, detach the driver air bag module upper clips from the steering wheel (driver air bag module removed for clarity).



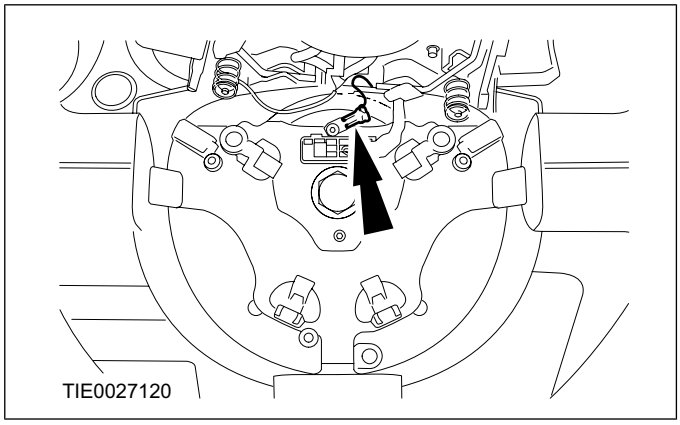
4. **Detach the driver air bag module from the steering wheel.**

REMOVAL AND INSTALLATION

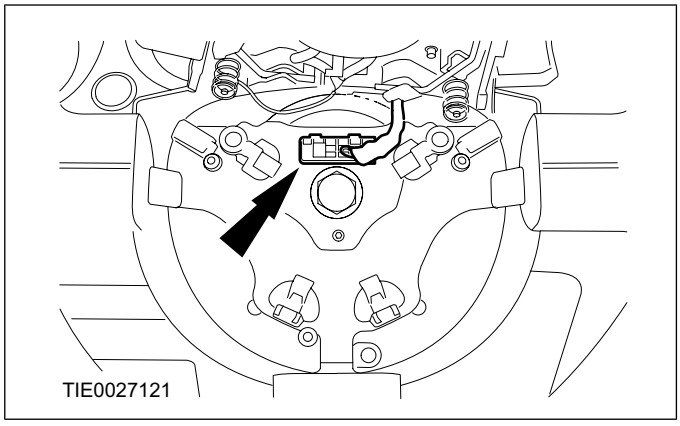
1. Pull the top of the air bag module away from the steering wheel.
2. Push the air bag module upwards to detach the lower retaining clips.



5. **Disconnect the driver air bag module ground connector.**



6. **Remove the driver air bag module.**
   - Disconnect the driver air bag module electrical connector.



Installation

WARNINGS:

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, do not use radio key code savers when working on the supplemental restraint system. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded and with the trim cover facing up. Failure to follow these instructions may result in personal injury.

Never probe the electrical connectors of air bag modules or any other supplemental restraint system component. Failure to follow this instruction may result in personal injury.

Painting over the driver air bag module trim cover or instrument panel could lead to deterioration of the trim cover and air bag modules. Do not for any reason attempt to paint discolored or damaged air bag module trim covers or instrument panel. Install a new component. Failure to follow this instruction may result in personal injury.

CAUTION: Make sure that the driver air bag module retaining clips are correctly engaged and the trim cover is flush with the steering wheel.

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Driver Air Bag Module Wiring Harness

Removal

All vehicles

WARNINGS:

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the air bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded and with the trim cover facing up. Failure to follow these instructions may result in personal injury.

Never probe the electrical connectors of air bag modules or any other supplemental restraint system (SRS) component. Failure to follow this instruction may result in personal injury.

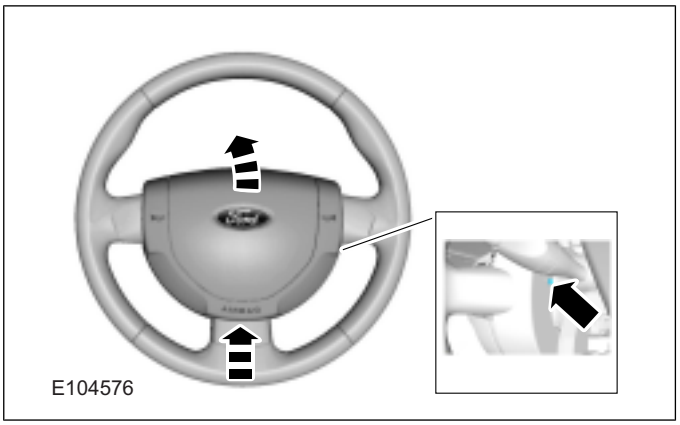
To minimize the possibility of injury in the event of premature deployment, do not work on the air bag module with the trim cover facing downwards. Support the air bag module vertically and work to the side of the air bag module. Failure to follow these instructions may result in personal injury.

CAUTIONS:

Note the position and routing of the driver air bag module wiring harness to aid assembly. An incorrectly routed driver air bag module wiring harness may become damaged when the steering wheel is rotated.

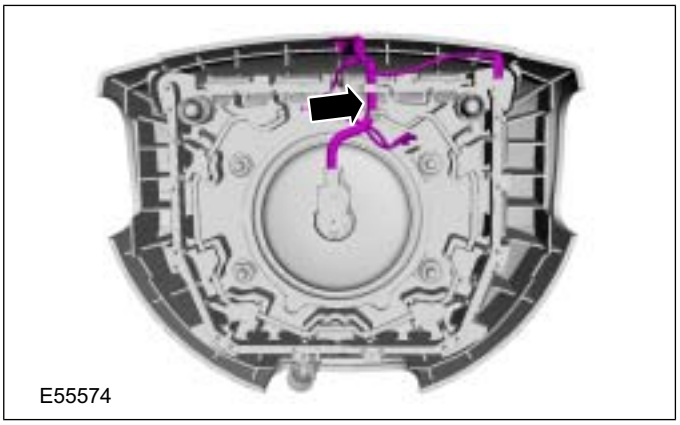
This procedure must only be used if referred to from the Diagnosis and Testing procedure in this section. Under no other circumstance must the driver air bag module wiring harness be disconnected from the air bag module.

1. **Detach the driver air bag module from the steering wheel.**
   1. Pull the top of the air bag module away from the steering wheel.
   2. Push the air bag module upwards to detach the lower retaining clips.



Single stage air bag modules

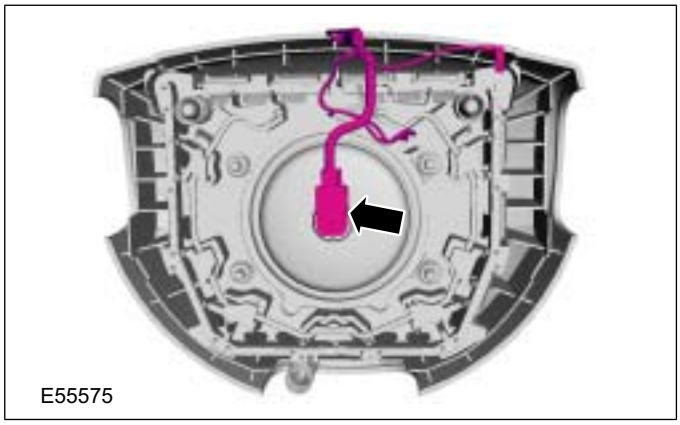
2. **Detach the driver air bag module wiring harness from the driver air bag module.**



3. **Remove the driver air bag module wiring harness.**

REMOVAL AND INSTALLATION

- Release the driver air bag module wiring harness locking tangs.



Installation

WARNINGS:

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded and with the trim cover facing up. Failure to follow these instructions may result in personal injury.

Never probe the electrical connectors of air bag modules or any other SRS component. Failure to follow this instruction may result in personal injury.

1. **CAUTIONS:**

   Make sure that the driver air bag module electrical connectors are free from any wiring harness connector fragments.

   Make sure that the driver air bag module wiring harness is correctly routed and is secure under the locating clips. An incorrectly routed driver air bag module wiring harness may become damaged when the steering wheel is rotated.

   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Passenger Air Bag Module(40 701 0)

Removal

All vehicles

WARNINGS:

To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS), or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, do not use radio key code savers when working on the supplemental restraint system. Failure to follow this instruction may result in personal injury.

To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded and with the trim cover facing up. Failure to follow these instructions may result in personal injury.

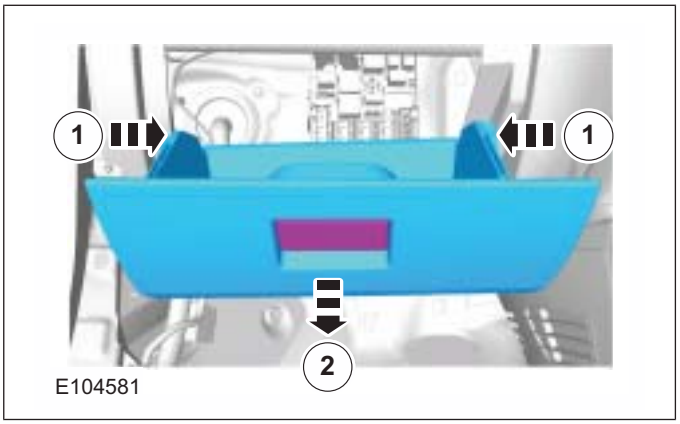
Never probe the electrical connectors of air bag modules or any other supplemental restraint system component. Failure to follow this instruction may result in personal injury.

Painting over the air bag module trim covers or instrument panel could lead to deterioration of the trim cover and air bags. Do not for any reason attempt to paint discolored or damaged air bag module trim covers or instrument panel. Install a new component. Failure to follow this instruction may result in personal injury.

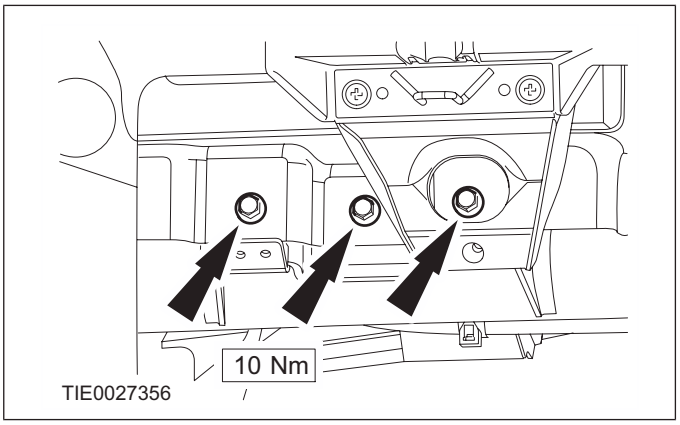
1. **Disconnect the battery ground cable.**

   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. **Remove the glove box.**
   1. Push glove box sides inwards.
   2. Tilt the glove box forward.
   3. Pull the glove box away from the instrument panel.



3. **Detach the passenger air bag module bracket from the in-vehicle crossbeam.**

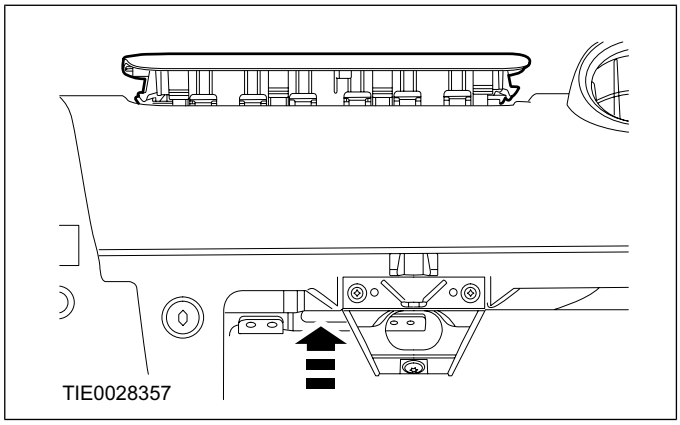


4. **NOTE: If necessary, use a trim pad removal tool to aid the release of the passenger air bag module cover retaining clips from the instrument panel.**

   Detach the passenger air bag module from the instrument panel.

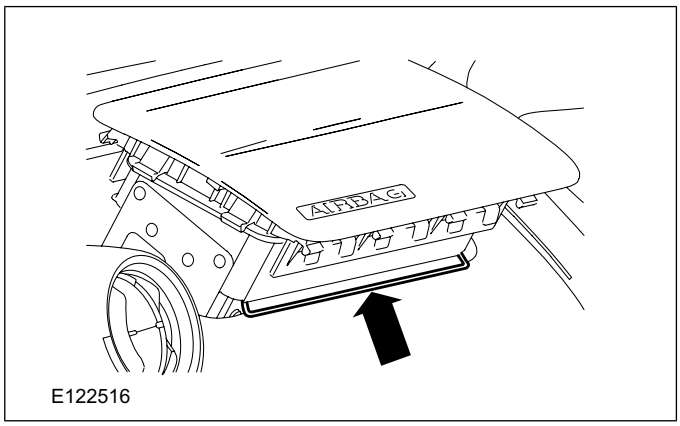
REMOVAL AND INSTALLATION

- Push the air bag module upwards to detach the air bag cover from the instrument panel.



5. **CAUTION: To prevent damage to the instrument panel, use the plastic edge on the air bag module wiring harness shield to support the passenger air bag module on the instrument panel.**

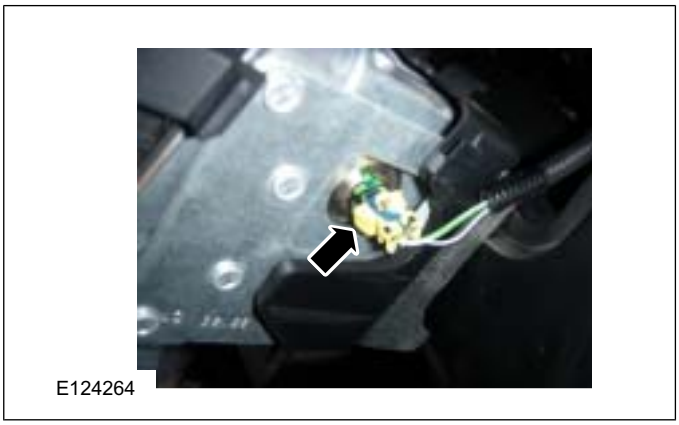
   Support the passenger air bag module.



Vehicles with passenger air bag

6. **CAUTION: To prevent damage to the passenger air bag module electrical connectors, use a pair of circlip pliers to release the passenger air bag module electrical connector locking tangs.**

Disconnect the passenger air bag module electrical connector.



Installation

WARNINGS:

- **Make sure the air bag module electrical connectors are correctly installed and are secure. Failure to follow these instructions may result in personal injury.**
- **Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.**
- **To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.**
- **To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded and with the trim cover facing up. Failure to follow these instructions may result in personal injury.**
- **Never probe the electrical connectors of air bag modules or any other supplemental restraint system component. Failure to follow this instruction may result in personal injury.**
- **Painting over the air bag module trim covers or instrument panel could lead to deterioration of the air bag module trim cover and air bags. Do not for any reason attempt to paint discolored or damaged air bag module trim covers or instrument panel. Install a new component. Failure to**

REMOVAL AND INSTALLATION

follow this instruction may result in personal injury.

CAUTION: Make sure that all the passenger air bag module trim cover retaining clips are correctly engaged and the passenger air bag module trim cover is flush with the instrument panel.

1. **To install, reverse the removal procedure.**

SECTION 501-25A Body Repairs - General Information

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Description	Finis Code	Specification
Underbody protection	5 030 492	-
Anti-corrosion wax	1 219 834	WSK-M7C89-A
Cavity wax	5 030 081	-
Profiled butyl seal	1 128 983	S-M3G4620-A
Weld primer	1 205 996	-
Clinched flange protection	1 136 479	WSK-M4G245-B
Seam sealing compound	1 205 817	WSS-M4G364-A
Body sealing compound	1 143 255	-
Windshield sealant	1 613 838	WSK-M4G329-A
Adhesive spoiler set	1 219 837	-
Metal adhesive kit	1 203 241	-

DESCRIPTION AND OPERATION

Description and Usage of Body Repair Literature

The purpose of development and existance of this document is to inform the Ford India Dealerships Body shops of the latest technology and also the materials and repair techniques currently used in body making. It provides information on bodyshop equipment and tools and on the most fundamental body repair methods.

In addition, ongoing information will be provided in the Technical Service Bulletins.

Ford approved body and collision repair equipment suppliers in India equipped with state of the art training facility including best in class workshop facility to demonstrate and provide On the job practical assistance.

The general section is divided into the following chapters:

- **Specification** lists technical information about the various materials used in current body applications.
- The chapter **Description and Operation** provides information on the fundamentals of vehicle body construction and materials. In addition you will also find there notes about tools, materials as well about fundamental body repair methods.

DESCRIPTION AND OPERATION

Symbols

Warnings and hazard notices

Warnings and hazard notices are shown in this literature by WARNING, CAUTION and NOTE indicators. These notices are always shown before a job step which can be associated with an immediate personal or material danger.

WARNING: This notice is used when failure to exactly follow the instructions given in this literature or failure to follow them at all may result in a hazard to persons and/or in persons being injured.

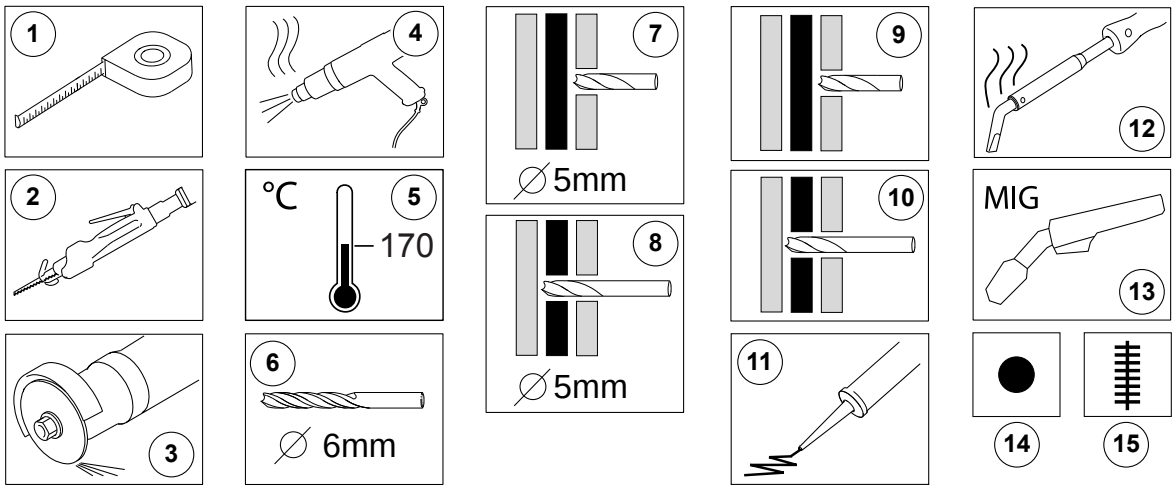
CAUTION: This notice is used when failure to exactly follow the instructions or test procedures given in this literature or failure to follow them at all may result in damage to the vehicle or to components.

NOTE: This notice is used when the operator should be made aware of special or extra information.

Symbols used

Symbols are used to graphically represent additional information about the operation, tool or materials. This information will not be shown separately again in the text.

The symbols used in this and other body repair manuals may be used alone as well as in combination in a diagram.



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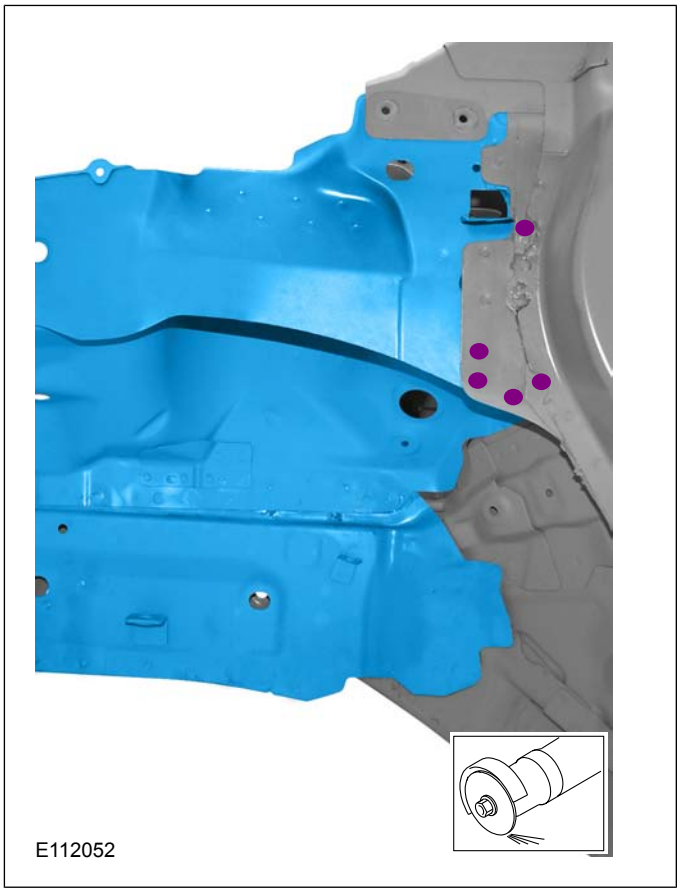
Description	Description
1	Measuring tape
2	Saw
3	Abrasive cutter
4	hot air blower
5	Temperature specification (170°C in this example)
6	Drill with 6mm diameter
7	Drill through one panel thickness with a 5 mm dia. drill

Description	Description
8	Drill through two panel thicknesses with a 5 mm dia. drill
9	Drill through one panel thickness
10	Drill through two panel thicknesses
11	Apply substance
12	Soldering iron
13	Metal-Inert Gas (MIG) weld
14	Resistance Spot Weld
15	Welded seam (full or intermittent seam)

DESCRIPTION AND OPERATION

Color coding

Different colors or shading can be used to depict special areas and components.



E112052

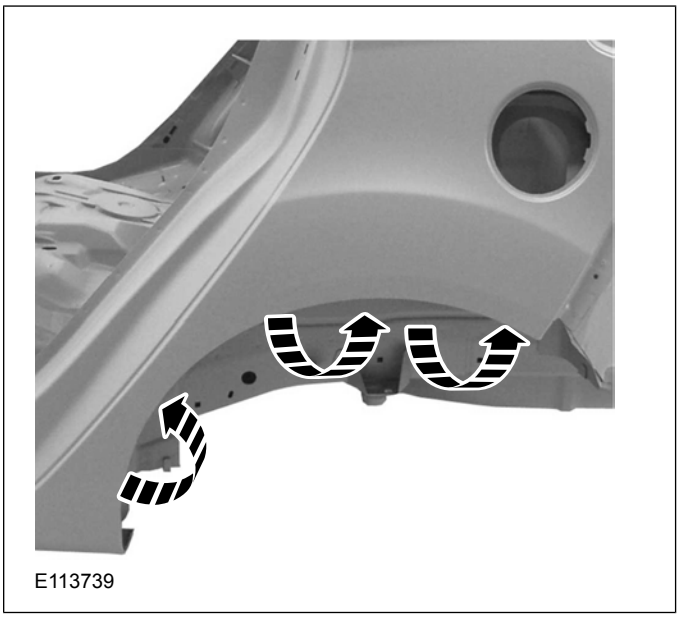
- Blue: Main component which will be removed or installed. Only actual movements will be shown in blue in the diagram.
- Magenta: Materials or fixings, e.g. spot welds or adhesives.

In an assembly operation, the colors show the sequence of removal steps.

- Green: First component or the first partial replacement section.
- Blue: Second component or the second partial replacement section.
- Brown: Third component or the third partial replacement section.

Movement arrows

Necessary work such as clinching flanges or moving lugs etc. will be represented by broken arrows.



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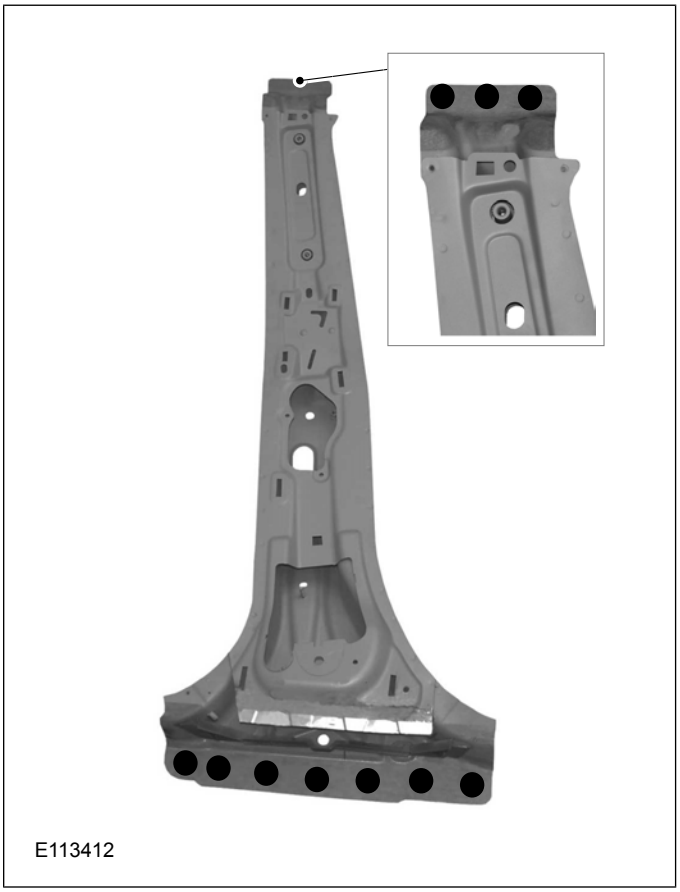
Magnified and detailed views

If a detail cannot be clearly seen in the illustration because of its size or location, it is shown enlarged in a separate window.



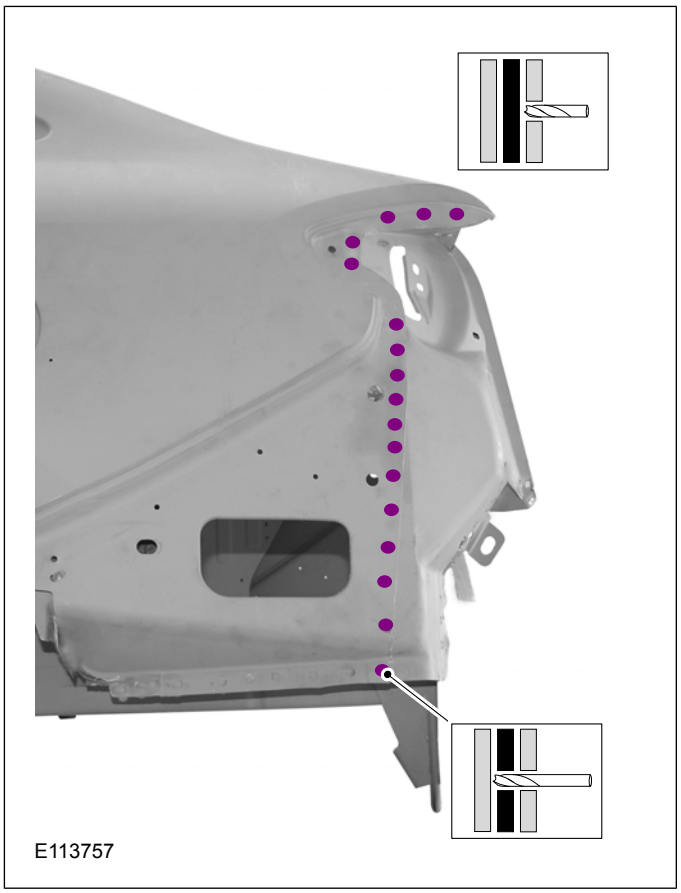
E113412

Position lines within a diagram

A position line is used to indicate a special position or a component. A spot weld which must be drilled

DESCRIPTION AND OPERATION

out through two panel thicknesses is indicated here, different to all the others.



DESCRIPTION AND OPERATION

Health and Safety Precautions

General

Appropriate repair methods and carrying out repairs correctly are particularly important for the operating safety of vehicles and for the safety of people.

WARNING: There is danger of injury through:

- High voltage when electrical welding.
  - Do not perform welding work in a damp environment or on a wet substrate. Use suitable insulation underneath.
- Flammable substances in the welding area.
  - Remove flammable substances from the danger area. Remove the fuel tank and components which supply fuel. When welding in the battery area, the battery must be completely removed.
- Welding fumes, which are harmful to health.
  - Ventilate the workplace well and use the welding fumes extraction system.
- Welding spatter and UV radiation.
  - Wear protective clothing, gloves and welding mask or welding goggles.
- Pyrotechnic components.
  - Disconnect the battery negative clamp and cover the battery terminal. Remove any airbag components.

All the regulations governing Health and Safety at Work must be complied with during body repairs.

Measures to prevent accidents

Outline

Almost all paints and thinners used in vehicle repair are combustible or highly inflammable. As there is a high danger of fire or explosion, care in handling and storage is necessary. Because paints and thinners include organic solvents, there is a danger of poisoning if they are used in poorly ventilated areas or use them for longer than the specified time.

Furthermore, even if a worker is familiar with using the equipment, he/she should always operate it carefully and correctly. if not, a serious accident may result.

To prevent fire and poisoning, understand the explosive, combustible, and toxic characteristics of the paints and thinners in use. It is also necessary to understand the features and construction of the equipment to carry out safe operation.

Equipment and Safety Measures

Usually many painting related tools and devices,explosive, combustible, and toxic substances exist in the painting booth. Always keep the equipment in good working order and correctly handle and store the paint and thinner.

Ventilating Equipment

In order to prevent poisoning by organic solvents (inhalation of toxic gas), the most important element is good ventilation. it is desirable to design the painting booth with high ventilation flow or to install high performance ventilation equipment.

Drying Equipment

Always pay attention to the following items:

- Appoint a responsible overseer for the painting and drying equipment.
- Master safe operation of equipment and check it more often than yearly.
- Do not use direct heating hot air type in the booth.
- Position the power switch of the infrared heater outside the painting booth.
- Take measures to prevent electrostatic buildup and connect a ground cable to the equipment. Regularly sprinkle the booth with water.
- Before baking vehicle paint, remove gasoline from the gasoline tank.

Electrical Equipment

Explosion-proof construction is desirable for the electrical equipment as it is installed in a highly inflammable environment. Pre-check them for no sparks or leakage. install the equipment’s lamps and switches outside the painting booth. Connect a ground cable, and take the necessary steps to prevent static electricity buildup.

Fire Extinguishing Equipment

Liquid fuels and thinners have high inflammability and present a fire risk. As their inflammability is more dangerous than other types of fire, the worker should fully understand the methods of fire extinguishment. If a fire breaks out, using the

appropriate type of fire extinguisher during the initial stages is important in reducing damage.

Important notice:

When you find a fire, do not panic. judge from the look of the fire and take appropriate measures.

When you fight a fire, extinguish fire from the windward side considering wind speed and direction.

Understand the circumstances of the fire, then start extinguishing it.

Consider preventing the spread of the fire if there are some inflammable materials nearby.

Establishment of Safety Regulations

Even if a worker has sufficient knowledge and skills, it is difficult to work safely if sufficient safety regulations are not in place. It is very important to establish work standards and safety rules and to post them in a prominent place. All workers should observe these rules.

Preparation of Handling Manuals

An accident happens easily when a worker gets too familiar with the painting procedure and he/she cuts corners or becomes inattentive to the painting work. Prepare handling standards and manuals for all painting steps and for all equipment. For safe operation, all workers must always check the painting procedure.

Proper Arrangement

The first step in safe painting and fire prevention is the proper arrangement of the equipment in the painting booth.

- Do not leave things in people's way. Always keep the tools, paints, and thinners in their own place.
- Clean the painting booth every day and remove combustibles and hazards from the booth.
- Always clean-up and do not leave things to block the emergency exit, the fire extinguisher, electric switches, etc.
- If paint or thinner spills on the floor or a shelf, immediately wipe it up. Dispose of the saturated cloth in a safety hazardous materials container.
- Unnecessary waste paints, solvents, used cloth, paper, etc. must be disposed of immediately.
- Securely cap any used empty containers and containers with residual paint or thinner remaining. Store them in a cool dark place.

Solvents Handling

Solvent Toxicosis

Typically solvent toxicosis is caused by breathing its vapour or direct skin contact. Toxicosis consists of two forms: acute poisoning which occurs in a comparably high solvent concentration environment, and chronic poisoning which occurs at low vapor concentration. Urethane paint has increasing market demand, however it is said that isocyanate, a component of the urethane paint hardening agent, has toxic effects.

The organic solvents have the capacity to decompose fat. If the skin is often in contact with organic solvents, this may reduce the resistance of skin and solvents will accumulate in the kidneys and the liver and affect the blood.

If a worker gets organic solvent poisoning, he/she suffers irritation of the skin, the mucous membrane, the respiratory tract, the trachea and/or the eyes and has nausea, dizziness and/or headache. Especially, if a worker puts up with his/her chronic toxicosis, it will result in serious organ damage. Any worker who has an allergic disease should avoid painting work.

Preventive Measure for Toxicosis

Ventilation Equipment

Always carry out painting work with sufficient ventilation.

WARNING: The vapor of the organic solvents is heavier than air, it always flows to a lower place and stays there. Therefore, install a discharging outlet as close as possible to the floor.

Post Warnings Inside/Outside

Post the following board in a place where it is easily visible to all the workers.

The workers must completely understand the message on the board and follow the notice for safe painting.

Wearing Protective Clothes

Always wear protective clothes and a gas mask.

After finishing the painting work, clean hands and face and apply barrier cream.

DESCRIPTION AND OPERATION

Item	Description
1	Welding Mask
2	Protective Goggles
3	Safety Shoes
4	Face Mask
5	Safety Gloves
6	Overall with long sleeves

Precautions in using paint and thinner:

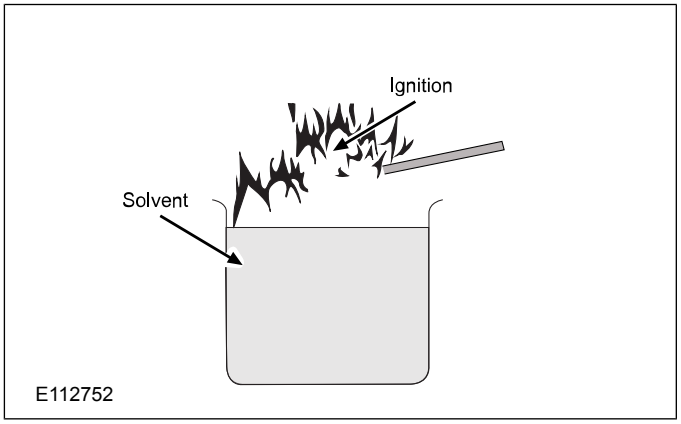
Prepare the necessary amount of the paint and thinner. Always pay attention not spill the paint or thinner and close the cap to prevent evaporation of solvent.

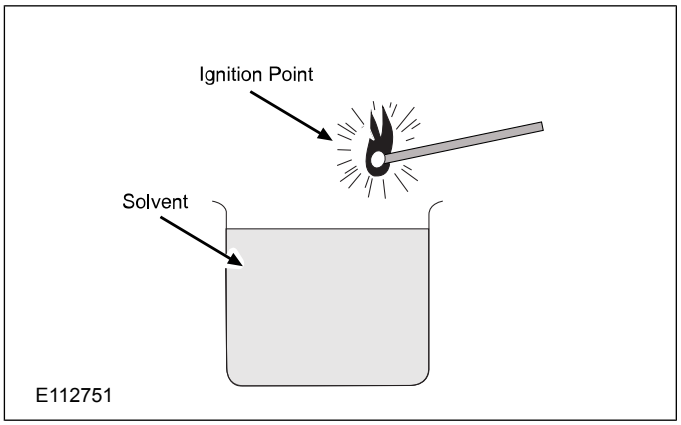
Fire Danger and Fire Control

Paint and thinner used for vehicle repair have low flash and ignition points which can result in fire. If the paint or thinner reaches the critical temperature, it will produce combustible vapor and will be

DESCRIPTION AND OPERATION

ignited. The flash point is the standard of flammability of the paint/ thinner. The flash point is defined as the lowest temperature at which the solvent can be ignited while increasing toward the ignition point. The ignition point is defined as the lowest temperature at which the solvent ignites while its temperature is being increased. The ignition point is far higher than the flash point.





Fire Prevention in the Factory

Ventilation

As the vapor of organic solvent is heavier than the air, it always flows to a lower place. When the vapor of the solvent and air are mixed at a given ratio, and an ignition source is located near the mixed gas, it may explode below the flashing point temperature. Therefore install the discharging outlet as low as possible.

NOTE: The explosive limit is the concentration of solvent below which it does not explode.

- Gasoline: 1.4 (7.6%)
- Thinner: 1.0 (7.0%)

Check the Equipment and Tools

Always lubricate the sliding portion of any equipment (where metal friction generates heat.) Always check that the exhaust fan dose not contact the wall of the painting booth and check for wear of the fan belt. Use safe tools (spark-free tools) when possible and use other equipment and tools carefully and correctly. Pay attention not to drop them or subject them to shocks.

Electrostatic Prevention Measures

Solvents have poor electrical conductivity. If paint or thinner is stirred in a container, static electricity is produced and when the electrostatic level reaches a critical value, it may cause a spark and ignite the solvent. Always connect a ground cable. To maintain a certain humidity in the painting booth, spray water on the floor. Wear anti-static coated cotton overalls avoiding synthetic fiber clothes.

Handling Organic Solvents

The organic solvent categories include: inflammable, explosive, toxic, and radioactive. In order to prevent fire, pay attention to the following items:

- Never have a naked flame in the painting booth. If there is no choice but to have a naked flame, suspend the painting work.
- When the paint or thinner is not being used, always cap its container. If it is spilt on the floor, wipe it up with a cloth.
- Do not put the paint and thinner in the sun or in a hot place.
- Always spray water in the painting booth to maintain enough humidity in order to reduce the danger of ignition.
- If the spray dust from the oil paint, the sanding waste of polyester putty or used cloth are massed together, there is a danger of auto ignition. Keep them in a container filled with water until they are disposed of.

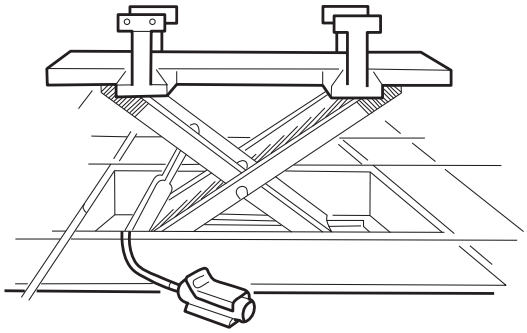
Safety Work

Maintenance of Equipment

In order to carry on the painting work safely, the equipment in the painting booth must be fully utilized. Periodic checks of the equipment and daily maintenance before operation are necessary.

Check the work environment carefully, especially the ventilation conditions, and the storage of poisonous chemicals.

DESCRIPTION AND OPERATION



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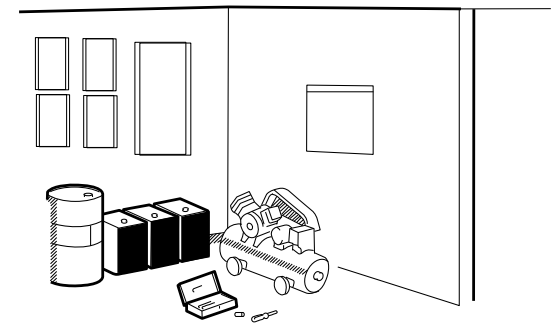

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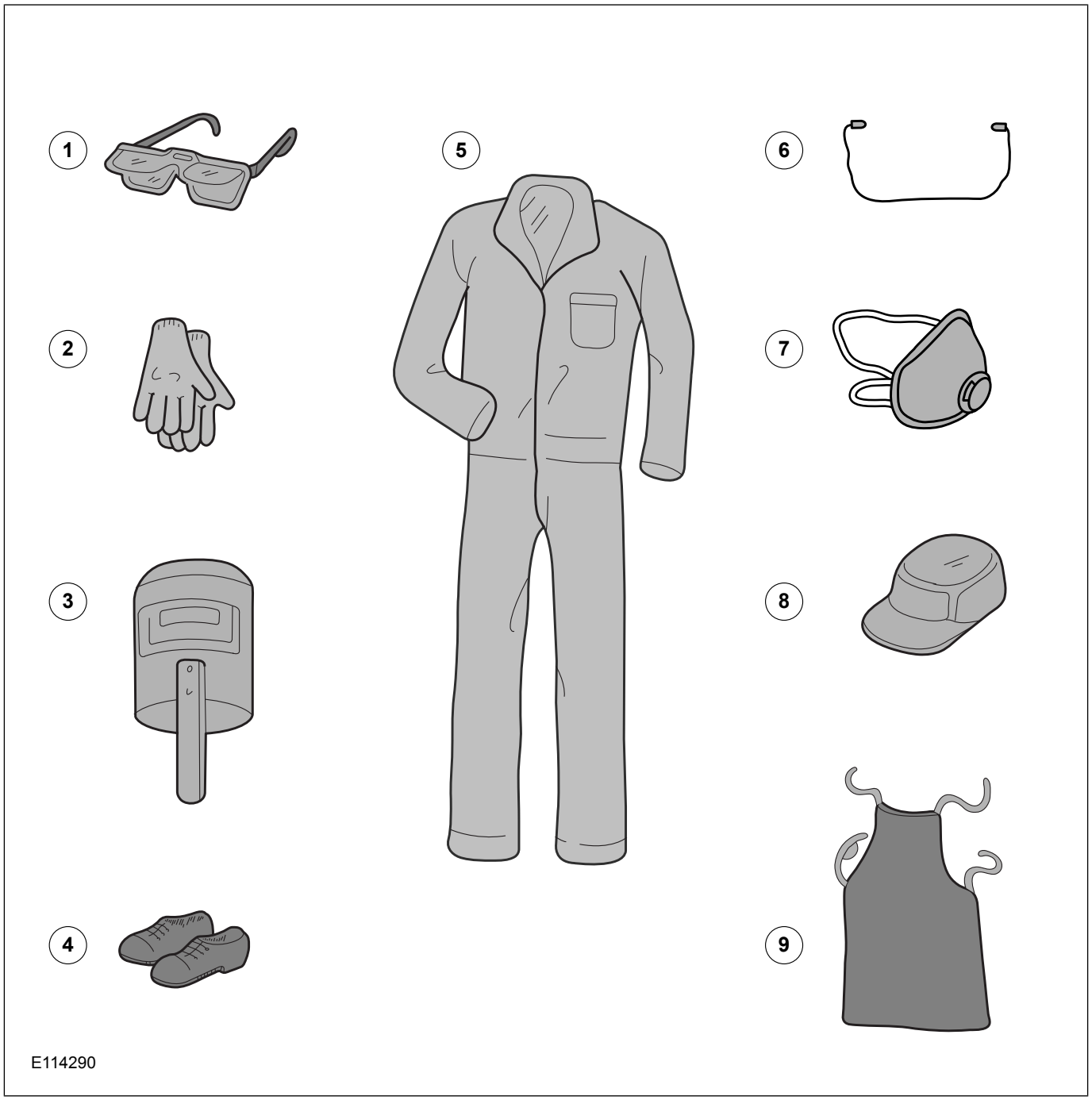
Notice of Work

Worker

Worker must always wear long-sleeved overalls, hat and safety shoes. Depending on the type of painting work, wear protective glasses, gloves, earplug and/or gas mask.

DESCRIPTION AND OPERATION



Item	Description
1	Protective Goggle
2	Work Gloves
3	Shield for Eyes
4	Safety Shoes
5	Overall with long sleeves
6	Ear Plugs
7	Face Mask

Item	Description
8	Cap
9	Protective apron

Jack Up

Do not use a floor jack on a slope or on a weak floor. If a floor jack is used on a such floor, it may result in the vehicle falling.

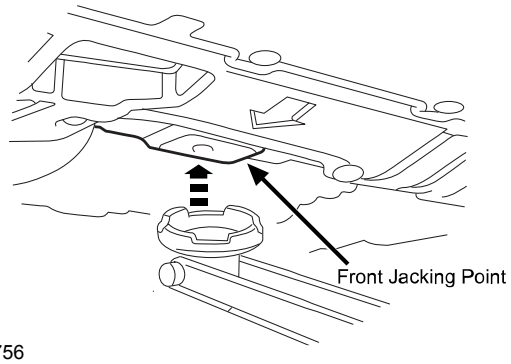
If a vehicle has weight imbalance due to cargo on board, do not use a floor jack.

DESCRIPTION AND OPERATION

When a floor jack is used for the front wheels, set the wheel chock under the rear wheels. When a floor jack is used for a rear wheel, set the wheel chock under the front wheels. When a vehicle is jacked up, always set the wheel chock under the wheels contacting the ground.

After a vehicle is jacked up, always secure the vehicle with a safety stand.

Never crawl under the vehicle while the vehicle is jacked up. Even if it is a short time to work, do not work while only a jack is supporting a vehicle. If the vehicle falls, it may result in serious injury or even death.



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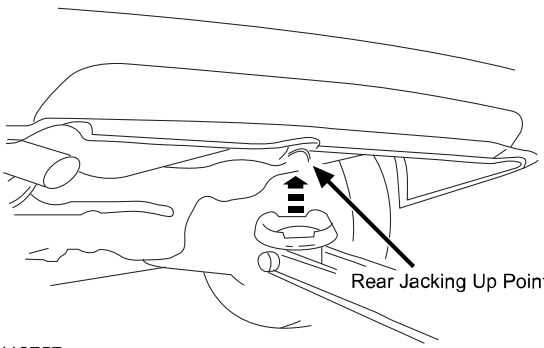

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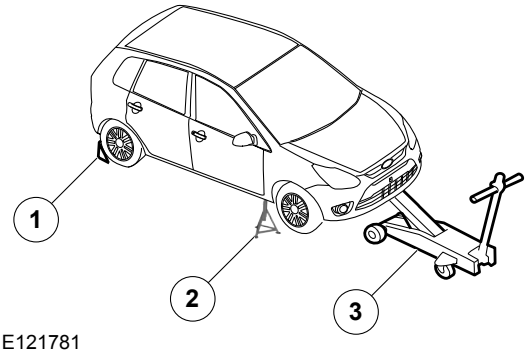


E121781

Item	Description
1	Wheel Stopper
2	Safety Stand
3	Floor Jack

Lift Up

Set the lift blocks securely at the specified points. If the lift blocks are positioned at places other than those specified, this may result in damage to the vehicle or the vehicle falling from the lift blocks.

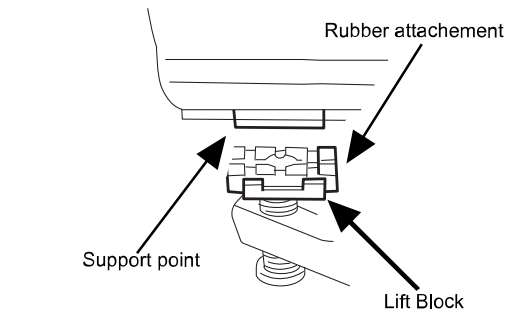
After the main rear parts are removed, put weight in the trunk compartment equivalent to that of the removed parts in order to maintain the weight balance.

Never lift one whole side of a vehicle using only one lift block. When lifting up a vehicle, always watch the vehicle's condition and confirm that a safe environment is maintained.

In order to lift a vehicle up, raise it until all four wheels float a little and confirm that the lift secures it completely.

Never crawl under the vehicle while the lift is operating.

After the vehicle is lifted up, deploy the safety equipment to lock the lift completely.



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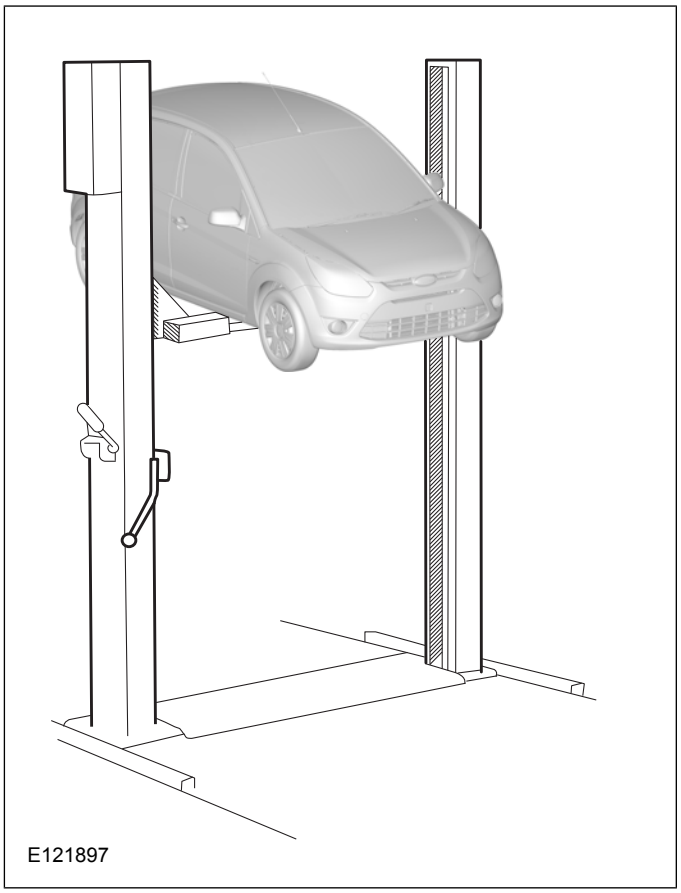
DESCRIPTION AND OPERATION

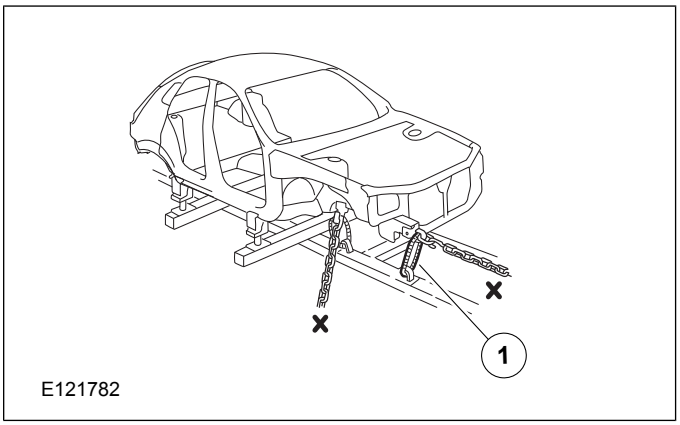


Drawing Work

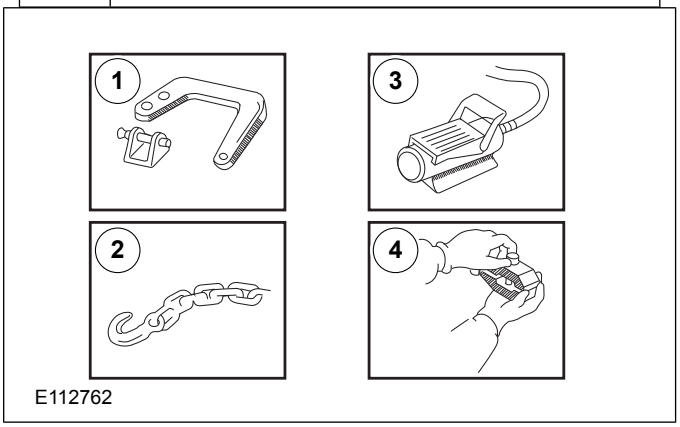
Before starting the frame drawing work, check the condition of the clamps and chains. If any deformation or crack exist, do not use them.

Use appropriate capacity clamps and chains. If the size and/or the capacity are different, the clamp may be removed or the chain break and be scattered.

If a frame correction jig is being used for rough frame correction, do not enter the chain drawing area. Furthermore, be sure to connect safety wires to the frame to prevent its sudden movement.



Item	Description
1	Safety Wire

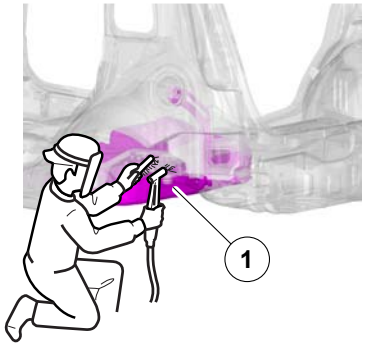


Item	Description
1	Clamp
2	Chain
3	Pump
4	C-Clamp

Welding Work

Remove the fuel tank and /or fuel lines if welding equipment is to be used near the fuel system.

DESCRIPTION AND OPERATION



E121898

Item	Description
1	Fuel Tank

Drying Work

Do not put inflammable things near the painting booth or dryer. Furthermore, do not use electrical apparatus near the painting booth or dryer. In either case, there is a risk of an explosion.


E112763

Protection of the vehicle

Protect affected areas from weld spatter and dust during all welding and grinding work on the vehicle. If metallic dust stays on the vehicle for some time, there is the likelihood of film rust formation. Grinding or sanding work produce tiny spots of damage to the paint surface, which may cause corrosion.

For this reason, make sure to:

- Use carbon fibre blankets to protect the vehicle body.
- Use covering film to protect the vehicle body from sanding dust and metal dust.

Use suitable protective measures to protect the interior when performing repair operations which relate to the inside of the vehicle.

Carbon fibre blankets are used directly around the working area. They offer maximum protection to the areas of the vehicle.

In addition, take into account:

- Remove fuel supply components as necessary.
- Protect working areas which are in danger of catching fire with a fireproof blanket.
- The welding must not cause components of the air conditioning system to become heated.
- Removal of any attached components in the space adjoining the repair area.
- Use covering paper to protect the interior from grinding dust.
- Create a definite barrier between the work area and the interior by using a carbon fibre blanket.

Protective equipment

The following protective equipment must always be used:

- Protective helmet or welding mask.
- Ear defenders and breathing protection.
- Protective gloves and safety boots.
- Welding fume extraction.

Electronic components

Increased use of comfort and safety electronics in modern motor vehicles also requires the greatest attention to be paid during body work.

Overvoltages produced during welding and in alignment work during bodyshell rectification may cause electronic systems to be damaged. In particular, the safety instructions for performing welding work on vehicles with airbag systems must be adhered to.

NOTE: After disconnecting the power supply and before performing further work, a wait time of up to 15 minutes must be maintained, depending on the vehicle. Work on airbag systems may only be performed by persons who have a relevant certificate of competence.

Pay attention to the following points:

- Disconnect the battery negative clamp and cover the battery terminal.
- Disconnect the electrical connector at the airbag control module.
- If welding is to be performed directly near a control module, it must be removed before hand.

DESCRIPTION AND OPERATION

- Never connect the negative cable of the welder near an airbag or a control module.
- Connect the negative cable of the welder close to the location of the weld.

5S Implementation,Periodical Audit and Sustenance

Understanding the 5S Principles and Philosophy

The **5S's** are 5 Japanese PRINCIPLES beginning with the letter **S**:

SEIRI - **SEITON** - **SEISO** - **SEIKETSU** - **SHITSUKE**

Like most of the Japanese words, the literal translation of each into English has very little significance in identifying their true meaning. To truly understand each of them the **5S's** need to be explained in detail.

SEIRI : **CLEARING UP**

SEITON : **ORGANISING**

SEISO : **CLEANING**

SEIKETSU : **STANDARDIZING**

SHITSUKE : **TRAINING** & **DISCIPLINE**

SEIRI : CLEARING UP

It is the first step of the 5S. Initially, the significance is not just "clearing up" objects or things in a working area, but it concentrates more on identifying the objects. In this particular case, the objective is to differentiate the useful from the useless. You have to throw away the unnecessary items, and keep only what you really need, what is necessary for the work in the bodyshop. What is useless takes extra space and can be the source for error.

During this first step, which consists in throwing away the useless, there might be tools or equipment items which cannot be 'classified' immediately. In other words, nobody can say immediately they are useful or not. What is useful for someone may not be for someone else. Therefore a list of "questionable objects" should be made and be observed for a time, in order to be able to classify them correctly. During this observation period, the objects will have to prove their usefulness, otherwise they will have to be thrown away.

SEITON: ORGANISING

This is the second step of the 5S. You have quantified and identified all the useless objects and made a list of all the objects which are 'in doubt'. All you have left are the necessary objects, which everyone agrees with. But even then the remaining objects seem to be in a mess and it is as difficult as before to find what is needed. Here again, the most important action is not tidying up but the way you do it. You have to define a methodical approach to storage. This method must be established by the frequency of use of the useful objects. The useful objects must be stored in a practical way.

The objective is to have a spot for each thing in order to systematically put them back in place. You have to eliminate the needs for searching an object for more than 30 seconds: tools, equipment's, documents, parts. Store useful things = Define a proper way of storage

SEISO: CLEANING

This is the third step of the 5S. You have defined and build up a working area where useful objects are stored and tagged and also where it is quick and easy to find them. But even then, the working area is not clean; dust, dirt, leaks are causing inefficiencies & health & safety hazards. Avoid making dirt in order not to have to clean up. Inspect and detect failures or a drop in standards.

The objective is not just to clean up to have a better working environment, but to use the clean area to identify the problems and the sources of dirt & eliminate them. Keep these objectives in mind: Inspect in order to repair, eliminate the sources of dirt, and look to prevent damage by taking good care of the material and search for the most practical way to spend less time cleaning up.

SEIKETSU: STANDARDIZING

This is the fourth step of the 5S. The objects are all useful, stored, and easy to use, the cleaning time is reduced and there is an improved working area that is clean. Despite all of that, the dirt & rubbish reappear, the way people approach their job is not the same for everyone; we do things we are asked, but often with a degree of resentment. The objective of SEIKETSU is to establish visual operational rules to prevent returning to the 'bad old ways'.

SEIKETSU is achieved by consensus; it is a critical phase where everyone agrees to put into practice the same agreed operational rules. This is where people have to learn how to work together. To

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reach this state of mind, you should use as many visual signs as possible: position marking, labels, etc. In order to respect the rules and make the problems visible, everyone must understand and respond to the visual signs installed. Anyone should be able to see if everything is alright at a glance. Signs must be clear, easily understood, and accepted by all.

SHITSUKE: TRAINING & DISCIPLINE

This is the fifth step of the 5S. There is now a good working environment, the rules are well defined, the suggestions increase and there is a real team spirit. Despite that, we need to ensure that it stays that way, we need more personal and collective discipline.

The final objective is to make the 5S become a daily behaviour, a working reflex against losses and wastes. DISCIPLINE must be understood as self-demanding, and respect towards others. SHITSUKE must develop the cleaning habits, the communication, the training of others as often as possible.

The 4 basic principles of SHITSUKE are:

- Apply the 5S so that it becomes a 'way of life'.
- Train the others in adopting the right habits, without forgetting yours.
- Be as demanding with yourself as you are with others.
- Make sure that the commitment to produce a more effective and efficient working environment is maintained & meets the required visual standards continuously.

5S Implementation in Bodyshop

1. Obtain or draw outline plan of the department. Should be of sufficient size for laminating and notice board display.

2. Divide the department up into individual areas of responsibility. Technicians will normally have at least their own bays but may also have responsibility for common areas. Semi-productive, testers, foremen, apprentices should all have assigned areas. Ideally, offices and office staff should be included.

3. Develop a marking sheet for each 5S zone.

4. Decide date/time of Special 5S event. Inform all staff / pay arrangements, etc., DP and Manager must participate. Arrange refreshments and food for the event.

5. Arrange equipment for Special 5S, as necessary e.g.:

Tools

- Empty Skip(s)
- Brooms
- Shovels
- Buckets
- Mops
- Camera & Film
- Tags tape & pens
- Trolleys / Barrows

Clothing

- Overalls
- Gloves
- Goggles
- Heavy-duty footwear

Refreshment

- Soft drinks / teas, etc.
- Sandwiches
- Fish & Chips

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Environmental Regulations

Orderly and responsible waste management is not only very important for the protection of health and the environment, but it also has great importance where saving natural resources is concerned.

In body repair shops, since the introduction of the EU directives on the avoidance of vehicle waste and the promotion of return, re-use and recycling of vehicles and their components (2000/53/EU), more rigorous attention than before is also paid to avoidance and recycling of waste materials.

NOTE: The organization of disposal in the operation must comply with the country specific waste regulations:

In this respect, body repair shops must take into account and comply with the following requirements:

- Separate waste according to its recycling and disposal methods.
- Produce evidence for the correct transport and disposal of waste.

NOTE: The organization of disposal in the plant must comply with the requirements of the Waste Avoidance and Management Act.

The avoidance and recycling of waste must always take priority. However, despite all measures which may be taken, waste cannot be completely avoided.

NOTE: Usable waste which is not allowed in household rubbish, must be disposed of as special waste.

All remaining waste must be treated as commercial waste and disposed of according to the local requirements.

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Body Construction

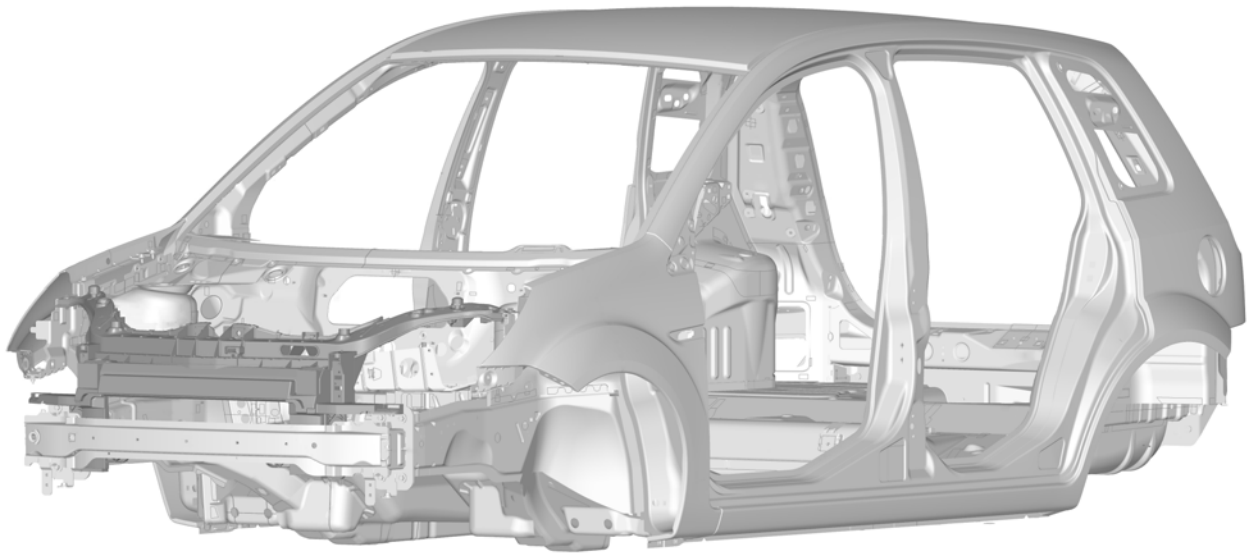
General

Two design principles have prevailed in body design. The body design can either be an integral body-frame or a frame with all attached superstructures. Mixed versions are also possible, with the design significantly increasing the stability of the frame. In all versions, the passenger cell must be preserved in the event of an accident. To this end, the front and rear ends are designed so that they absorb the energy of the impact via crumple zones.

The use of modern design and manufacturing methods, and the use of body panels whose reshaping and strength properties have been finely balanced, mean that despite the reduced weight, all safety-related aspects and requirements can be met.

Integral body-frame

In the car market, the integral safety body-frame is the result of this technological development and manufacturing technology.



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NOTE: Always follow the repair instructions published in the existing workshop literature, particularly for repairs in the crumple zone. All of the specified safety requirements must be met after the work has been carried out.

The integral body-frame is completed with ancillary components, such as doors, hood, bumpers and other components. The advantages of this are:

- Maximum passive safety due to the stable passenger cell.
- Defined deformation behavior at the front and rear.
- High torsional rigidity and high flexural strength.
- Weight reduction.
- Economical manufacturing technology.

The safety of the driver and passengers is paramount for every body design. There are two key safety aspects in the body:

- Safety body cell.
- Crumple zone.

The safety body cell is characterized by the following design features:

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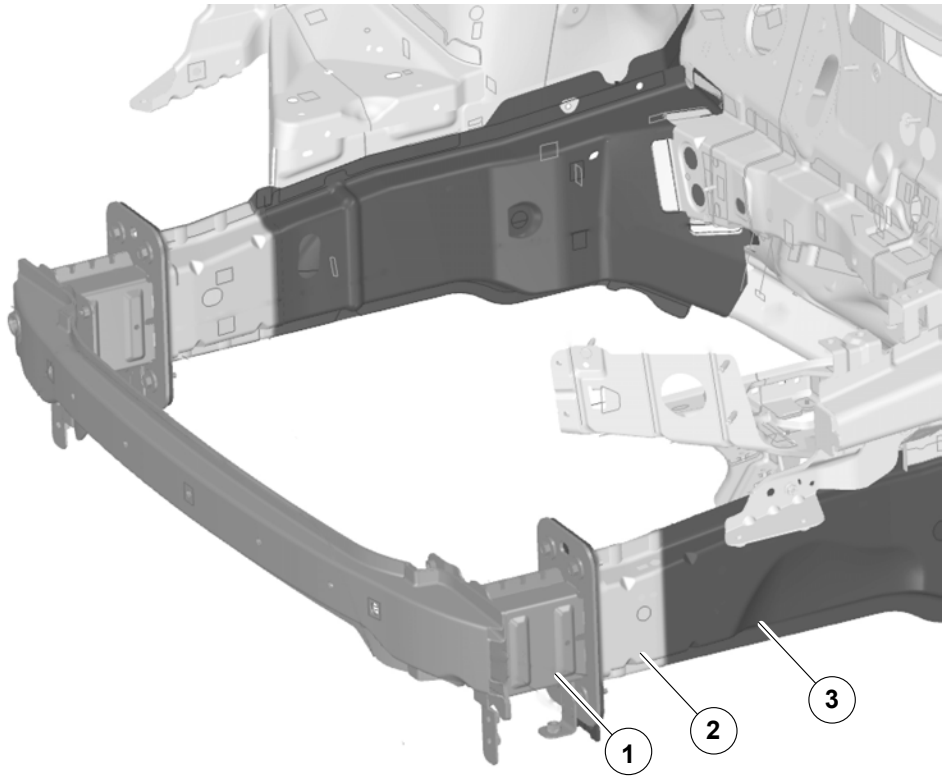
- Stable pillars, door sills and door profiles.
- Integrated side impact protection in the doors.
- The doors are designed to open even in the event of extreme deformation.

Deformation behavior

Different materials and design features lead to staged deformation of the front and rear of the vehicle in an accident. The passenger cell remains undamaged, and the driver and passengers are not shut in.



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Item	Description
1	Bolted sheet metal crash element
2	Front side member
3	Rear side member

NOTE: For more information on types of steel, please refer to the section on body materials.

The bolted crash element is made of high-strength steel. Built-in pre-determined folding points prevent damage to the cross member during gentle impacts. The use of bolts means that this can be quickly and cheaply replaced.

Side members can be manufactured from panels of different thicknesses. These are joined together through laser welding. These panels are called tailored blanks.

NOTE: Please note the model-specific instructions when repairing tailored blanks.

The rear of the vehicle, like the front of the vehicle, has structures which protect the passenger cell through staged deformation in the event of an accident. The design layouts, however, are adapted to the requirements of the rear area.

Frame structures

Frame structures are used for off-road vehicles and light commercial vehicles. With these structures, a distinction is made between a separate frame structure, as on an off-road vehicle, and the composite structure of a light commercial vehicle.

The entire body structure of the commercial vehicle body differs fundamentally from that of the saloon car. The requirements of such a body cannot be compared with a passenger car body. The payload is paramount here. Accordingly, the stability requirements must also be taken into account in the body design.

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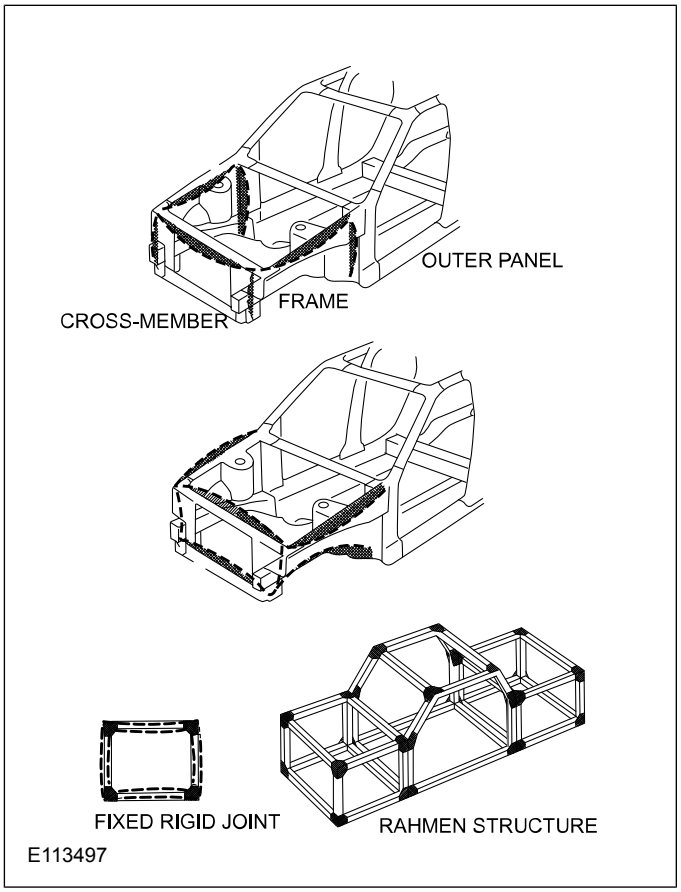
These are:

- Floor pan as frame structure with high torsional rigidity and flexural strength.
- Thicker materials and greater reinforcements in the frame area.
- Partly large surface panels and high volume shaped parts.
- Side panels only make a small contribution to the overall stability of the body.
- Longitudinal crimping, reinforcements and bonded connections prevent the panel surfaces from oscillating during drive mode.

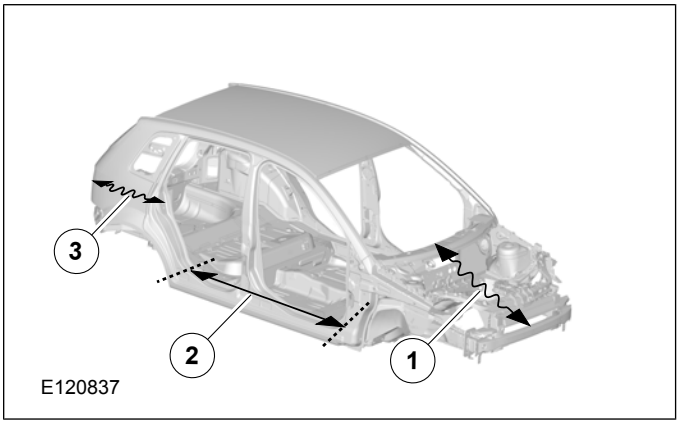
Monocoque Body Structure



A monocoque body is made up of a rigid frame structure (commonly called Rahmen Structure) rigidly connecting more than one basic member. Here, Rahmen structure refers to a skeletal structure that is composed of basic members that are connected to each other through rigidly fixed points of which jointed angles never change. Exposed to an outer force, a Rahmen structure resists it or, if needed, is deformed as a whole because the structure consists of fixed rigid joints.

A monocoque body is a combination of a number of rigid frame (Rahmen) structures that are assembled into one with rigid fixed points connecting their component member parts. It is so designed and manufactured that, when the body takes forces such as stress or impacts coming from starting, acceleration and braking or from the road surface, or twists, bending moments or twisting moments at cornering, it resists those outer forces by dispersing them over all of the body.

Impact Absorbtion Structure



Item	Description
1	Front Compartment
2	Center Compartment
3	Rear Compartment

The monocoque body has a crushable structure to absorb collision. impact energy through deformation of its body structure.The front and rear compartments are constructed to abosrb the impact/collision energy.

Concentration of Stress

During impact, the stress is concentrated where the body shape is altered. For example, to bend a metal plate, first open a hole at the bending position. When the plate is bent, the stress concentrated at the area of reduced width and it is easily bent here.

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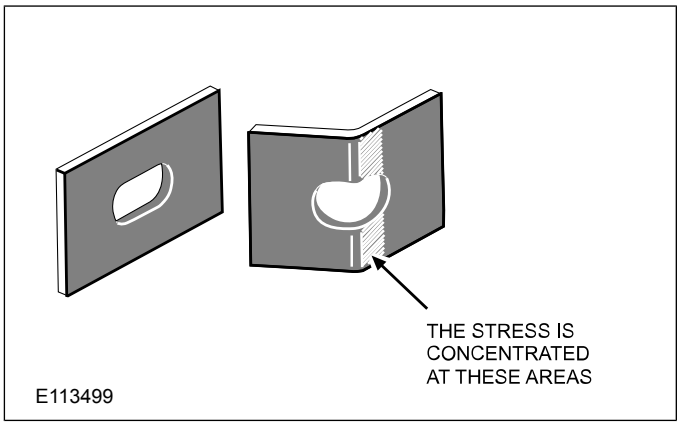
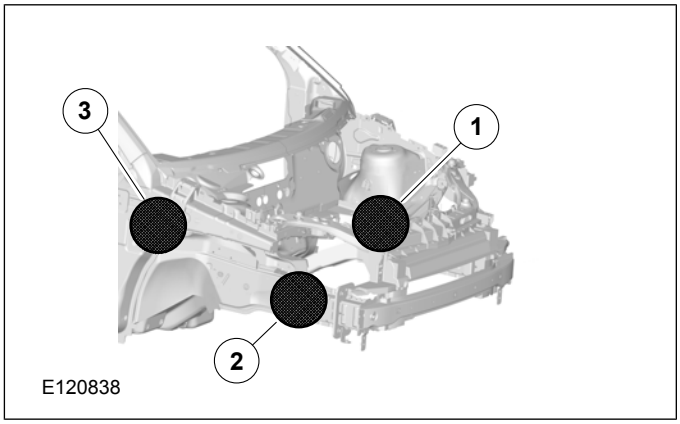
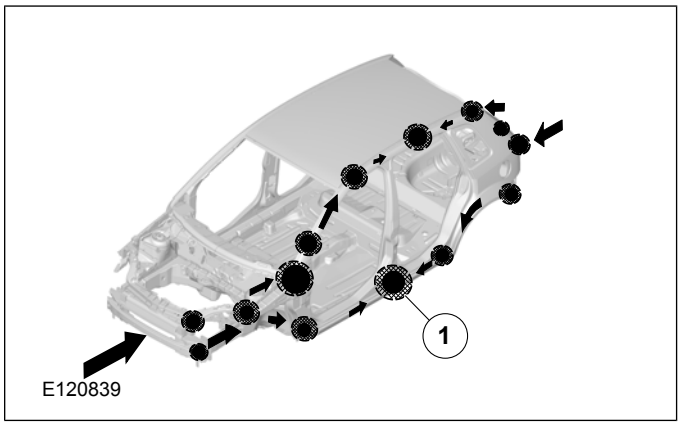


The actual monocoque body has reduced cross section area in the front side frames, and the upper member of the front wheel house has bends and holes to disperse the stress of collision through deformation of the chassis structure.



Item	Description
1	Reduction of Cross Section Area
2	Bend
3	Hole

The collision energy passes the stiffest portions without bending and seeks the weaker portions, deforming (damaging) these areas until the energy is expended.

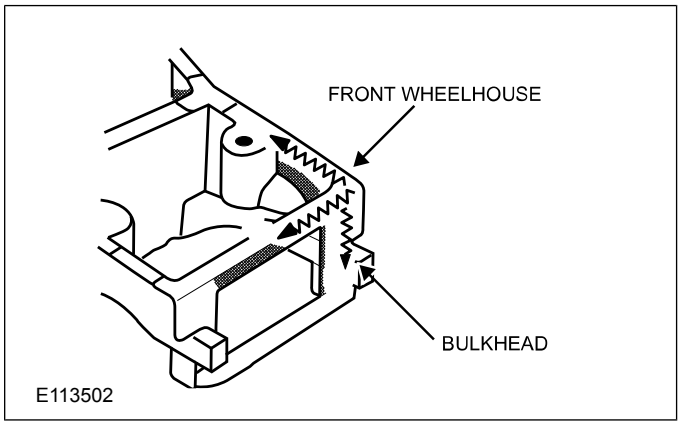


Item	Description
1	Impact Absorbing Portions

Impact Dispersion

The impact (outer force) consists of three variables, input point, angle and magnitude. When impact is applied to a vehicle, its direction and magnitude can be divided into two or more variables. When the specified force “F1-O” is applied at input point “O” with angle (vector) “ ”, F1-O for an actual vehicle is divided into the horizontal forces, F2 and F3 and the vertical force F4.

- F2: To push the front wheel house backward
- F3: To push the bulkhead upper frame to the center
- F4: To push the bulkhead downward



Collision Angle and Damage

The collision can be categorized into two types depending on its direction of impact, one is the centripetal-force collision toward the vehicle’s center of gravity and another is the tangential- force collision directed off the center of gravity.

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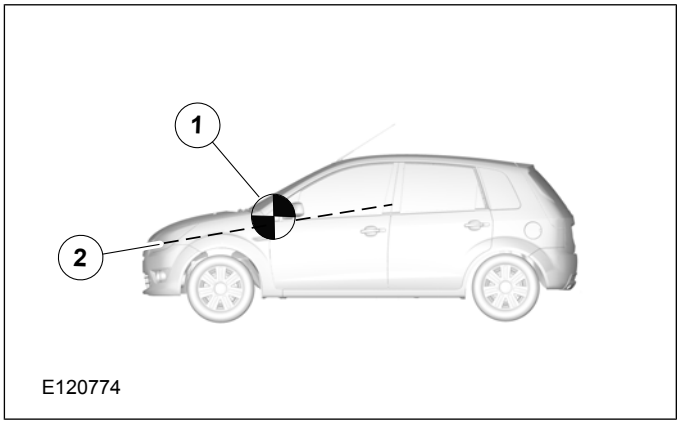
Centripetal Forced Collision

When the impact force is added directly to the center of the gravity center, the resulting damage is the most serious.



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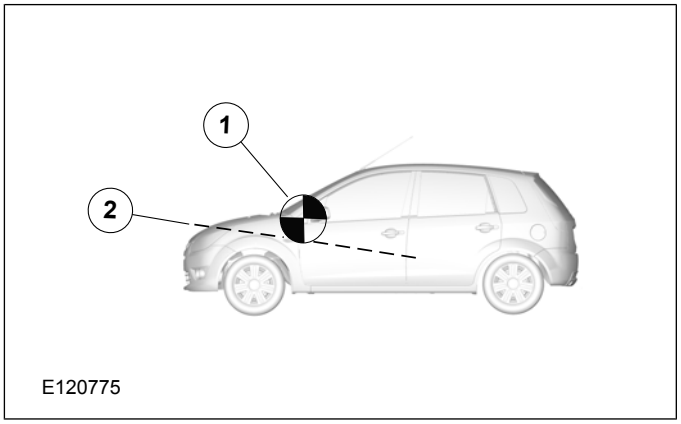
Item	Description
1	Center of Gravity
2	Impact Force

Tangential Forced Collision

When the impact force is added to a point out of the gravity center, the damage is less serious as the vehicle rotates to avoid the impact.



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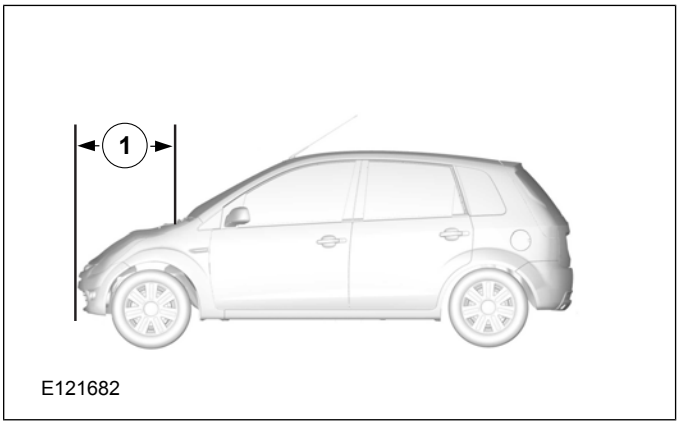
Item	Description
1	Center of Gravity
2	Impact Force

Impact Force and Impact Area

Even if the car weight and speed are the same between the two cases at the time of a crash, the degree of the damage will be significantly different according to the object the car crashes.

As the total impacted area is wider, the impact force per unit area is smaller and accordingly the degree of deformation is smaller but the area of damage is larger.



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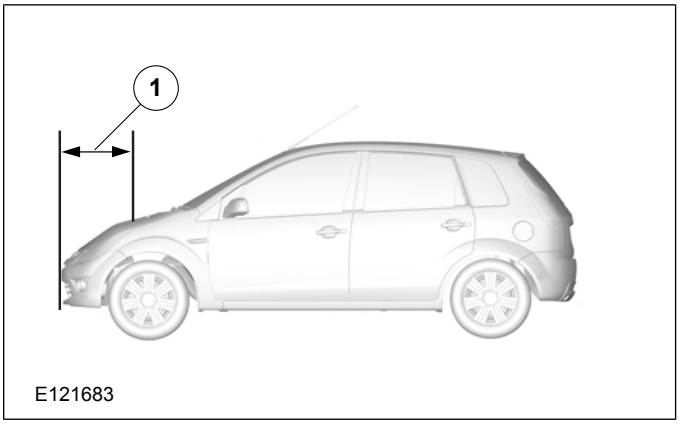
Item	Description
1	Impacted Area

When the impacted area is small as in the case of an electric pole, the impact force per unit area on the car is the greatest, so the degree of deformation is accordingly the greatest.



E121683

Item	Description
1	Impacted Area

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Diagnosis and Damage Evaluation

In order to correctly determine the extent of the damage caused by an accident, in-depth technical knowledge, practical experience with the technical equipment and the testing and measuring devices is required.

Assessment of the extent of the damage includes visual inspection and dimensional inspection of the vehicle. If damage to the chassis geometry is visible even during the visual inspection, the vehicle is to be inspected on an axle alignment jig.

Visual recording of the damage

From a profitability perspective, the possibility of a sectional replacement must be taken into consideration when assessing the damage to a vehicle damaged in an accident.

NOTE: Training courses are offered on this subject. For an overview, please refer to the Ford Service Organisation's training course brochure.

Positive accidental damage assessment can only be achieved if the service technician is able to reconstruct the effect of an impact on the body structure.

For example:

If the impact occurs on the front left-hand side member, the right-hand side member will usually also have been damaged. Often the length of this side member will not have changed, but because of the rigid body design, it may have become deformed. This damage can be detected through the size of the gap between the door and fender or by measuring the vehicle.

In the case of more severe impacts, in which the front part of the vehicle cannot absorb all of the impact energy, the passenger cell is also used to absorb the energy. Here, the energy is transferred via the A pillar and distributed there. This results in deformations in the roof and the door sill.

NOTE: In order to determine the damage as accurately as possible, it may be necessary to remove ancillary components, such as bumpers and inner fenders.

It is possible to draw conclusions about the extent of the damage through a visual inspection of the external damage. In general, the following areas are to be checked during the visual inspection:

- Outer panel including seam seals for cracks or flakes in the paint caused by the accident.
- Size of the gap on doors and hoods for evenness.
- The vehicle roof for folds (gap measurement on vehicles with sunroof)
- Dotted flange in door section for deformation and cracked weld spots.
- The side members and crash components for crumpling and folding.
- Trunk floor and floor pan from above and below for crumpling.

Hidden damage

In addition to external indicators, such as flaked off paint or cracks in the underbody protection, it is vital to check for deformations that are not visible from the outside (hidden body damage) during a damage assessment. Unless ancillary components are removed, it is often impossible to achieve accurate diagnosis of the underlying body parts.

Particular attention must be paid to the following components:

- The A, B and C pillars in the roof area.
- Floor pan.
- Rear ancillary components, such as bumper, lights, etc.
- Trunk floor, spare wheel cavity.
- Rear coverings, such as interior trim, carpet, etc.
- Lower rubber seals, e.g. in door area (welded flange).
- Area under the rear seat.
- Attachment points of transmission system, steering, engine, drive shafts, front and rear axles.
- Electrical components, e.g. radio (damage through shaking).

Body Damage Characteristics

Front Body Damage

According to the magnitude of the impact force, the front body, as the first stage, absorbs the impact before it reaches the suspension-installed

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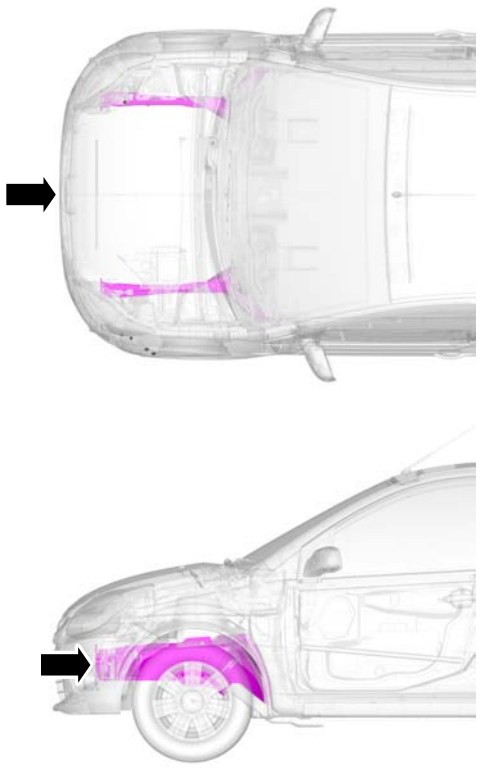
points that exert the influence of the impact on the front wheel alignment. And, as the second stage, the front body prevents the impact dispersion to the dashboard panel. Finally, as the third stage, it decrements and weaken the impact that has reached the dashboard.



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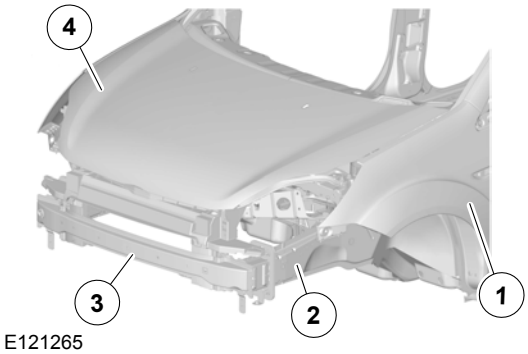
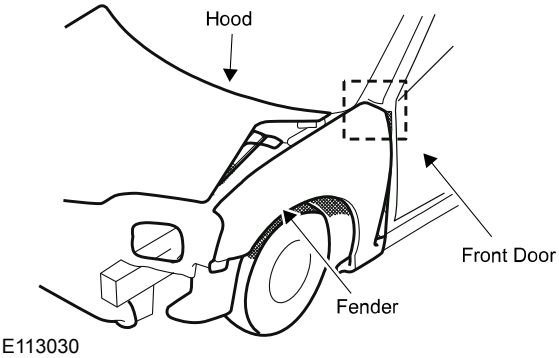
1. When the impact from the front is comparatively small, the bumper is pushed inward causing the deformation of the front side frame through the bumper beam, further leading to the deformations of the front fender, bulkhead and engine hood.



E121265

Item	Description
1	Fender
2	Front Side Frame
3	Front Bumper Reinforcement
4	Hood

2. When the impact force is greater, the front fender collides with the outer panel getting rid of the clearance between the front fender and the front door. At this time, the engine hood hinge is bent or broken in its middle.



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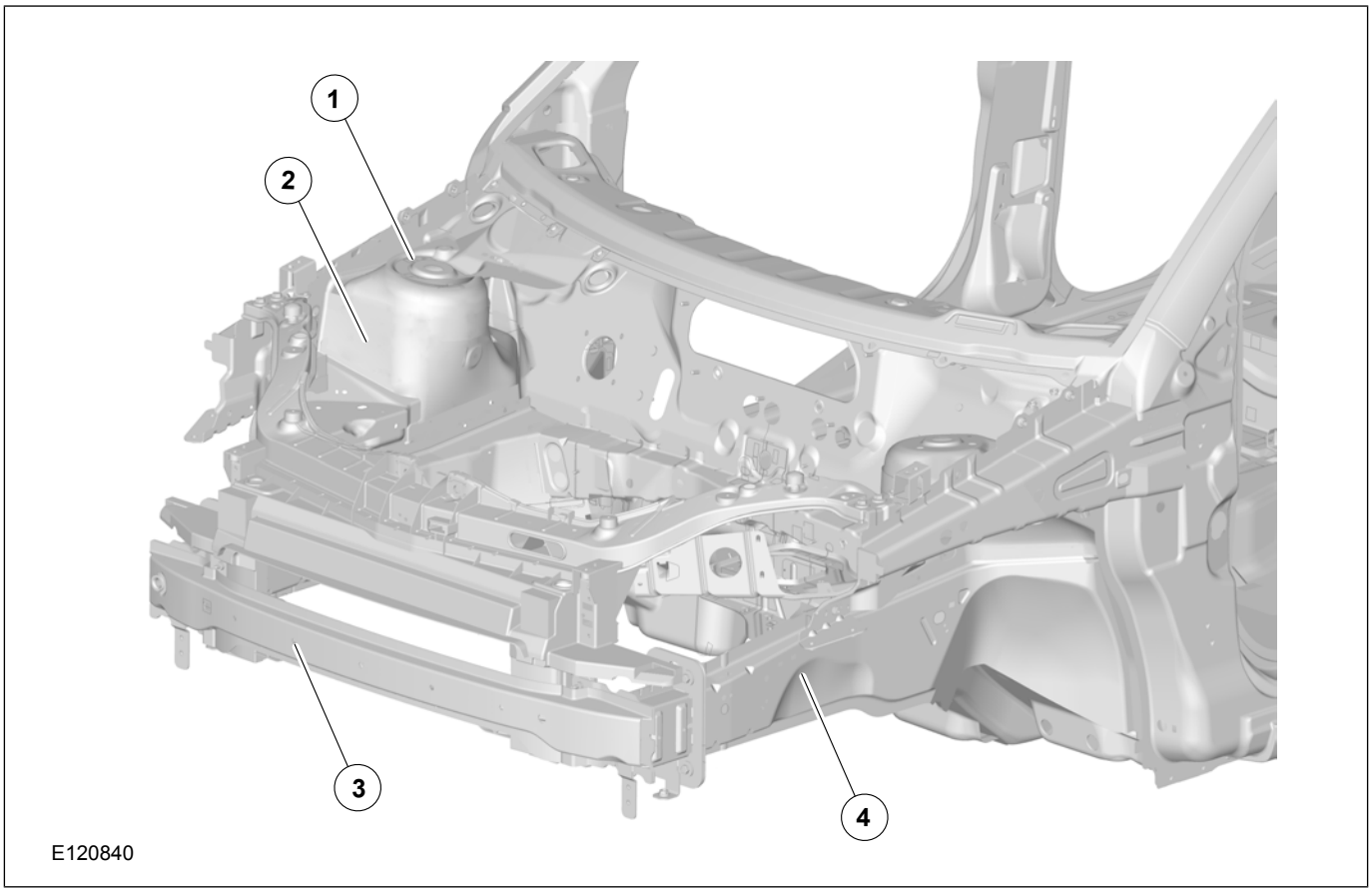
3. The front side frame will be collapsed before the damper housing and the front wheelhouse will be greatly deformed. In some serious cases, the pushed sub-frame will deform the side frame on the other side, too.

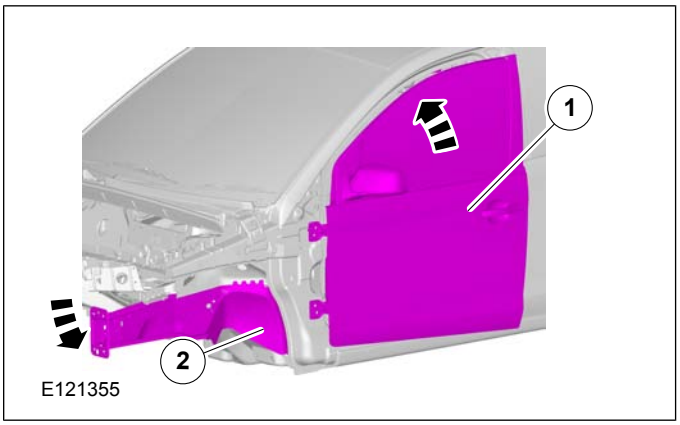
DESCRIPTION AND OPERATION



Item	Description
1	Damper Housing
2	Front Wheel Housing
3	Front Bumper Reinforcement
4	Front Side Frame

4. In a head on collision the front side frame may be pushed down or pushed up. In both the cases, with the root of the side frame as the center of rotation, bending moment is generated, causing the deformation of the front side frame and the dashboard lower panel.

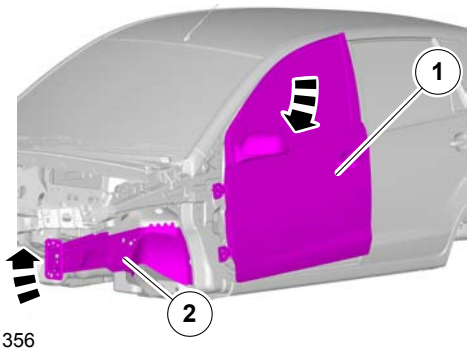
- If the front side frame is pushed down, the root of the front door hinge is deformed and consequently the door is raised.
- Inversely if the front side frame is pushed up, the root of the hinge installed area is also deformed causing the door to move down.



Item	Description
1	Front Door
2	Front Side Frame

Pushed down

DESCRIPTION AND OPERATION



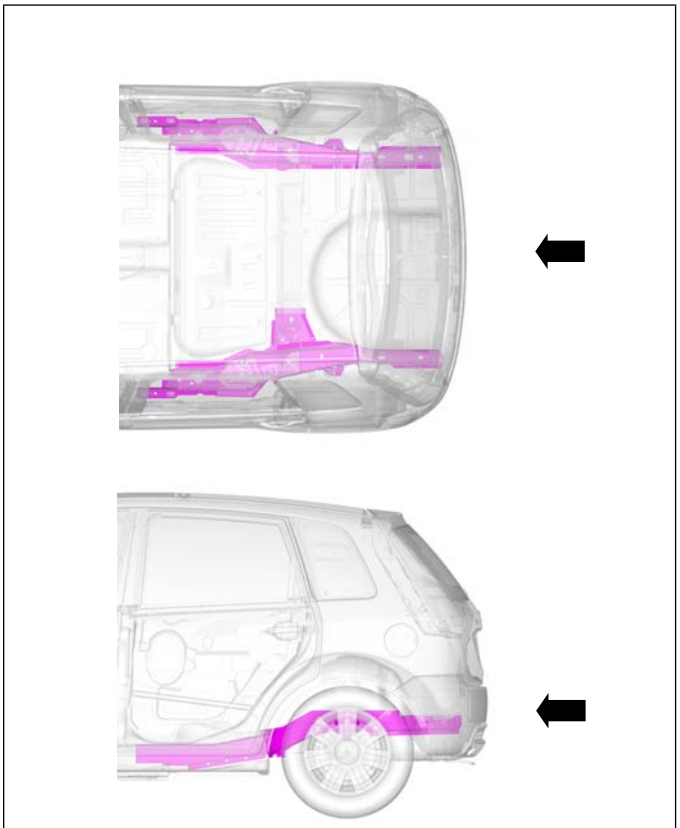
E121356

Item	Description
1	Front Door
2	Front Side Frame

Pushed up

Rear Body Damage

The rear body is composed of the rear frame that is made up of spot-welded panel parts such as the rear panel, rear side outer panel, inner panel and rear floor and skeletal members. If the rear body takes an impact force, those panels mostly absorb the shock. The rear frame is reinforced particularly with the parts for absorbing the impact because the rear frame has, as a whole, great resistance against deformation.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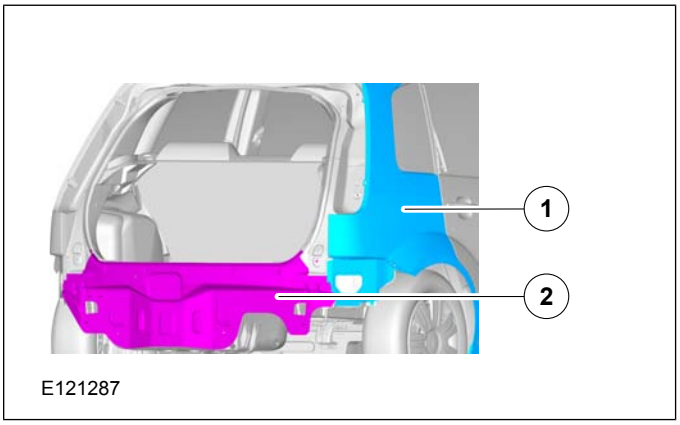
1. If the impact force is not so big, the rear bumper, rear panel, trunk lid and or tailgate absorb the shock through the deformation of either or some of them. At this point, it may happen that the rear side outer panel swells.



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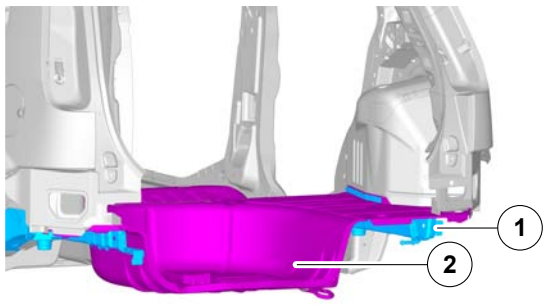
Item	Description
1	Quarter Panel
2	Skirt Panel

2. The rear floor is also deformed further causing the deformation of the rear end of the rear frame.

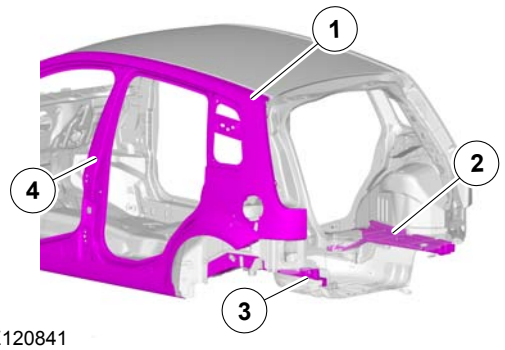
DESCRIPTION AND OPERATION



E121288

Item	Description
1	Rear Frame
2	Rear Floor Panel

3. When the impact force is too great, even the lower end of the rear pillar and the roof panel are deformed. The center pillars may also deform. Sometimes, it goes far enough to deform the rear frame kick-up area.

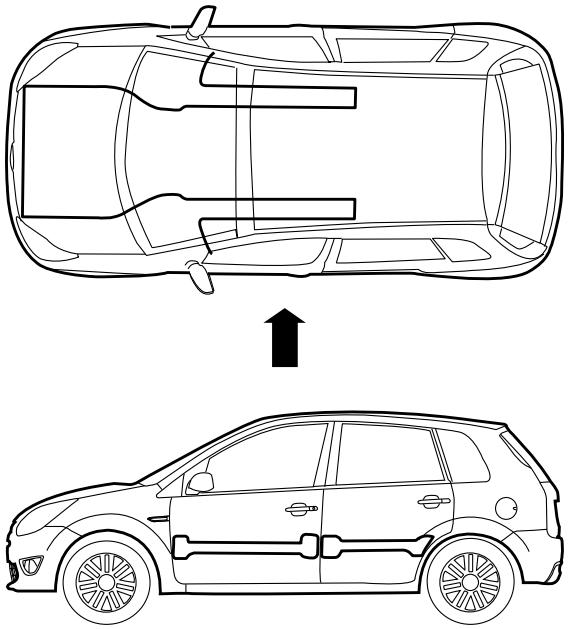


E120841

Item	Description
1	Quarter Panel
2	Kick-Up Area
3	Rear Frame
4	Center Pillar

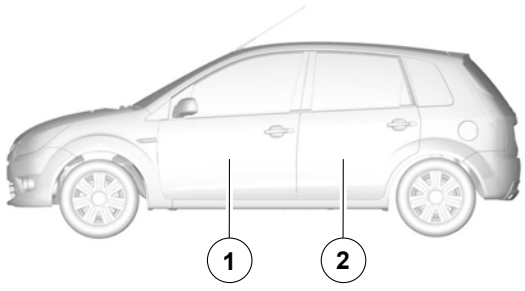
Side Body Damage

In order to raise the ability to resist the resistance deformation, the front pillar, and the side sill center on the side body are enhanced with stiffeners and the doors with beams inside. The impact force taken by these members are dispersed to the cross members of the floor and the roof arch.



E121638

1. Depending upon the configuration of the car, the level of the damage caused by the crash becomes different. When the hit is from the side of the car, first the door is pushed inside causing the deformation of the outer panel. If the impact is great, the front pillar, center pillar and side sill are deformed. Depending upon the level of the impact, the floor is also deformed.



E121289

Item	Description
1	Front Door
2	Rear Door

2. If the front pillar, rear side outer panel of the car takes a great impact force sideways, that force

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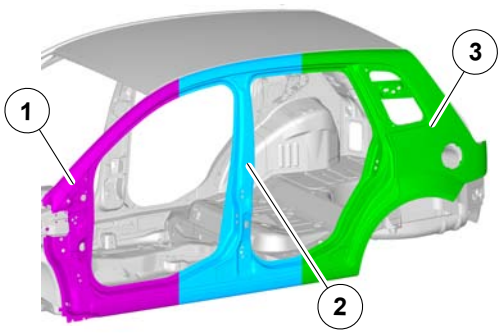
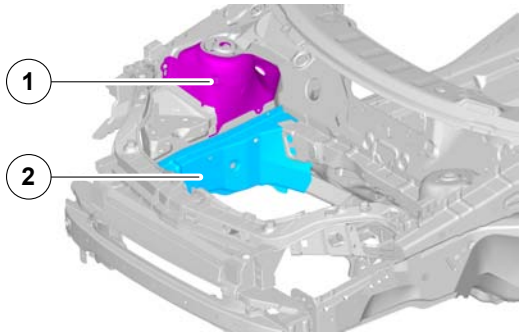
extends its influences as far as the opposite side of the car.



E121290

Item	Description
1	A-Pillar
2	B-Pillar
3	Quarter Panel

3. When the impact force hits the center area of the front fender, the front wheel takes the impact. But, depending upon the level of the impact, its effect may reach the damper housing and the front side frame. If this happens, more than one part of the suspension system will be damaged and the wheel alignment and the wheel base will be out of adjustment. Not only that, the steering system will become affected.



E121291

Item	Description
1	Damper Housing
2	Front Side Frame

DESCRIPTION AND OPERATION

Body Sheet Metal

Types of steel

The types of steel sheets used for automobile body are mostly carbon steels (carbon-ferrous alloy) because of the necessity of meeting molding and processing requirements and heavy-load conditions on the road. Depending upon the content of carbon in the steel, the technical feature of the metal is different. The higher the carbon content is, the stronger the anti-impact ability is, but the easiness of its molding and welding processing becomes lower. Even paneling jobs becomes difficult. For a body, therefore, low carbon steels, of which carbon contents are from 0.1 to 0.4 %, are mostly used. The recent trend is to use high-tension steel, though much thinner than the conventional soft steel, but capable of providing the same level of strength.

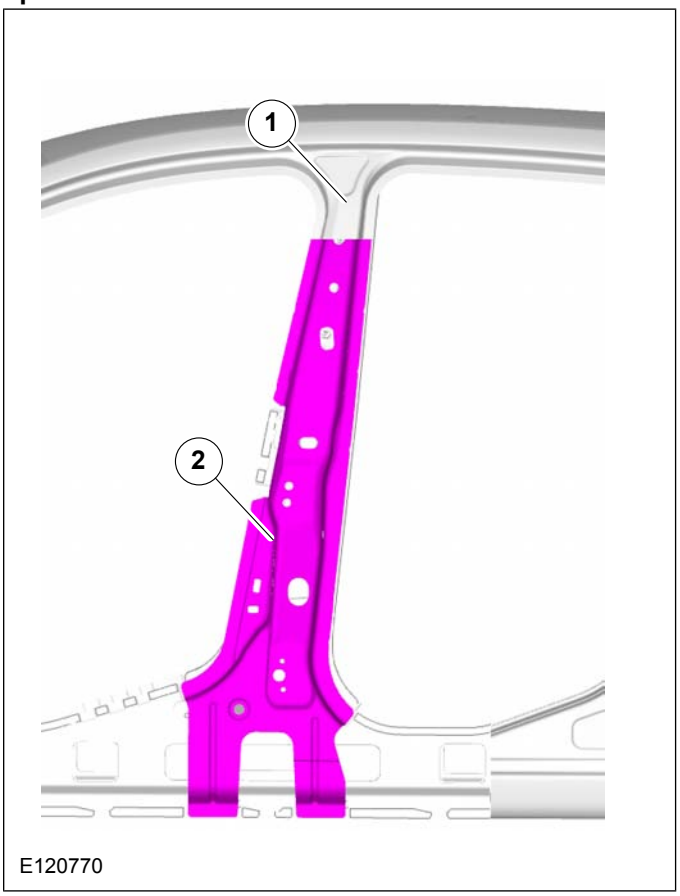
Types of steels are classified by their properties of strength and elasticity.

- Normal strength steel has a minimum yield strength of up to about **210 N/mm²**.
- High strength steels have a minimum yield strength of about **150 to 600 N/mm²**.
- Ultra-high-strength steels have a minimum yield strength of about **400 to 1200 N/mm²**.

High-strength and ultra-high-strength steels are mostly installed in safety relevant locations (structural components). Among others, these are side members, pillars, roof frames.

Body component parts have various kinds of sections. Because all of them are usually press formed from a thin steel sheet, they are designed so as to have different rigidities, depending upon where it is needed, with reinforcements or with different thicknesses.

Example of the use of high-strength steel in side pillar



E120770

Item	Description
1	Normal strength steel
2	High strength steel

Normal strength steels

Normal strength steels are most often used in body construction. They are relatively soft and are therefore particularly suitable for the deep drawing processes used in body manufacturing. As well as very good reshaping properties, the panels also have a relatively high rigidity.

High strength steel panels

The strength of the material and the nature of the surface can be changed as required by different engineering processes. In order to achieve suitable configuration and a good match between construction specifications and what is possible in

DESCRIPTION AND OPERATION

production, a large range of high strength panels is available.

The range of the minimum yield strength is from 180 N/mm² to 460 N/mm². High strength thin steel panels usually have a surface finish. Electrolytic surface sealing is preferred.

Within the group of high strength steels, various types of steel are used in body construction:

- **Micro-alloyed high strength steels** for very difficult drawn components such as fenders, the internal components of doors, hoods and luggage compartment lids or load bearing components such as sidemembers, crossmembers etc.
- **Bake-hardening steels** and **phosphorus alloyed steels** for external panel components with higher draw depth and subject to higher operational demands.
- **Isotropic materials** for flat shaped outer steel panels on doors, hoods, luggage compartment lids, roofs.

Ultra-high-strength steels

These steels are predominately used for body structural components which are relevant to safety. Despite the reduced thicknesses of the panels used, weight reduction is often achieved together with greater strength.

As with high-strength steels, special types of steel are used in the ultra-high-strength steels group:

- **Complex phase steels** are used for door side impact carriers, bumper carriers and body components relevant to crashes. Besides high strength, they have good cold reshaping properties and are easily welded.
- **Dual phase steels** have the same properties as complex phase steels. Because of their high strengthening properties they are suitable for body reinforcements.
- **Residual austenite steels** and **martensite phase steels** have very high strength levels of up to 1200 N/mm² and are mostly used in body structures relevant to crashes.

Because of the use of such steels, some special points must be taken into account during body repair:

- Increased force required during straightening.
- Strong springback tendency during alignment work.
- Cutting tools have a shorter useful life.
- **NOTE:** High-strength and ultra-high-strength steel panels must not be heated during straightening work.

  Work without applying heat when carrying out straightening work. Losses of strength will occur at temperatures as low as 400°C.

The basic working methods and the tools to be used are the same however.

Coated steel panels

In a similar way to high-strength steel panels, coated steel panels are finding more applications because of the better corrosion protection which they offer. There are basically two different process which are used to apply a zinc layer:

- Hot dip zinc coating (no longer used in vehicle construction).
- Electrolytic zinc plating.

The following points must be noted when welding:

NOTE: Welding fumes are harmful to health. Make certain that the workspace is well ventilated and use welding fume extraction.

- Zinc starts to melt at about 420°C.
- The zinc vaporizes at a temperature of about 900°C.
- The amount of heating determines the damage to the zinc coating, and therefore to the corrosion protection.
- **NOTE:** Coated panels have a higher electrical resistance, but this can be compensated for by increasing the welding current by 10 - 20% .

  Resistance spot welding is particularly suitable for welding zinc-coated panels, because no widespread warming occurs.
- With electrolytically zinc-plated panels there is no need for any special preparation because the zinc coating does not need to be removed.

Tailored blanks

Tailored blanks are panels which are made up of at least two separate panels with different material thicknesses and/or material properties. The panels are joined together by a laser weld seam and then shaped in a press.

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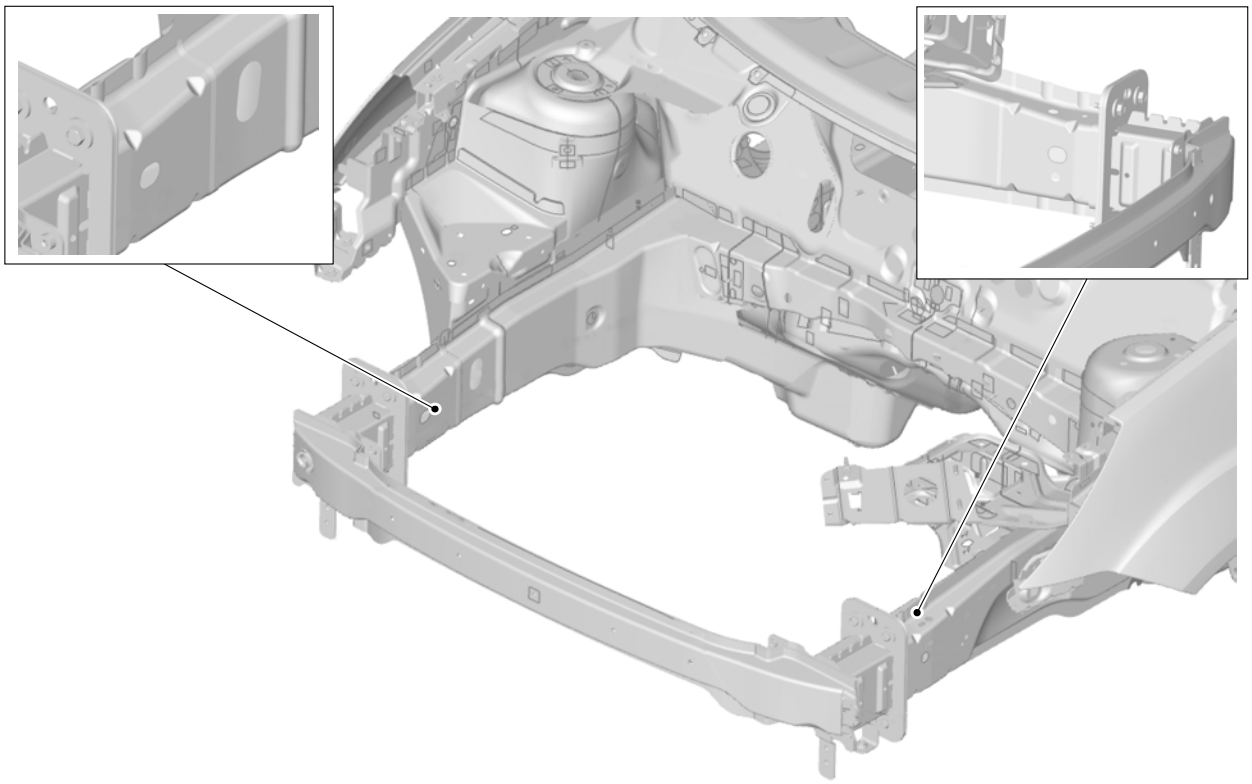
This technique allows panel shapes to be produced which meet special requirements with regard to deformation behavior, strength and weight.

Laser weld seams at the sidemember



E120512

NOTE: No cutting, no welding and therefore no sectional repairs are permitted in the immediate area of the laser weld seams. The model specific requirements are documented in the respective Body Repair Manuals.

Typical examples of application are:

- Sidemember.
- Door inner reinforcement/door frames.
- Wheelhouses.
- Rocker panel inner reinforcement.
- Roof rail inner reinforcement.

When repairing the vehicle body, pay special attention that such a connection is never separated. The possible cut line locations are given in the respective repair manuals.

Characteristics of Steel Sheet

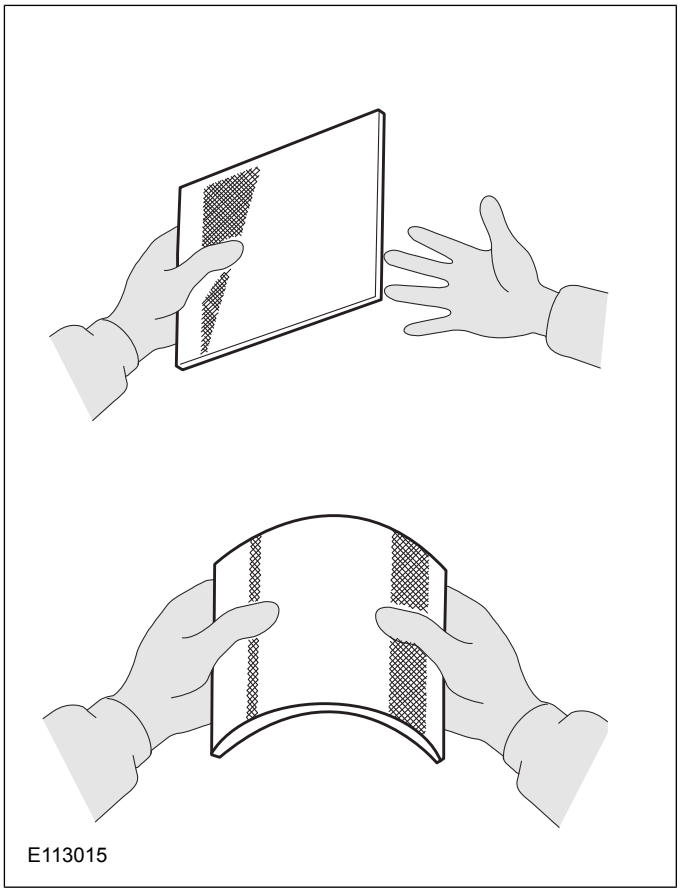
Elasticity

Elasticity is a property that metal has which allows the metal returns to the original shape when the force, which caused the deformation, is removed.

Even if a steel plate is bent with your fingers it returns to the original shape when the force is removed from the plate without leaving any deformation. This returnable deformation is called an elastic deformation and this characteristic of metals is referred to as elasticity.

DESCRIPTION AND OPERATION

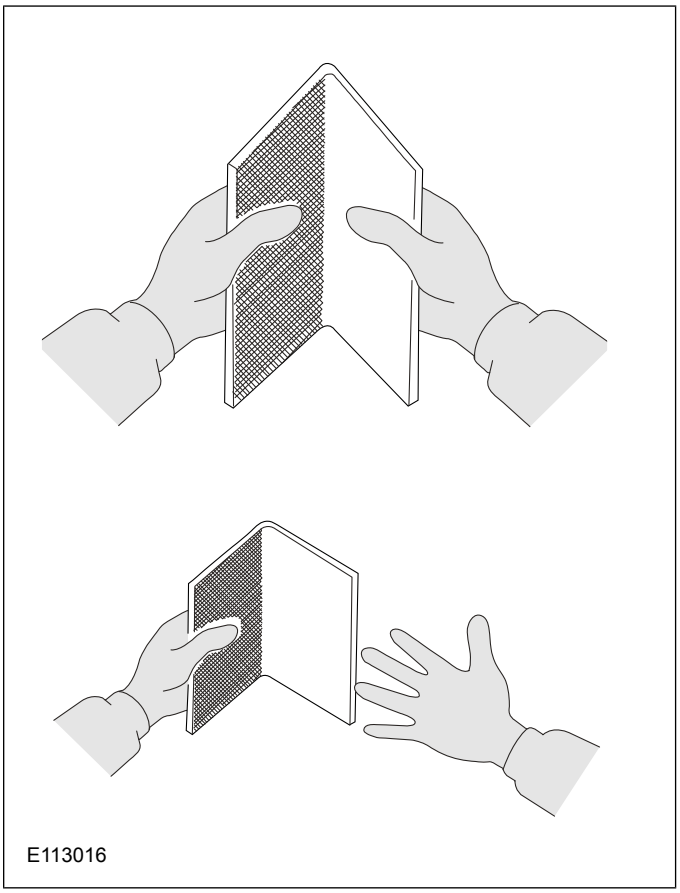
Elastic deformation:



If a further pressure is added to the plate beyond a certain point that is determined in relation between a load and its resulting amount of deformation, the deformation remains even after the pressure is removed and dose not return to the original shape. This situation is called the force has reached the elastic limit. The harder the steel is, the greater the elasticity is. Therefore, as the steel is hardened, its elasticity is increased.

Plasticity

When a steel plate is bent strongly, it may return a little toward the original shape, but it remains bent. This is called a plastic deformation and the characteristic of not returning to the original shape is called plasticity.

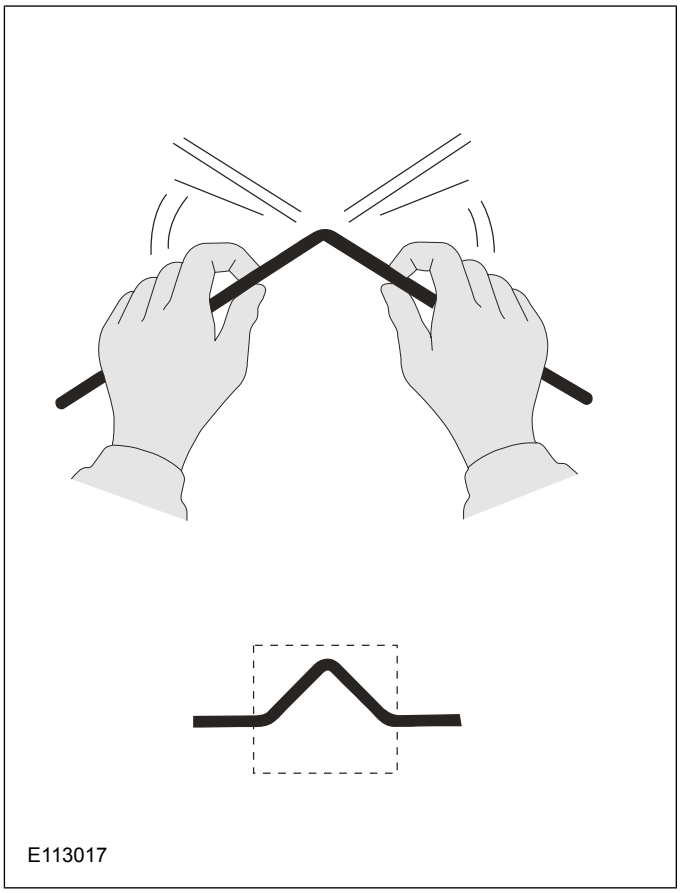


Automotive body panels such as fenders, engine hood, roof panel and others are press formed into each required shape from large steel sheets. In this way, the characteristic that the shape of an object remains changed after a pressure is applied is plasticity. It is also possible to change the shape of an object by pulling or pressing it. The deformation caused by pulling is called ductility and the one by pressing is called malleability. The result of ductile deformation is an elongation and the one of pressing deformation is compression.

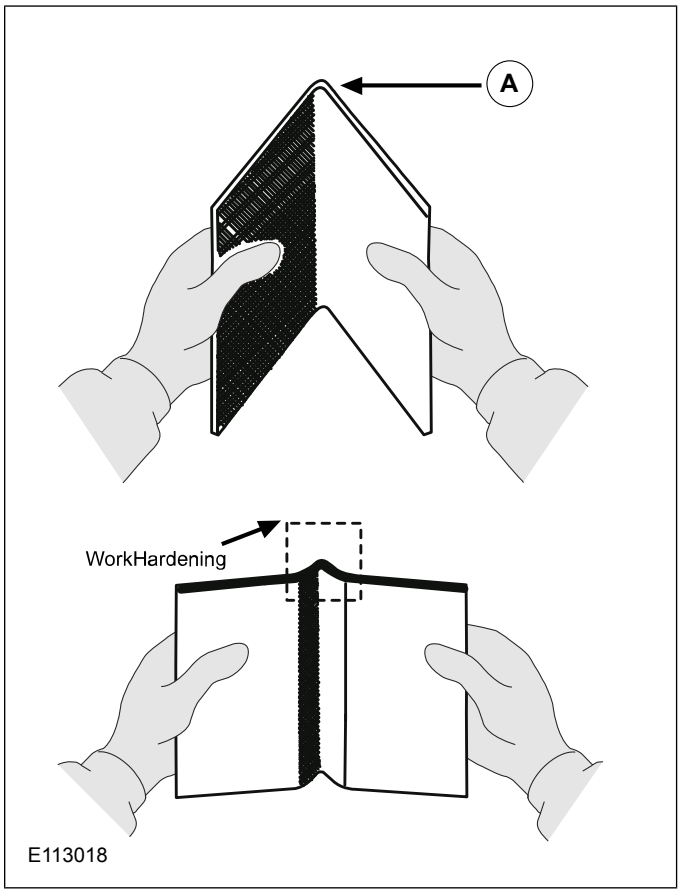
Work Hardening

If a metal wire is repeatedly bent and bent back, it is gradually hardened. The same way, a steel sheet becomes hardened and strong through plastic deformation.

DESCRIPTION AND OPERATION



If a flat steel sheet is repeatedly bent, the first bent area (A) remains and the new bent areas are formed on both sides of the sheet. It happens because the first bent area becomes hardened and strong. In the same way, when a body panel is press-formed (plastic molding), a work hardening takes place on the sheet.



On an actual crashed car, the same work hardening is taking place where it was crashed due to the external impact force. Work hardening also takes place when it is repaired.

Heat Change

The changes that heat extends to steel sheets can be divided into the following three kinds.

- Scale (Thin oxidized layer that appears on heated steel)
- Change to molecular structure
- Expansion and shrinkage

Those changes take place on the steel panel through heating by welding work including oxygen/acetylene and others, and friction by grinding or grindstone work.

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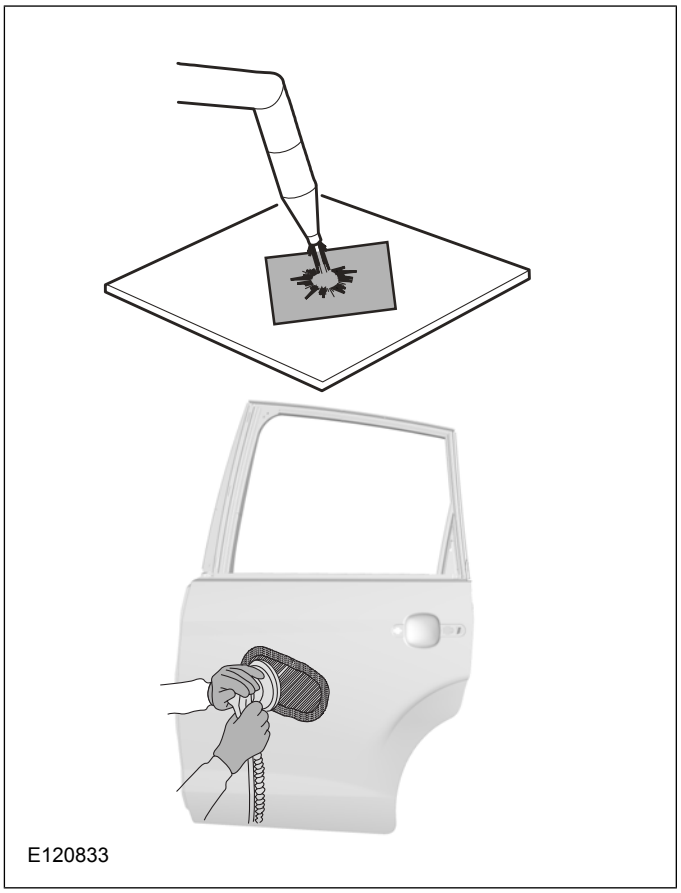


E120833

Temperature and Color Change by Heat

NOTE: As the heat added to the steel sheet increases, the color changes until it starts to melt at 2732°F (1,500°C).

Color	Temperature range °F (°C)
Dark red	1112 (600)
Red	1292 (700)
Rose-pink	1562 (850)
Yellowish red	1652 (900)
Yellow	1832 (1,000)
Orange	2012 (1,100)
White	2192 (1,200)
Bright white	Over 2282 (1,250)

Heating Temperature and Material Change

As steel sheet is heated, its plasticity becomes higher. However, if the temperature of the sheet exceeds a certain point, changes to the material or hardening brittleness takes place. It is, therefore, important in steel process not to exceed 1333.4°F (723°C) because of its structural change (structural transformation) that happens at this temperature. At 392 to 482°F (200 to 250°C), blue heat brittleness happens to the sheet and if 1328°F (720°C) is exceeded, red brittleness takes place. Further, if it goes to over 1652°F (900°C), the steel grains become large and rough causing oxidization and worsening the material. Generally, as one of the heating body repair methods, spotting is widely used.

Brittleness

Generally, the more heated a metal is, the softer it becomes and the easier to be worked. But, as long as soft steel is concerned, its hardness and tensile strength reaches the highest and after that at higher temperature, its elongation decreases.

Heat Treatment

As temperature increases, structural change (transformation) takes place in the metal. If the cooling speed is quickened, the progress of the transformation is delayed and, as a result, a metal structure that is unusual at a normal temperature can be obtained. Heat treatment is a technical process to obtain metallic features to meet desired requirements through heating and cooling.

Hardening and Tempering

A kind of heat treatment used for cutting tools and blades that have to be harder than works to be processed.

- **Hardening:** If these steel objects are heated about to 1472°F (800°C) and then submerged in water or oil, they are quick hardened. As the result of this process, the objects become almost 5 times harder. Steel can be hardened but, at the same time, it becomes brittle.
- **Tempering:** In order to provide stickiness to steel, the object is heated up to around 1112°F (600°C) and then after that, it is gradually and slowly cooled.

Normalizing

This heat treatment process makes the metallic grains minute that have been made large and rough after being heated or cast and remove eccentric crystallization and residual stress, thus returning its property to normal. Usually the metal is heated up to 1472 to 1652°F (800 to 900°C) and then gradually cooled down to normal temperature.

Annealing

In order to soften a material that has increased in rigidity and hardness but reduced its elongation, as the result of the work hardening caused by cold

DESCRIPTION AND OPERATION

working or a material that became hard after hardening, they are gradually cooled down after heating in the furnace. Depending upon the kinds of materials and desired requirements, heating temperature, time duration of holding temperature, cooling temperature, its speed has to be adjusted.

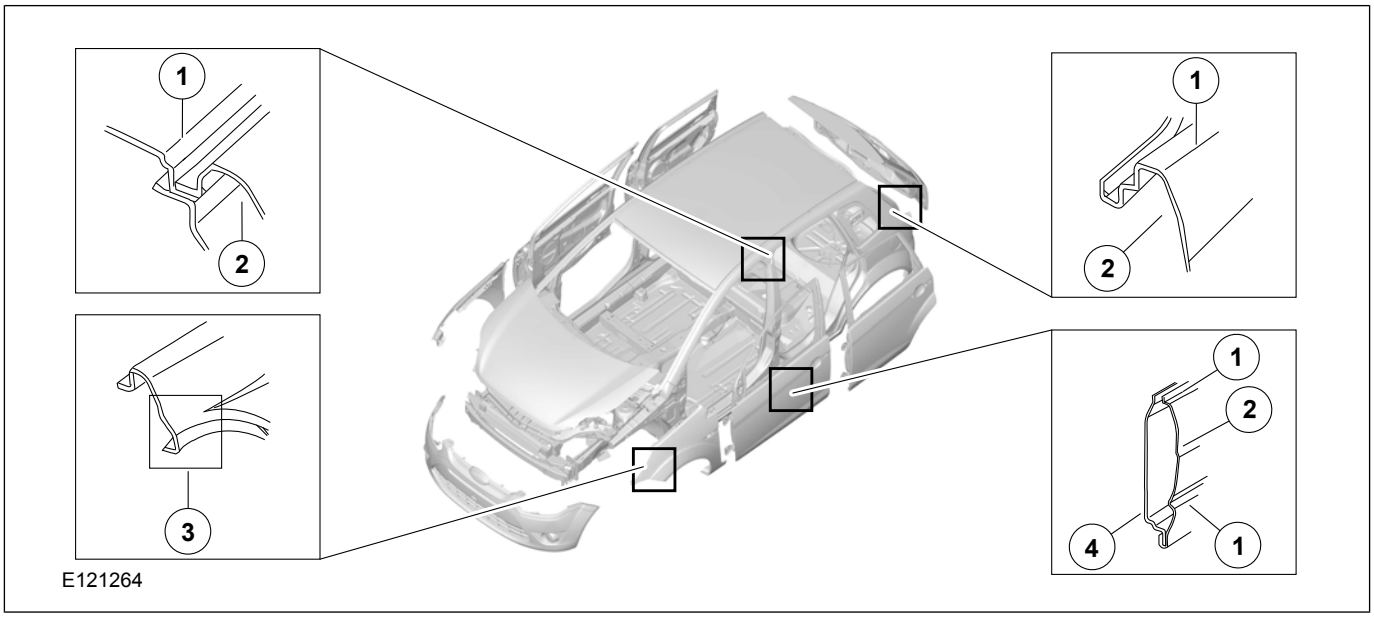
Bending and Strength

In considerations of external appearance and strength, automotive body panels are press-formed in various shapes and configurations. By giving a steel panel its own designed shape and configuration, it heighten its strength and, likewise, obtain its needed strength from other parts with which it is assembled into a unit.

Steel Sheet Bending

While considering its design (external appearance), automotive body panels are press formed with sharp bent areas where it is necessary for higher strength. Those sharply bent areas are called Crown and has the following categories.

- **Low crown:** Its curved surface or edge is very gently sloping.
- **High crown:** Its curved surface or edge is very sharp.
- **Combination crown:** A low crown and high crown are combined on panel.
- **Reverse crown:** An edge curved inward toward the panel.



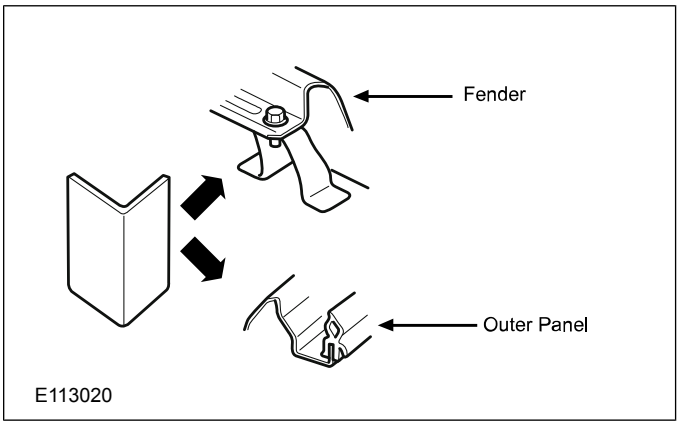
E121264

Item	Description
1	High Crown
2	Low Crown
3	Combination Crown
4	Reverse Crown

In repairing a damaged body or panel, a smaller load is required for a low crowned panel because it has a small curvature, while a high crowned panel (deep-drawn panel with a high curvature) has some restoring force against the deformation of the damaged area. On the other hand, a reverse crown is incorporated in a panel that has a sharp inward curvature. Because of this, the strength is so concentrated that the repairing work becomes difficult.

Angle Bending

When a panel is bent at a right angle, this bending is called an angle bending. The angle bending is mainly used for door panels and fenders.



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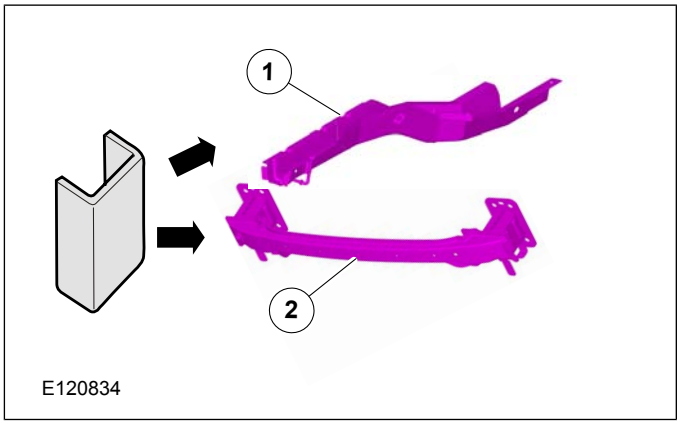
DESCRIPTION AND OPERATION

Channel Bending

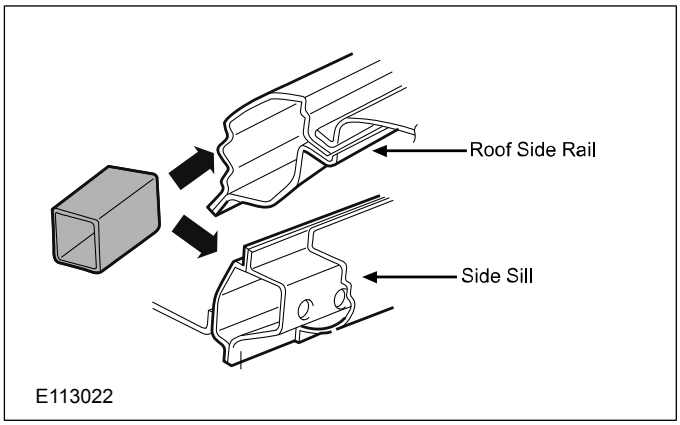
This way of bending a steel sheet has a greater strength than angle bending. It is mainly used for under-body component parts such as a rear frame, a cross member or a floor frame.



Item	Description
1	Rear Cross Member
2	Front Cross Member

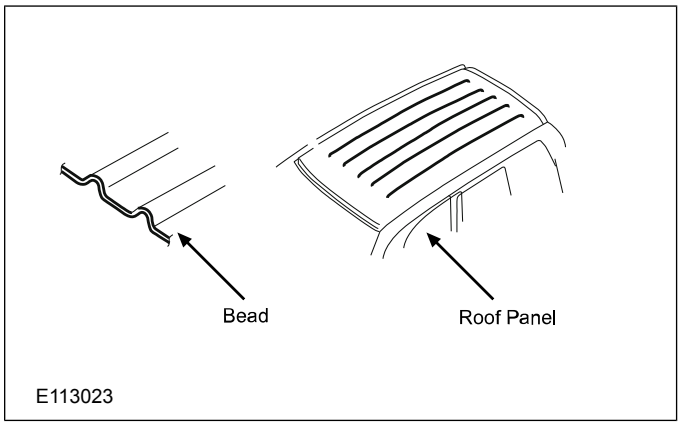
Box Gutter

A skeletal component part with a box-shaped section. It is used for a side sill, pillar, side rail, front side frame etc. that require high strength.



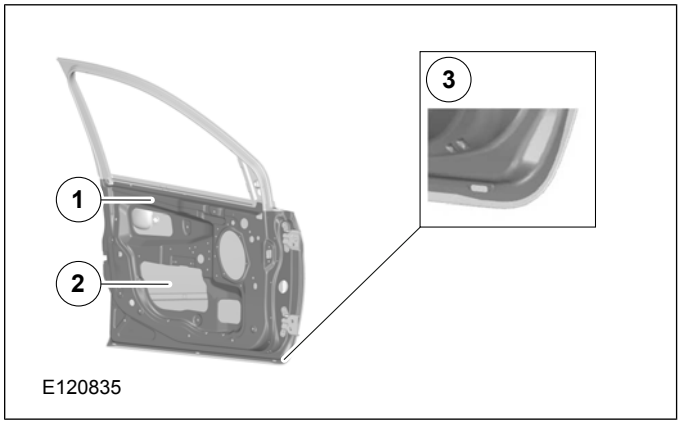
Beading

It is used for large panels (floor panel, roof panel), and its panel strength.



Hemming

It is used at panel joints where an outer panel and inner panel are press-jointed.

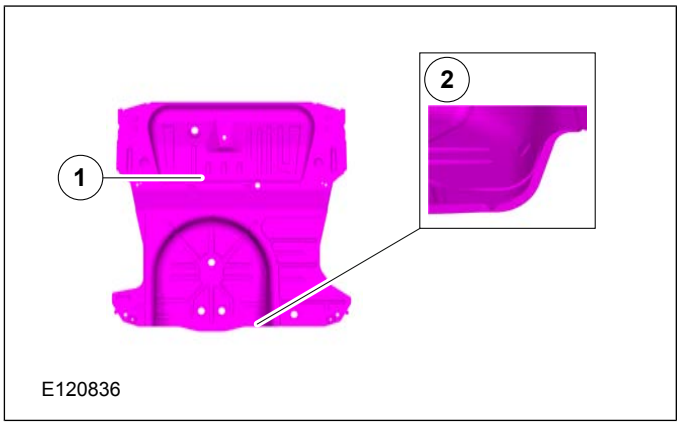


Item	Description
1	Door Inner Skin Panel
2	Door Outer Skin Panel
3	Hemming

Burring

It is used around the cutting holes for water drains on floor panels. The projected edge around a hole increases its panel strength.

DESCRIPTION AND OPERATION



Item	Description
1	Rear Floor Panel
2	Burring

Manufacturing Process of Steel Sheets

The alloy of iron (Fe) and carbon ©) is called “Carbon Steel”. As compared to other metallic materials, it is easily mass-produced and thus cheaper in price. Because it is possible to change the property of a carbon steel as is required by adding other elements or by heat-treating it, carbon steel is very widely used in the industries. Steel sheets made from rolling of carbon steel ingots are used widely in the automotive industry because it is especially good on presswork process. Carbon steel accounts for more than 50% of the total weight of a car.

1. **Iron manufacture**: Iron is contained in iron ore as iron oxide. The iron oxide is further tightly mixed with other minerals called gangue. In order to extract only iron from iron ore it is first necessary to remove oxygen (reduce) from the iron oxide and then separate gangue from the reduced iron. Coke (carbon) heated together with iron oxide plays the role of reducer and limestone the role of gangue separator.

2. **Steel making**: The pig ore extracted after the washing process includes excess carbon and other impurities that make the ore too hard and brittle. Therefore, it can be used only for limited purposes so that it is necessary through this process to reduce carbon contents and other impurities in order to obtain the desired chemical contents.

3. **Ingot** making Process to make ingots by pouring molten steel into a mold. The quality of ingots dominates the surface and inside quality of steel sheets.

4. **Slab making**: By heating ingots in the furnace until the temperature needed for rolling and by using a slab roller to remove bubbles in ingots, the internal steel structure and also the steel quality are improved. The thick slabs “normally 100 to 300mm (4.0 to 12.0in.) thickness” are produced. Surface defects and of the slabs that contain impurities more than limits are cut off.

5. **Hot-rolling**: Slabs produced through the slab making process are heated in the furnace until they reach the temperature required for the hot rolling process. The slabs taken out of the furnace have all the scales on the surfaces removed by a scale breaker and then rolled flat to about 25 to 40 mm (1.0 to 1.6 in.) thickness by a rough roller. After the scales on the surfaces are again removed, they are rolled flat to the required thickness as a product by a finishing roller. Most of the cool-rolled steel sheets used for automotive body components are further processed by the following process.

6. **Picking process**: On hot-rolled steel sheets rolled at 1472 to 1652°F (800 to 900°C) lots of scales grow that impair external appearance and lower the quality. They are, therefore, washed with sulfuric acid or hydrochloric acid before the cool rolling process.

7. **Cold rolling process**: After washed with acid, they are press-rolled to the required thickness.

8. **Annealing process**: Because the crystal structures in steel sheets are elongated in the direction of press rolling after cold rolling, the structures are left deformed causing work hardening. As the result of that, they are not good on work the process. In order to ease work processing, the steel sheets are heated up to about 1202 to 1292°F (650 to 700°C) and held at that temperature for a certain time so that their structures are correct and re-crystallized.

9. **Thermal refining rolling process**: Thermal refining rolling process is carried out to improve the steel sheets mechanical characteristics and give a final finish on the sheet surfaces. After this process, the elongation rate is improved to 0.3 to 3 %.

Characteristics of Steel Sheets

Steel sheets are of two types. One is a hot rolling steel sheet (JIS mark SPH) and a cold rolling sheet (JIS mark SPC). A hot rolling steel sheet is rolled above re-crystallization temperature “normally 1472 to 1652°F (800 to 900°C)”. In order to make it thinner, it is again cold rolled, but as it becomes

DESCRIPTION AND OPERATION

hard due to the rolling process, it is softened through an annealing process for better forming. This is called a cold rolled steel sheet. In automotive body components, while hot rolling steel sheets are used for frames and other parts of load vehicles like trucks and vans, cold rolling steel sheets are mostly used for monocoque bodies of passenger car. Because anti-corrosion feature is required for such panel parts as outer panels, side frame panels and wheelhouses, zinc treated cold rolling steel sheets are widely used.

Sheet Thickness

During the hot rolling process, slabs must be rolled while they are still hot. As they are cooled while being rolled, they cannot be rolled thin flat. On the other hand, cold rolling steel sheets can be rolled at normal temperature; it is possible to manufacture thin steel sheets.

Sheet Surface

As hot rolling steel sheets are rolled at a high temperature, a black oxidized (black skin sheets) grows on the sheet surface. The surface of the sheets that have been washed with oxide is gray. On the other hand, the surface of a cold rolling steel sheet is smooth with gloss (often called polished sheet) as it is subjected to the pickling process, cold rolling , annealing, and thermal refining rolling process after the hot rolling process.

Easiness on Work Process and Strength

Most of the body component parts are press formed. The easiness on presswork is determined by technical specifications of materials. Those technical specifications are, in turn, determined by material contents as well as the extent of thermal refining rolling. If the easiness of presswork is compared in terms of elongation rate obtained by an elongation test, a hot rolling steel sheet (SPHC) has about 35 % elongation rate while a cold rolling sheet (SPCC) has about 43 %, indicating that a cold rolling steel sheet has better easiness than presswork. If compared with pulling strength, a hot rolling steel sheet (SPHC) has a 320 Mpa (33 kgf/mm2) nominal value, while a cold rolling steel sheet (SPCC) has a 290 Mpa (30 kgf/mm2), showing no substantial difference between the two, but when it comes to high grade materials, their pulling strength come down to 270 Mpa (28 kgf/mm2).

Types	Marks	Purpose	Carbon ©)	Mangan (Mn)	Phos-phor (P)	Sulphur (S)	Classific ation	Mark
Type 1	SPCC	General Use	Less than 0.12	Less than 0.05	Less than 0.040	Less than 0.045	Annealed only	**A**
Type 1	SPCC	General Use	Less than 0.12	Less than 0.05	Less than 0.040	Less than 0.045	Normal thermal refining	**S**
Type 2	SPCD	Drawing	Less than 0.10	Less than 0.45	Less than 0.035	Less than 0.035	1/8 hard-ness	**8**
Type 2	SPCD	Drawing	Less than 0.10	Less than 0.45	Less than 0.035	Less than 0.035	1/4 hard-ness	**4**
Type 3	SPCE	Deep Drawing	Less than 0.08	Less than 0.04	Less than 0.030	Less than 0.030	½ hard-ness	**2**
Type 3	SPCE	Deep Drawing	Less than 0.08	Less than 0.04	Less than 0.030	Less than 0.030	Full hard-ness	**1**

Anti-rust Steel Sheets

In order to raise the anti-rust feature, the anti-rust steel sheets are electro-plated with zinc, tin or aluminum on their surfaces. Among them, zinc-plated steel sheets have the most reliable anti-rust feature so that these steel sheets are most widely used for automotive component parts that require high anti-rust conditions. Some of the well-known zinc-plated steel sheets are an electro-zinc plated steel sheet, molten zinc plated steel sheet, and alloyed molten zinc plated steel sheet.

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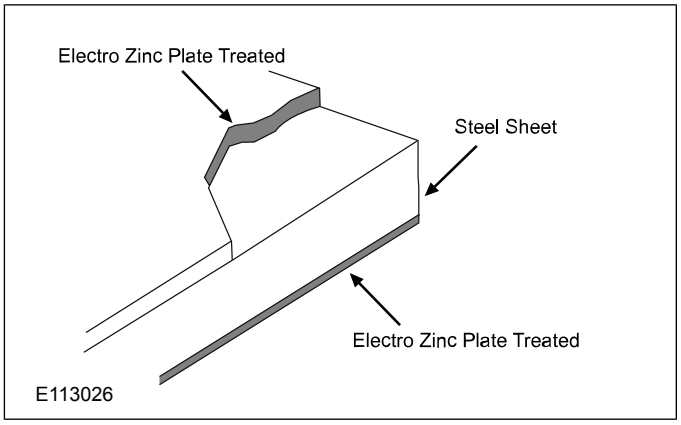
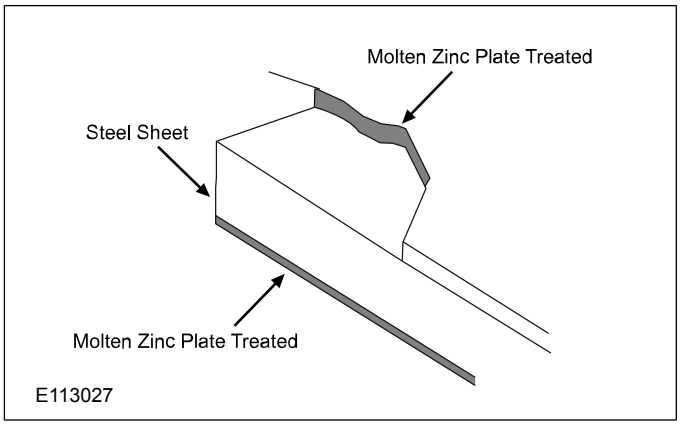
Electro Zinc Plated Steel Sheet

This is an anti-rust steel sheet on which surface high purity zinc is crystallized through electric plating process. Though its zinc-plated thickness is thinner than that of the molten plated steel sheet, this sheet is better that in press forming, welding and surface plating because it surface is much evener. But, it is inferior to the molten zinc plated steel sheet in anti-corrosion feature as it cannot be think-plated.



Molten Zinc Plated Steel Sheet

Steel sheets are covered with zinc by dipping them into molten zinc. This sheet has better anti-corrosive features than others but is inferior to the electro-zinc plated steel sheet in welding and painting.



High-tension Steel Sheets

Though thick high-tension steel sheets, of which tensile strength is more than 550 MPa (55 kgf/mm2), have been used for frames or other component parts of heavy-duty vehicles, its yield point and yield rate are too high to provide the desired easiness of press forming and welding strength, so it has been determined not to use it for automotive body panels. Later, however, as a much improved high-tension steel sheet in easiness in press forming, and welding has been developed, it is now used for skeletal members and reinforcement members and even for body panels. As the high-tension steel sheet is thinner than the conventional soft steel sheet, though it provide the same level of strength, its use reduces to the body weight.

Technical Characteristics

- High tensile strength
- High yield point (the point where material changes from elastic to plastic)
- High yield rate (yield point/tensile strength)

Sheet Thickness Guidelines

Coating

Manufacturers use coated and non-coated steel sheets for building the vehicle. In most of the cases the sheet blanks are coated either in single side or in both sides. Coating provides better resistance against corrosion and improves the welding and other parameters of the steel.

However pretreatment of BIW (body In White) in the early painting stages and adequate sealer application provides sufficient resistance to fight with corrosion.

Sheet Thickness

This model is produced using sheet panels of various thickness. Where strength and rigidity is required combination and tailor panels are deployed. Given below are the thickness of the sheets for general understanding.

0.63, 0.75, 0.80, 0.85, 0.90, 1.00, 1.13, 1.25, 1.38, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75 & 3.00

Aluminum

Aluminum is becoming ever more important in body construction because of the trend to reduce weight. Doors, hoods and body outer panels are increasingly being made of aluminum alloy panels.

Although at the time of publication of this document, Ford of Europe has not yet introduced any aluminum body or aluminum body components, this topic is briefly described in this section.

NOTE: Fine aluminum dust may catch fire if a flame or spark touches it. All persons working in

DESCRIPTION AND OPERATION

the workshop should pay special attention to this danger.

All the tools needed for body repair must be suitable for working aluminum, and they must be only used on aluminum.

The main properties of aluminum are:

- Low weight.
- High resistance to corrosion.
- High strength.
- High deformation rigidity.
- Very good heat conductivity.
- Very good electrical conductivity.

NOTE: When working aluminum components pay particular attention to avoid the danger of contact induced corrosion. The workplace must be free of steel swarf, and tools which have worked steel panels must not be used.

In the electrochemical potential series, aluminum has a negative potential of 1.23V in relation to steel. Because of this, when aluminum and steel touch and an electrolyte is present, contact corrosion occurs.

The following points should therefore be noted:

- Use only checked and coated connecting components (bolts, nuts, washers etc.).
- Always use new bolts.
- Use adhesives and sealants which are tolerant towards aluminum.
- No steel swarf in the workplace. Clean the workplace and pay attention to any steel-sanding dust from neighboring workplaces.
- Use a separate set of aluminum working tools.
- Use wire and rotating brushes made of stainless steel.

NOTE: In-depth knowledge and skill in panel beating techniques are the basic requirements for the repair of aluminum panels.

In the main, aluminum panels can be worked using the same processes as used for steel panels. There are however some special features to pay attention to:

- Do not use steel hammers or sharp-edged panel beating tools.
- Only use hammers with smooth surfaces.
- Working cold aluminum leads quickly to embrittlement. For this reason, perform more extensive mechanical deformation removal under exact temperature controlled heating.

NOTE: If uncontrolled heating is used on an aluminum panel, it will very quickly be destroyed, and a new one must then be installed. The necessary specialist knowledge cannot be given in theory, special courses must be attended instead.

In contrast to steel, aluminum does not display any surface color change when heated. This therefore means that the level of heating of the material cannot be seen.

Only once the material is overheated does a change in the material structure of the surface occur. By the time this has occurred, the structure of the material is already seriously damaged, and its strength very much reduced.

Overheated aluminum components must always be replaced.

Aluminum welding

Aluminum welding requires a welder which is specially designed to meet these requirements.

NOTE: As a rule, vehicle manufacturers require that persons who wish to weld aluminum must show evidence of having completed special training in aluminum welding. Please study the guidelines.

Both repair welding processes are based on fusion welding.

- MIG welding (metal-inert gas welding).
- MAG welding (metal-active gas welding).

Success of aluminum welding partly depends on how well the surface oxidation can be removed. Because aluminum oxide remains solid at the melting point of pure aluminum, it is important to remove it before welding.

- Melting point of aluminum (approx. 660 °C).
- Melting point of aluminum oxide (approx. 2040 °C).

The aluminum surface must be cleaned before welding. Cleaning improves the later fusion penetration and prevents contamination of the welding wire.

NOTE: If a stainless steel brush is used, it must never come into contact with steel components, so that it does not become contaminated.

The following three steps are to be performed in preparation:

DESCRIPTION AND OPERATION

- Clean the surface. Use a chemical cleaner to remove all traces of wax and other contaminants.
- Remove the oxide. This can be done using abrasive paper or a stainless steel brush.
- Wipe the oxide dust away with a lint-free cloth.

Aluminum oxide forms very quickly, therefore steps 2 and 3 should be performed immediately before welding.

Before working on the vehicle body, create a test seam on scrap which is made of identical material. Test the test piece visually and destructively, to make certain that all welding parameters are correctly set, and an acceptable weld seam can be achieved.

An optimum weld can be recognized by the following quality features:

- All visible weld surfaces are clean, light and have the same profile.
- The weld seam should have the same height and width over its complete length.
- There must have been complete melting between the surfaces of the work piece and the weld metal.
- The correct penetration has been achieved when a thin continuous line can be seen on the reverse side.

DESCRIPTION AND OPERATION

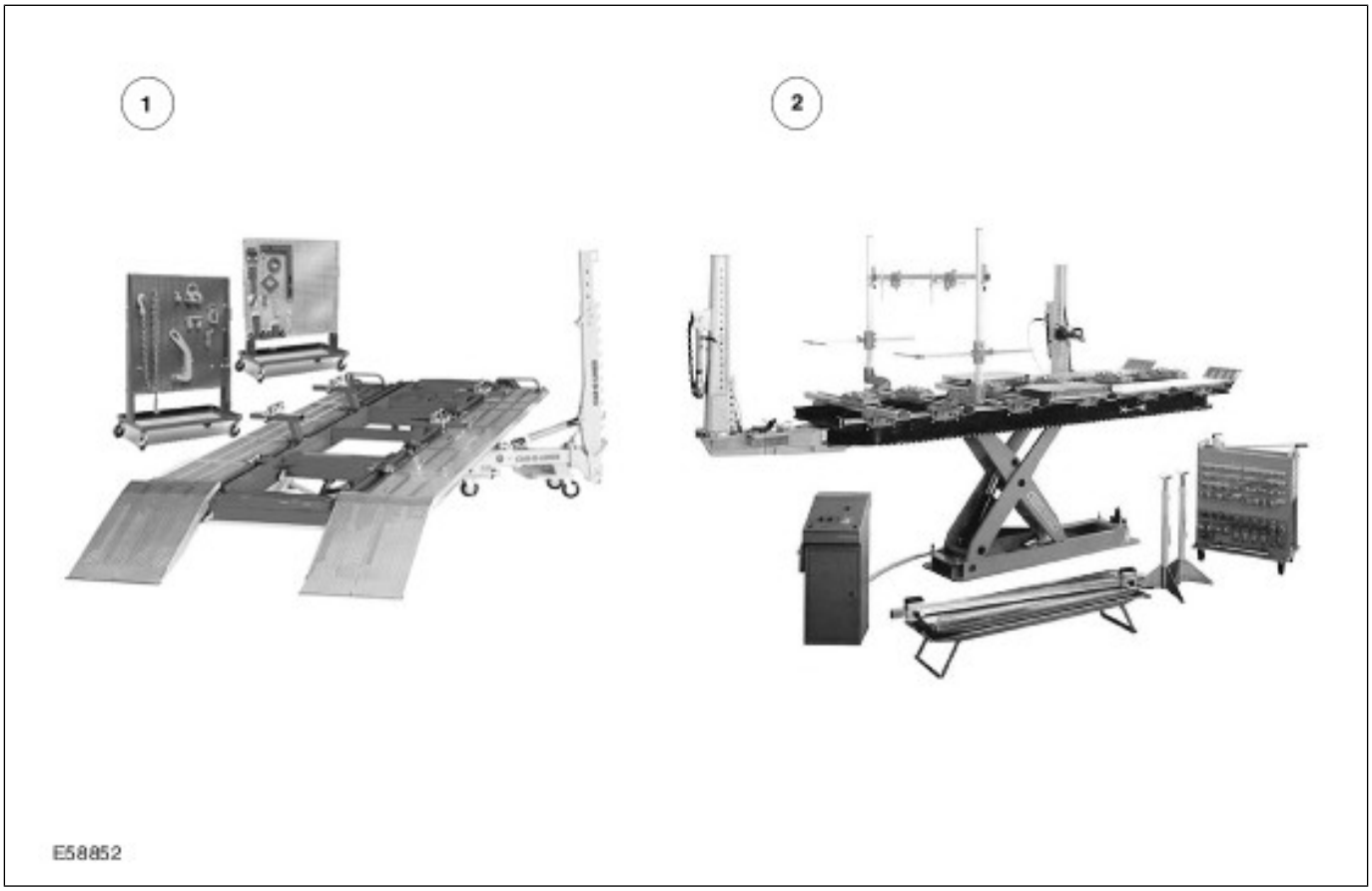
Tools and Equipment for Body Repairs

Alignment systems

NOTE: Please refer to the Ford Service Equipment Catalog for information on the body tools recommended by Ford.

Straightening and alignment repairs are often required to restore a vehicle body to its original shape after accident damage.

Universal aligning and measuring systems and universal alignment angle systems are suitable for this work.



Item	Description
1	Universal aligning and measuring system
2	Universal alignment angle system

Basically, the aligning and measuring system must satisfy the following requirements:

- Universally applicable to all types of passenger car. Can also be used on light commercial and off-road vehicles.
- Accepts the forces involved during straightening.
- High stability and mobility.
- Can accept all or part of the weight of the vehicle.
- Quick to set up.
- Simple to use.
  - Stationary design with drive-on ramp.
  - Height-adjustable aligning platform.
  - Universal gauge extensions with fast anchoring ability around the whole circumference of the aligning platform.
- Facility to test individual body measurement points, with or without aggregates being removed.

Alignment angle devices survey the vehicle at several points on the body. These are usually points which are also used in production. In addition, a recording over the rocker panels is possible. A measuring system is not needed, because the necessary body points are specified with gauges. For this purpose, vehicle specific or universal gauges are available.

DESCRIPTION AND OPERATION

Universal alignment systems consist of a vehicle mounting (universal clamps at the rocker panels) and a pulling device. In addition, a measuring system is required.

NOTE: Because universal clamps are used, the rocker panel area must be reworked for optical and corrosion protection reasons after the repair is completed.

Pay attention to the following points:

- Clean the attachment areas.
- Anchor the vehicle free of stress on the relevant system.
- Support the aggregates to take strain off the body.

Measuring systems

In order to exactly diagnose a damaged vehicle body, measuring systems are required. Depending on the measuring method, the systems vary in having mechanical, optical and acoustic measuring devices. In some cases, hybrid versions of particular systems are found.

NOTE: When working with each measuring system, the manufacturer's instructions provided in the description of the measuring equipment must be followed.

Basically, the measuring systems must meet the following requirements:

- Universally applicable to all types of passenger car. Also can be used on light commercial and off-road vehicles.
- Suitable for all accident damage.
- Fast capture of body measurement points in the underfloor and external areas.
- Data catalog to record all measurement points (length, width and height) both with and without the aggregates being installed.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range of training offered in the Ford Service Organization training brochure.

Beam compass

The beam compass is a very practical and straightforward aid for measuring bodywork and especially floor assemblies. The beam compass can be used to detect dimensional variations across the length and the width by means of comparison measurements and diagonal measurements.

As a basic principal, body reference points should be chosen which are shown in the body frame measurement data sheet.

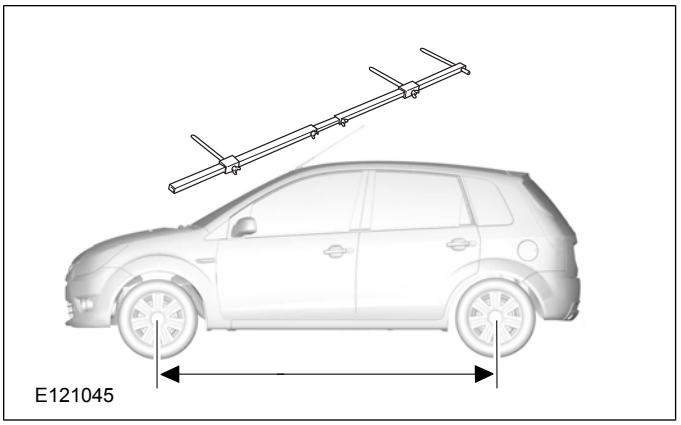
NOTE: To be able to determine difference in measurements, the same reference points must always be chosen on both sides. For this purpose the beam compass must be positioned symmetrically.

Comparison measurements can also be made on the outside of the body. Depending on the damage, left/right measurements (symmetry measurements) and diagonal measurements can be made using the beam compass, telescopic rod or a measuring tape.

Wheel Base Gauge

Used to measure the wheel base length, dimensions of a body, and an under body.

Using together with a centering gauge, it is possible to numerically evaluate the level of the damages.



Tram Tracking Gauge

Used to measure the size of a damage of a body and other large parts.

Because of its expandable measuring probes, it can be widely used for a variety of measurements.

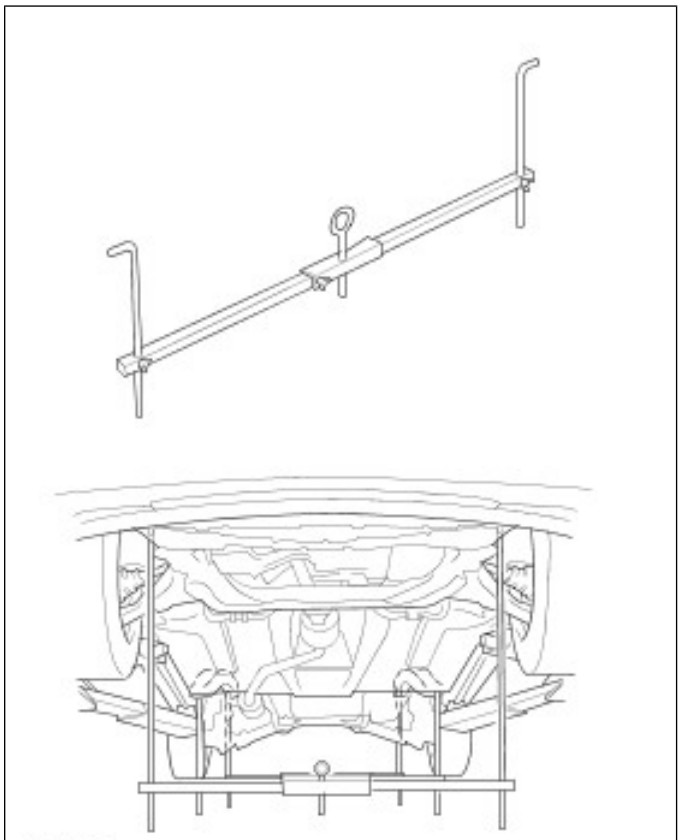
DESCRIPTION AND OPERATION


E113043

Centering Gauge

Used to measure the twists, bending in a side or forward/ rearward way of the body and frame.

The deformation of a body and frame can be easily viewed by eye.


E113044

Laser measuring systems

These systems use laser beams which are projected in one or more planes.


E59220

By the use of two parallel laser heads which can be turned, symmetrical points of a vehicle body can be tested and compared. Using the linear scales which are attached to the measuring points, the measurement data is read off with the aid of the projected laser beams.

The integral inclination gauge also allows differences in height to be quickly checked.

DESCRIPTION AND OPERATION

Mechanical measuring system

The use of mechanical measuring equipment is an easy and effective way to check a vehicle frame and chassis assembly quickly, exactly and reliably.

In many cases an assessment of the damage can be made with the help of this system, without the need for elaborate setting up.

E59088

Because of its self-centering mount, measurement can be carried out by one person.

Further advantages:

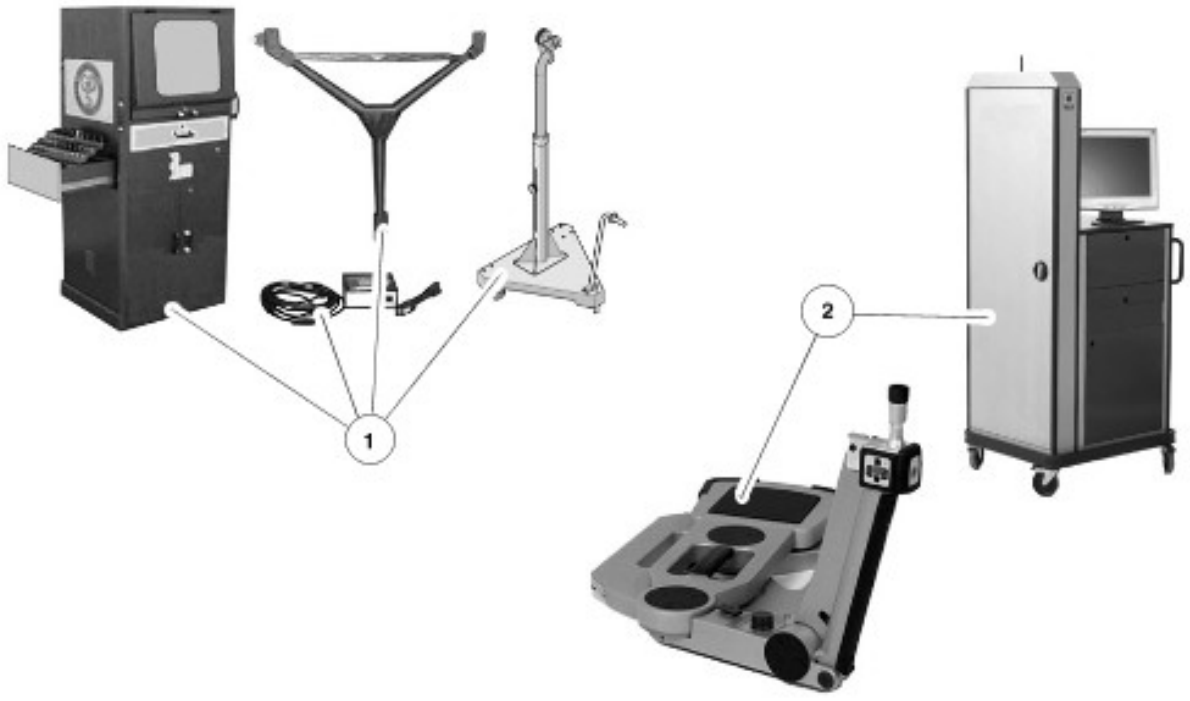
- Fast deployment.
- Simple to use.
- Can be extended using adapters, measuring probes and measuring tubes.

Measuring systems which are firmly mounted on an aligning platform require more work in setting them up. They are used to constantly check measurements during alignment work.

This type of mechanical measuring system has measuring scales and measuring slides in three measuring axes. So that the body can be measured, the vehicle is secured on the aligning platform base frame using four universal chassis clamps. The exact fixing points are given in each respective data sheet.

Acoustic-electronic measuring systems

These measuring systems can be combined with all current aligning platforms. In addition these measuring systems can be used independently of an aligning platform by using a vehicle lift or suitable support stands.



E59221

DESCRIPTION AND OPERATION

Item	Description
1	Ultrasound measuring instrument
2	Mechanical-electronic measuring system

Acoustic measuring systems use ultrasonic emitters and sensors to survey a body.

To do this, ultrasonic emitters are mounted on the vehicle using special attachments. During the measuring process the ultrasonic emitters constantly send out signals which are received by sensors (microphones) and then passed to a computer. The measurements are displayed on the computer screen and are compared with the required values supplied by the vehicle manufacturer.

Mechanical-electronic measuring system

The ways in which mechanical-electronic measuring systems can be used are similar to those of the acoustic measuring systems. They can also be set up on a suitable understructure, without an alignment jig.

After this system has been arranged under the vehicle floor and adjusted to three undamaged vehicle measuring points, the measuring arm is brought up to the required measuring points and the readings compared with the reference values.

The data is transmitted to a computer where it is evaluated and the results displayed on a screen.

Panel beating tools

Depending on the type and extent of the damage to the vehicle body, very different tools may be needed to repair it. The most usual tools and the way they are used are described below.

Item	Description
1	Aluminum hammer
2	Tapered hammer
3	Universal hand dolly
4	Box file

Item	Description
5	Pulling lever and spoon
6	Caulkers
7	Body plane
8	Body file

DESCRIPTION AND OPERATION

Item	Description
9	Gas torch
10	Soft soldering equipment
11	Shape gauge
12	External dent remover/puller

Aluminium hammer

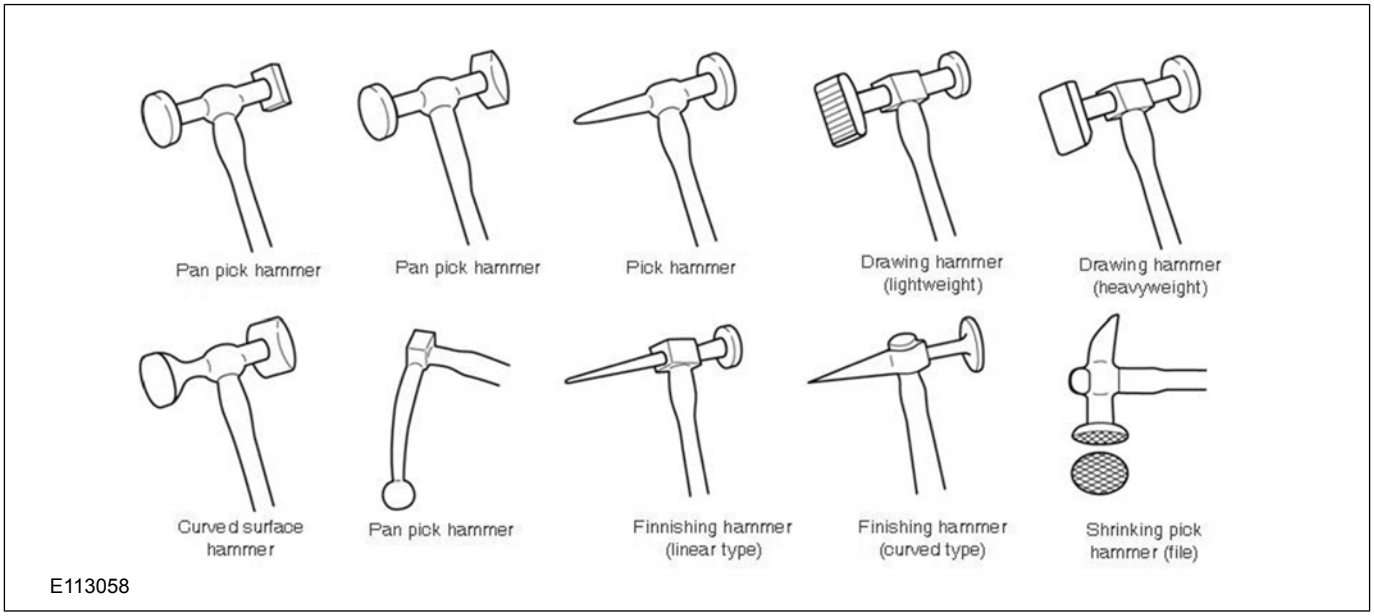
The aluminum hammer is the most important and most commonly used tool during body panel repair. The most usual areas of application are:

- Straightening of a dent from the inside without a counterhold (hollow leveling).
- Working a panel from outside with or without a counterhold.

Tapered hammer

The tapered hammer is chiefly used to rectify small high-spots.

Some other type of hammers are shown below.



Universal hand dolly

Because of its versatile shape, the universal hand dolly can be used as a counterhold in almost all areas of the vehicle body.

It is particularly suitable for use as a counterhold when rectifying material excess.

Because of its weight, the universal hand dolly can also be used as a hammer to straighten a dent from inside without counterhold (hollow leveling).

Box file

The box file is mainly used as counterhold in fine straightening work with the aluminum hammer. It is available in various shapes and sizes.

The corrugated surface (file-cut) prevents the panel from stretching during fine straightening work (barb effect).

Using the file-cut imprint on the panel surface, the effect and extent of the blows from the panel beating hammer can be judged.

Pulling lever and spoon

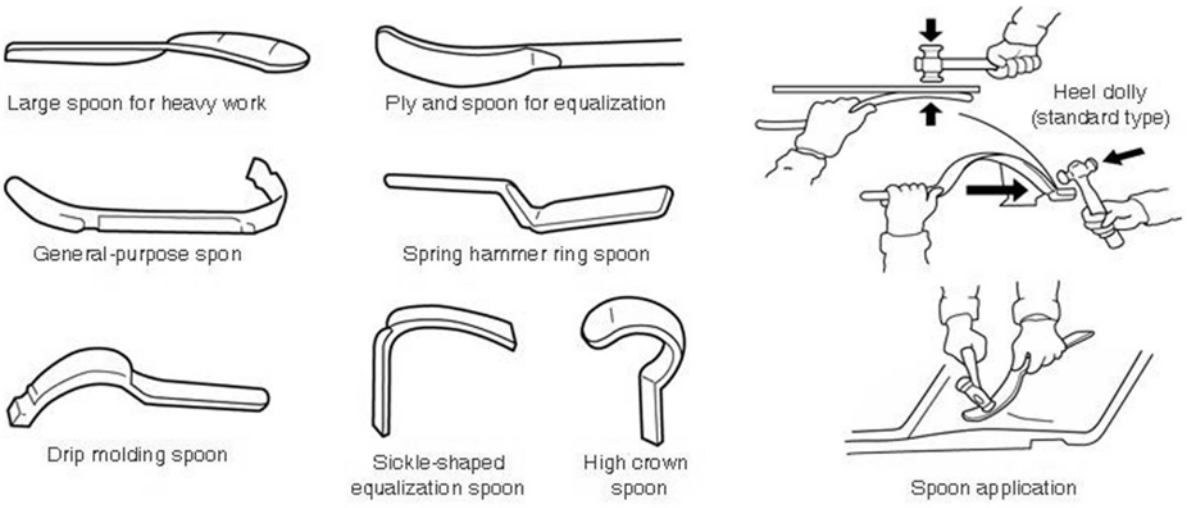
If access to the rear of the damage with the panel beating hammer is not possible, a panel beating lever can be employed.

Once the worst of the damage is rectified, work continues with the spoon. This also allows short striking movements to be made in inaccessible areas.

A spoon is often used as a counterhold in work with the panel beating hammer.

The most common type of spoons are shown below.

DESCRIPTION AND OPERATION



Caulkers

A caulker is mostly used in edge areas. In this case the caulker is inserted on the inside of the damaged area.

Selected blows on the shaft of the tool allow the damaged edge area to be reworked.

Caulkers can however also be used for straightening small areas which can only be reached from the back through small openings.

Body plane

The body plane consists of the two-faced plane blade and the solid plane body, which prevents pressure deformation of the plane blade.

The body plane is available in half-round and flat versions. The main application areas are:

- Recognition of surface high spots by creation of a so-called plane image.
- Removal of excess solder after its application to uneven areas.

Body file

The body file is used solely during heat treatment working of dents.

Because of the solid body of the file, it can absorb much heat. It stabilizes repair areas which are being straightened by warming. It does this by rapid removal of heat from the repair area, which has the effect of stabilizing the body panel.

Body files are graded by the size of their teeth (file-cut):

- The zero-cut file grade is used in the first working operation to remove the paint layer.
- The finer 1st and 2nd cut grades are used in the second working operation to remove as little material as possible from the panel.

Gas torch

The main area of use of the gas torch is heat working of small and mild dents. It is also suitable for soft soldering work on body panels.

The ready-to-use gas torch consists of the following parts:

- Gas canister with fixing.
- Burner with self-light facility.
- Small and large burner heads.

Compare with oxy-acetylene equipment, the gas burner has the advantage of easier handling due to its lower weight and shorter set-up times because of the quick-change burner heads.

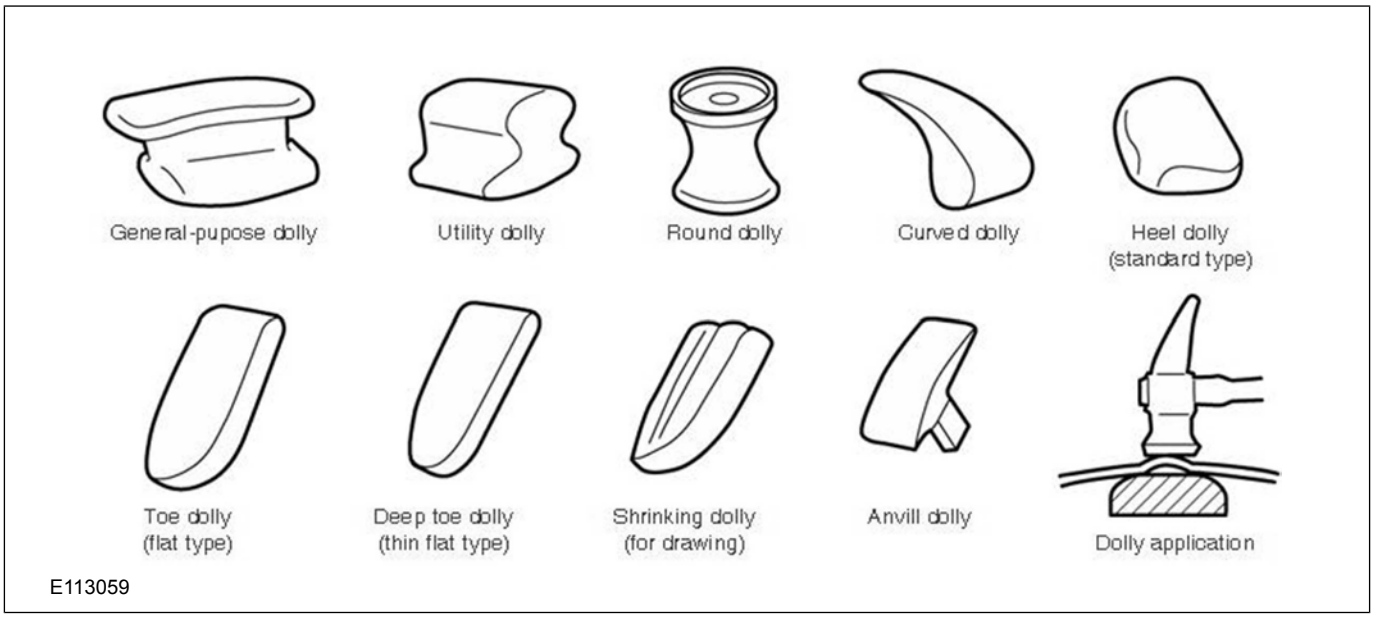
Soft soldering equipment

Despite good panel beating technique, it is not always possible to rectify all unevenness. For that reason, application of filling solder is an important part of surface treatment. Similarly the surface of weld seams created during partial repairs can be optimized.

Dollys

The most common type of dollys used are shown below.

DESCRIPTION AND OPERATION



NOTE: New wooden paddles must be soaked in clean engine oil before use, so that the filling solder does not attach to the wooden block.

A complete soft soldering kit consists of tinning paste, soft solder and brush. In addition, a set of wooden paddles with a variety of shapes and a lint free cloth rag are needed.

NOTE: Since 07/2003, no lead compounds are permitted to be used in production. In the workshop suitable lead-free solder must also be used.

Shape gauge

The shape gauge is used to check the contours of the area to be reshaped, when there is no other way of recognizing and checking the basic shape.

There are various designs of shape gauge. The short design made of steel is used for smaller repair areas. Because its segments are very thin, it allows a very exact fit at a contour. The longer design made of plastic is applied to larger areas. Because of its wider segments, it is better suited to large surface contours.

External dent remover/puller

Because of their multi-purpose nature, external dent removers and pullers are very useful in achieving an economical repair to a vehicle body outer skin. These repair methods are used on vehicle body components which are inaccessible from the inside. Small dents such as those caused during parking and larger areas of damage such as on the side panel, rocker panel etc. can be rectified.

Basically there are three different methods:

- Straightening using a slide hammer attached to U-washers, pull bits or corrugated wire.
- Straightening using the slide hammer attached to a pull electrode.
- Straightening using a pulling assembly and fulcrum.

Hydraulic tools

Use: A universal tool for minor adjustments of body, such as pillars, doors and roofs.

Maintenance: Check for leakage and change gaskets if necessary.

Keep the hydraulic couplings clean.

Put on the coupling protector when the tool is not in use.

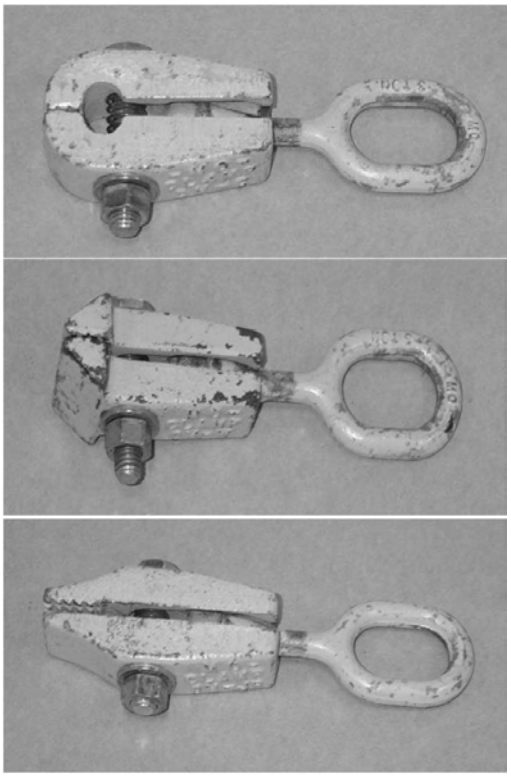
DESCRIPTION AND OPERATION

E113803

Pull Clamps

There is a clamp for almost every need. Always choose a clamp that withstand the pull force.

USES: Universal self-locking clamps for pulling work.



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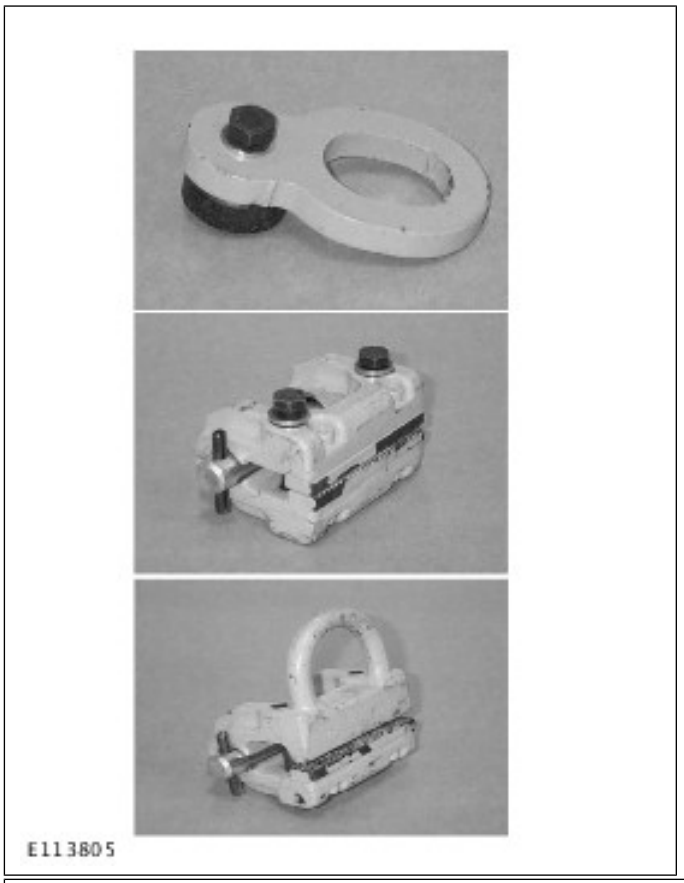
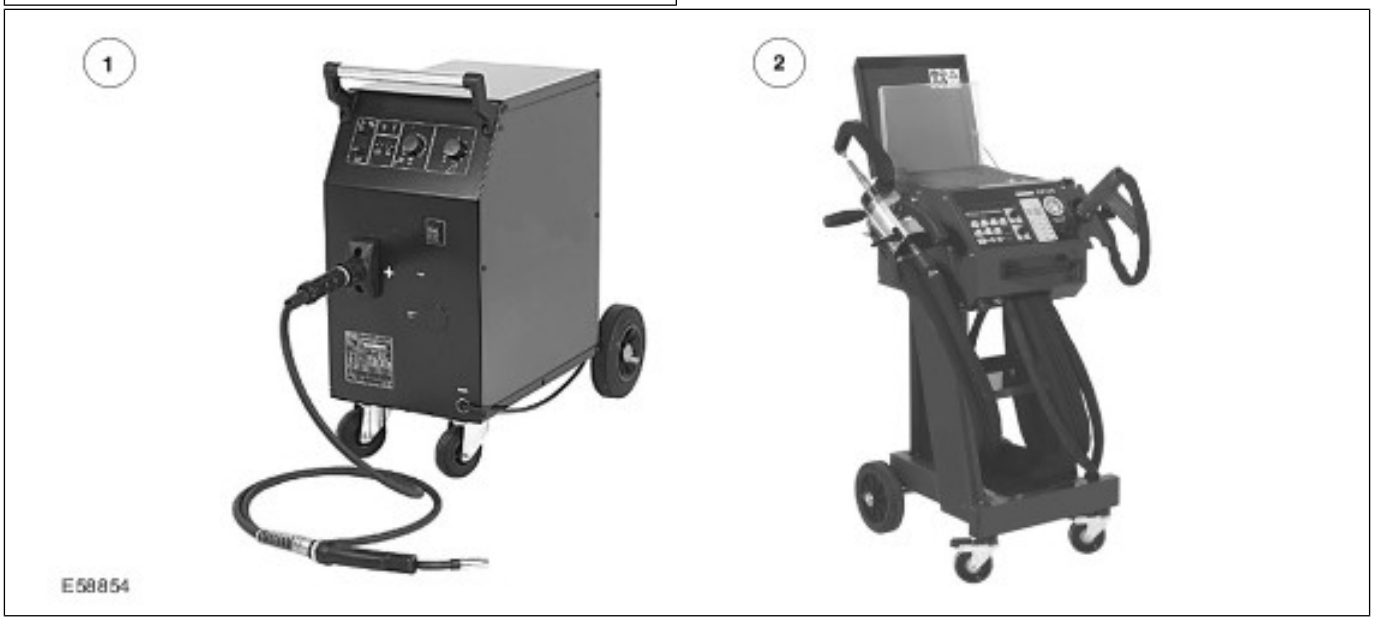
DESCRIPTION AND OPERATION



Welding gear

As in the past, the dominant process in body construction is resistance welding, in particular spot welding. Depending on body type, up to 5000 spot welds are applied, either by welding robots or in the multi-point welding machine.



Item	Description
1	MIG welding machine
2	Resistance spot welding machine

During repairs the resistance spot welds used in production must be re-created accordingly.

NOTE: If a suitably powerful welding machine is not available and multi-layer panel joints with a total thickness of over 3 mm need to be made, puddle welding must be used.

Although in principle high-strength panels are adequately- or well-suited to resistance spot welding, problems may arise, especially where large panel thicknesses or three layers of panel need to be welded together in the workshop, but these problems can be overcome.

In particular, older welding equipment does not have the latest welding technology nor welding

DESCRIPTION AND OPERATION

power and therefore cannot reliably join panel thicknesses greater than 3 mm.

Modern equipment with inverter technology allows better spot weld quality because of a constant high welding current. In addition the high welding current makes shorter welding times possible and the electrodes therefore have a longer working life.

In the case of resistance spot welded connections, faults in the weld are difficult to see from the outside. It is therefore absolutely vital to know the particular properties of the welding machine being used. A test weld with subsequent peeling test will provide information on the quality of the weld. The spot weld itself must not separate, it must tear away leaving a hole.

In the production of vehicle bodies, MIG welding plays a minor role as a joining technique. It is used for components subject to high demands, such as threaded plates for axle mountings, or at locations which cannot be spot welded for access reasons.

Separating tools

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

A variety of tools are available to the body specialist for the separation of body components. The use of the different tools depends on the joining technique involved and the access available to the repair location.

Spot weld milling tool

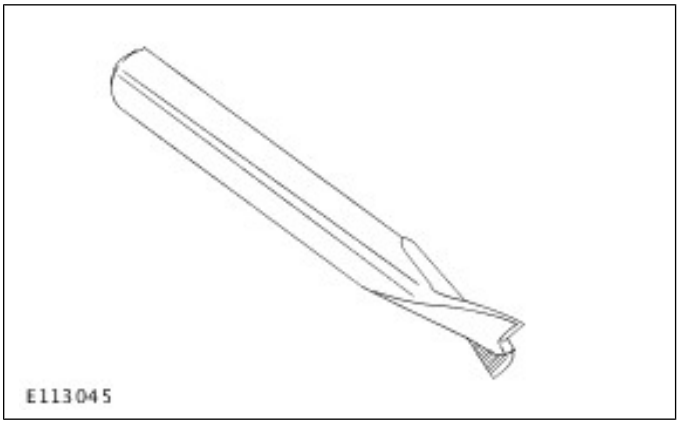
The spot weld milling tool is suitable for releasing spot welded connections.

In contrast to a normal drill, the milling depth can be set. This prevents the underlying panel from being damaged. In addition a safety fixing system prevents the milling cutter from slipping while working.

Spot Cutter (Drill Type)

Used with an air drill to cut off spot welded areas.

Makes work easy, because it does not leave any nuggets on the base plate.

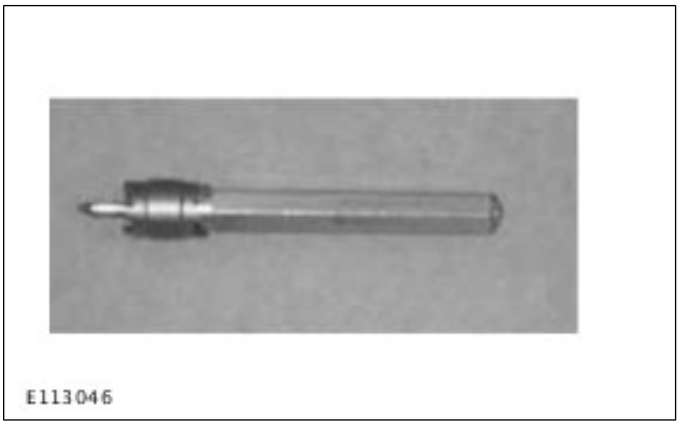


Spot Cutter (Holso Type)

Used with an air drill to cut off spot welded areas.

Because its cutting depth is adjustable the base plate is not damaged.

Grind off the remaining nuggets with a sander.

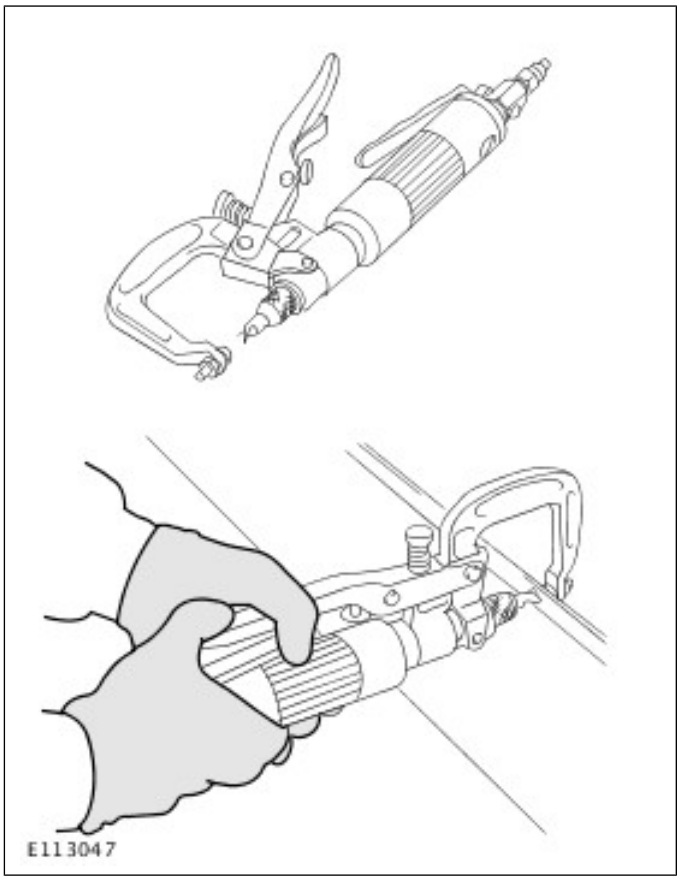


Spot Peeling off Special Air Drill

Used to cut off spot welded areas.

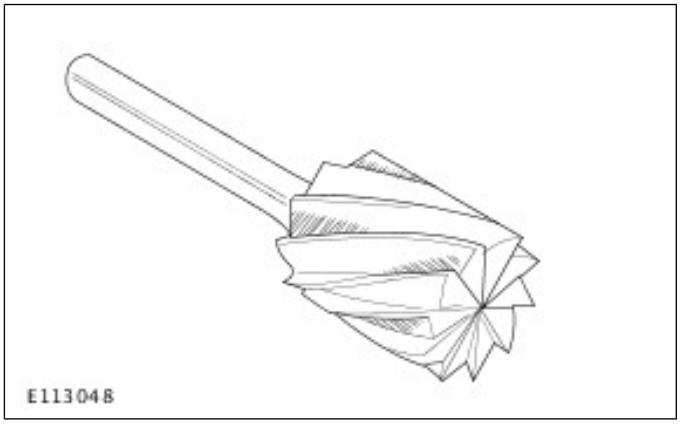
The cutter not dislodged during cutting work.

DESCRIPTION AND OPERATION



Rotary Cutter

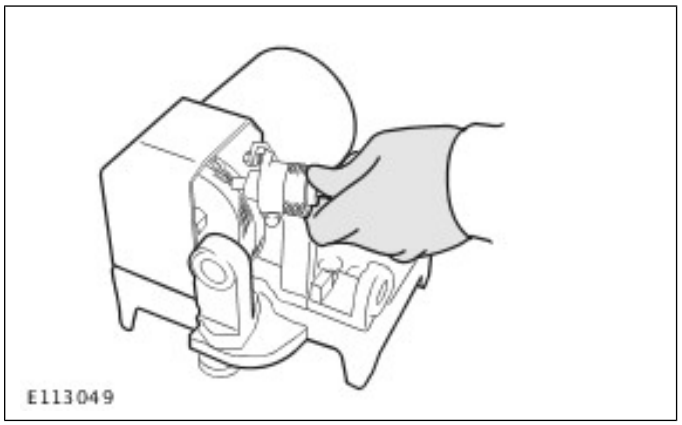
Used with an air drill to cut off cornered welded areas on aluminum alloy bodies.



Spot Cutter Grinder

Used for grinding spot cutters (drill type).

Easily grinds dull spot cutters within a short time.



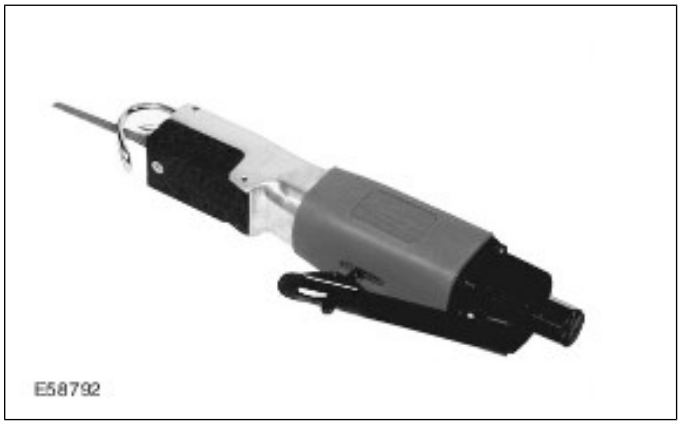
Rod sander

Spot welds which are not accessible to the spot weld milling tool can be ground out using the rod sander.

It is also suitable for releasing MIG spot welds and MIG seam welds.

Short stroke saw

The short stroke saw is most often used to separate vehicle body components.



It is also very flexible in its ability to access hard-to-reach areas.

DESCRIPTION AND OPERATION

Orbital saw

Among other things the orbital saw is suitable for the creation of narrow and straight cuts.

In addition the cut can be made to an exact depth limit. This prevents damage to underlying components.

After any work with swarf producing machines, all swarf must always be removed from cavities, otherwise there is the danger of corrosion.

Air Auto Hammer

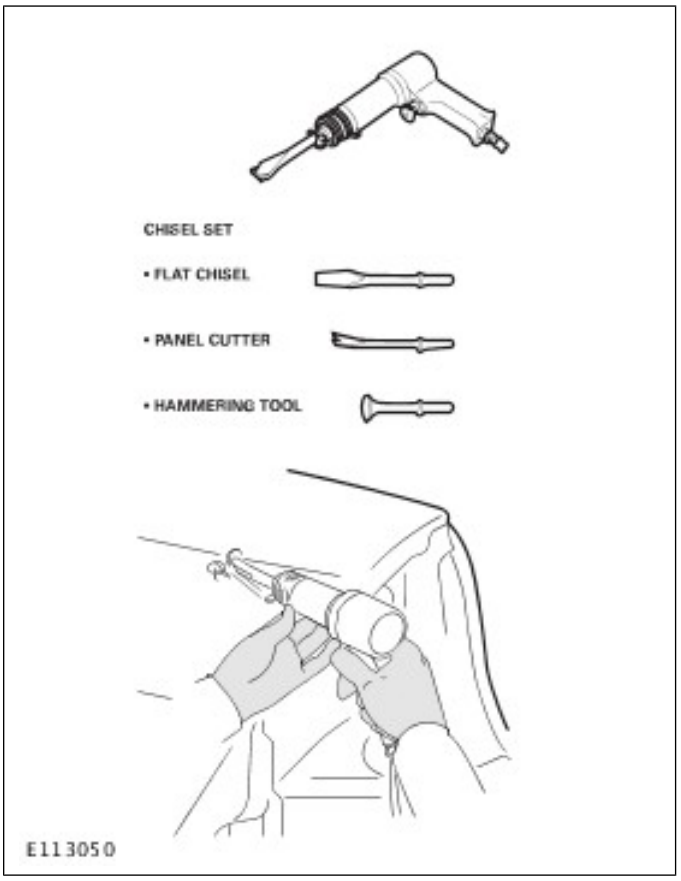
Used to roughly cut panels.

Compact and light in weight. Superb in hammering-out work.

As a panel cutter, it can cut in a straight or curved lines.

No cutting chips produced.

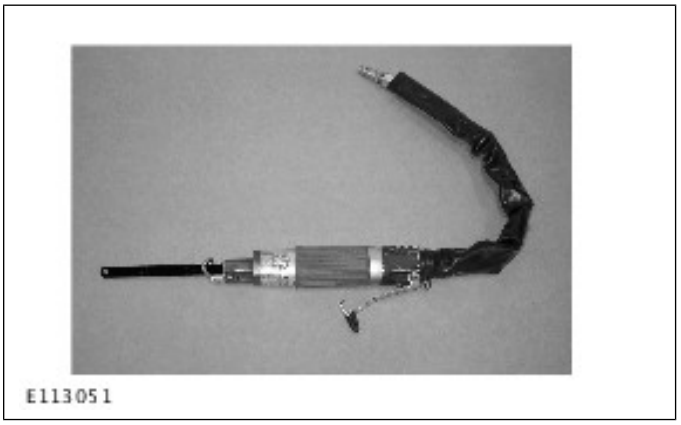
Vibration and noise significant.



Air Saw

Used to cut outer panels.

Speedy cutting but vibration and noise significant.



Air Chuck Grinder

Used to cut panels with a grinding wheel attached.

Compact and light in weight. Superb in cutting work.

Speedy cutting.

Protection needed to avoid contacting sparks splattered during cutting.

DESCRIPTION AND OPERATION

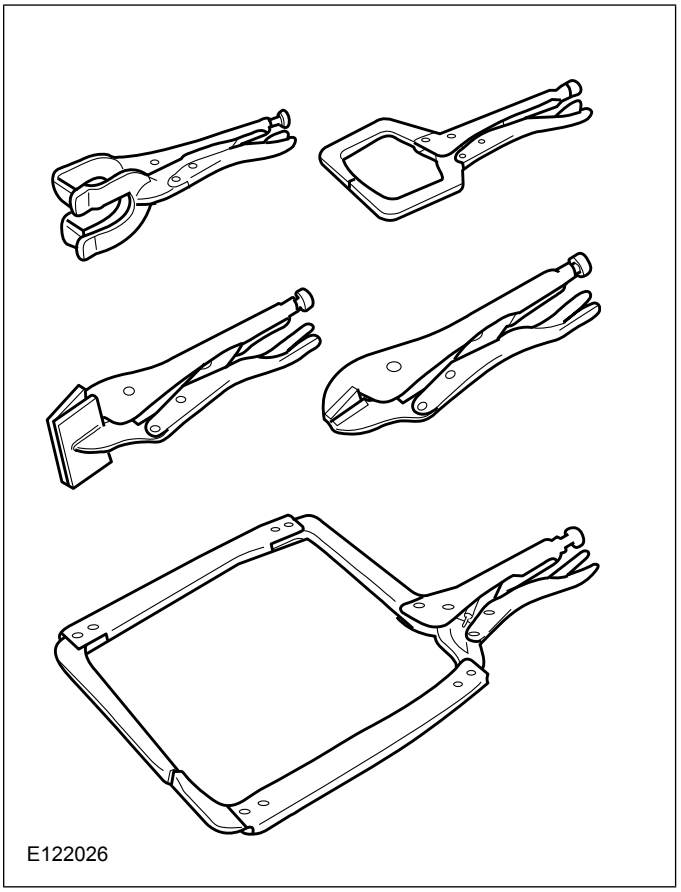
Installation Tools

Vise Grip Wrench

Used to install panels and tightening welded areas.

Adjustments of openings' dimensions and tightening forces can be easily made.

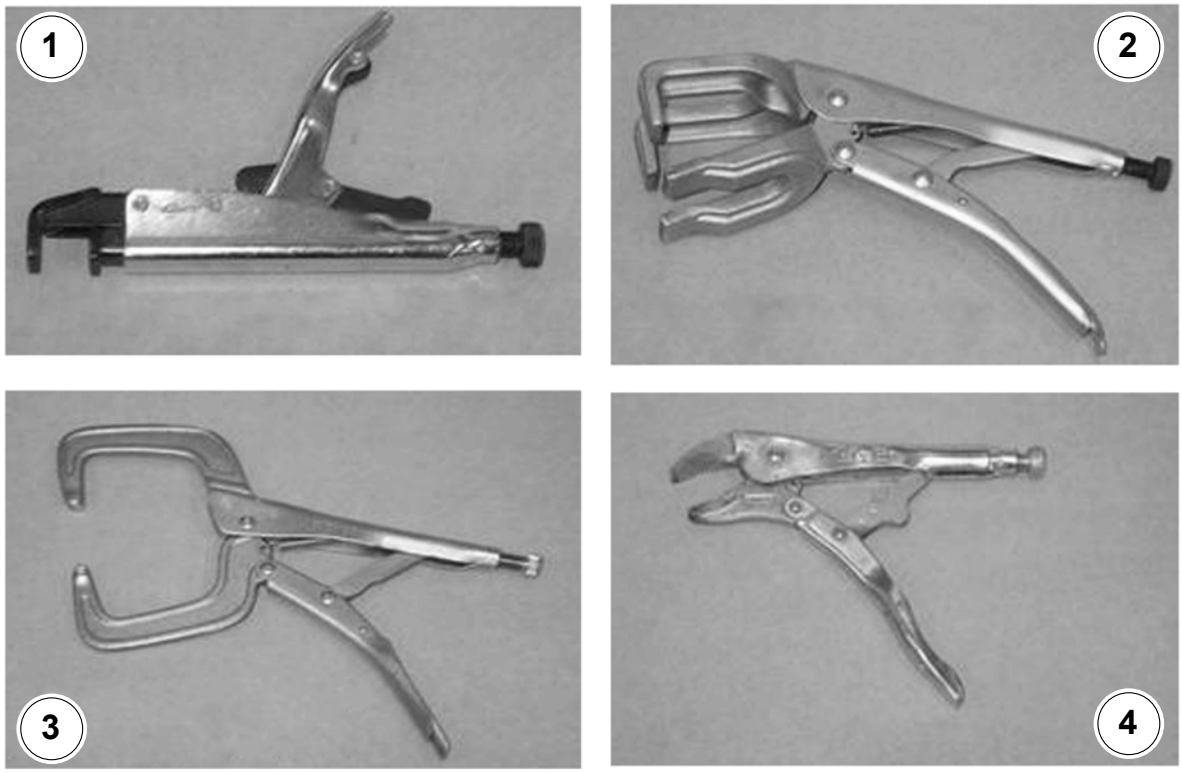
Panels not scratched easily.



C-Clamps

Some other type of C-Clamps are shown below

DESCRIPTION AND OPERATION

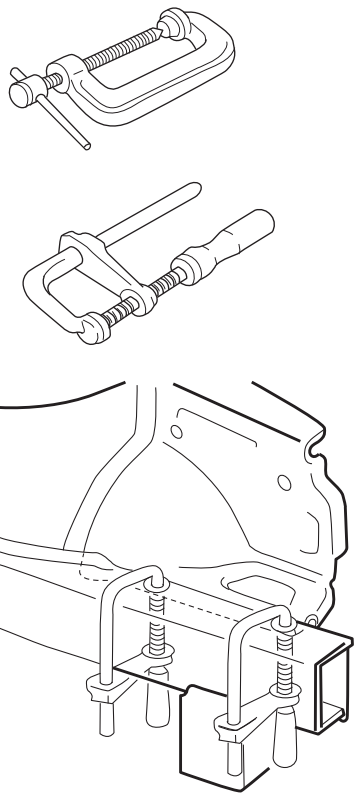


E121044

Item	Description
1	Door Opening Clamp
2	U-Shaped Clamp
3	C-Shaped Clamp
4	Clamp with Straight Jaws

Screw Clamp

Used for clamping panel for joining.



E113053

DESCRIPTION AND OPERATION

Safety Protection Gear

Welding Mask

Used during welding work.

It protects the technician from flying sparks.

E113054

Anti Dust Mask

Used during putty grinding/polishing work.

Light weight and comfortable to wear.

Authorized by governmental agency as 2nd grade item.

E113055

Face Protector

Used during sanding work on welded areas.

Anti-mist treated.

Light weight and good visibility.

E113056

Ear Plugs

Used during panel sheet work.

Small and light weight. Does not cause fatigue.

E113057

DESCRIPTION AND OPERATION

Establish Repair Method

General

Before starting an accident repair, a sequence plan must be compiled, containing an outline of the individual job steps.

Similarly, the availability and preparation of all the necessary materials, spare parts, tools, workshop equipment such as alignment and measuring systems must also be checked.

Planning

NOTE: The body interconnection is to be maintained if possible. Repair is preferred to renewal of body components. Furthermore, check if it is possible to perform a partial repair.

During planning the following job steps must be observed and adhered to:

- Determine the direction of the main impact and the extent of the damage.
- Establish the repair method.
- Work out which repair components will be needed and obtain them.
- Establish what disassembly work is needed.
- Check for specific features such as airbags, route of water drain hoses, electric cables and the location of NVH elements.
- Cut out the old parts (only when the new parts are waiting ready).
- Install the new parts.
- Apply solder/seal the repair location.
- Recreate the corrosion protection.
- Constantly check all the job steps.

After the scope of the work has been determined, before making the repair, check all own technical prerequisites:

- All tools required must be to hand.
- The same applies to materials, replacement parts, sealants and adhesives.
- You must have the knowledge needed to use all the necessary technology.

Chronological sequence of repair

The actual sequence of repair can be divided into the following steps:

NOTE: Refer to each vehicle specific chapter in the workshop literature for details on the individual points.

Job steps:

- Establish separating cuts and mark them.
  - Take into account the requirements given in the repair instructions.
  - Place the new part ready for use and include it in the repair plan.
  - Decide on the joining method.
- Separate and remove the old part.
  - Take into account the special features particular to the vehicle.
- Prepare the joint locations.
  - Sand and align the weld flanges.
  - Offer up the new part.
  - Apply corrosion protection measures.
- Weld the new part into place.
- Perform sealing and corrosion protection measures.
- Create an outer surface ready for painting.
- Insert cavity protection.
- Perform a quality control check.

Repair Outline

On a minor damaged body or panel, the repair is processed through first repairing the damaged part by washer welding or using hammers and dollies (curve master models), reforming with putty and finally finishing it.

On a major damaged vehicle, vehicle is first roughly reformed using a frame correction machine and then replacing damaged panel and frame parts with new ones. After panel repairing work follow with anti-rust treatment, sealing, and partial painting processes. Depending upon the condition of the damage, the repair of plastic parts may became necessary.

Minor damaged vehicle

- Remove related parts (If necessary).
- Pulling out work by washer welding.
- Hammering out correction by hammers and dollies.
- Reforming by applying putty/body filler.

DESCRIPTION AND OPERATION

- Anti-rust treatment.
- Vehicle ready for further process.

Major damages vehicle

- Remove related parts (If necessary).
- Rough pulling out by body pulling/alignment machine.
- Replace damaged parts.
- Panel repairs and parts positioning.
- Anti-rust treatment.
- vehicle ready for further process.

Repair or Replace

This is a critical decision often practiced in the bodyshop. Depending upon nature and severity of the damage this decision is taken.

Often this decision is influenced by various factors:

- Severity of the damage
- Availability of the parts (Body panels) as serviceable
- Estimated cost of overall repair
- Time required to complete the repair
- Body shop capability in carrying out the repair
- Manufacturers direction

Ford has made list of serviceable parts exclusively to improve the quick turn around in the body repair and thus reduce the overall repair cost burden to customers.

All panels are available as a replacement and it is essential to replace them to complete the repair quickly and economically. However, the damage is small it is better to perform spot repair and rectify the damage.

Country specific insurance policies and governance also plays pivotal role in deciding the repair or replace the component during repair.

An experienced bodyshop manager in association with Body repair manual and parts guidelines can take decision to improve quick turn around and increase the satisfaction of customers.

Commodity Depreciation Guidelines-India

Commoditywise Depreciation

Commodity	Depreciation %
Rate of depreciation for all rubber nylon/ plastic parts, tyres and tubes, batteries and air bags	**50%**
Rate of depreciation for all fibre glass components	**30%**
Rate of depreciation for all parts made of glass	**Nil**
Rate of depreciation for all other parts including wooden parts is to be as per the following table	~

Aging Factor

Age of the vehicle	% of Depreciation
Not exceeding 6 months	Nil
Exceeding 6 months but not exceeding 1 year	5%
Exceeding 1 year but not exceeding 2 years	10%
Exceeding 2 years but not exceeding 3 years	15%
Exceeding 3 years but not exceeding 4 years	25%
Exceeding 4 years but not exceeding 5 years	35%
Exceeding 5 years but not exceeding 10 years	40%
Exceeding 10 years	50%

DESCRIPTION AND OPERATION

Alignment Check

General

If there is concern that the body has been deformed, the body must be measured. Several measuring procedures and tools can be used for this purpose.

With simple measuring scale/tool, it is possible in most cases to draw a conclusion about the extent of the damage through a quick measurement without time-consuming assembly work (straightening jig).

Measuring System

To measure the body imperfections and to aid and improve collision repair efficiency and accuracy, measuring system is inevitable equipment plays vital role in collision repair shop along with Body repair bench.

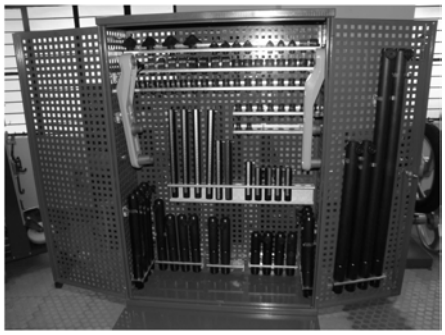
Ford India as per **BSQC** guidelines and as per performance approved **CAR-O-LINER** (conditions apply) measuring system to be used in body shops for damage measurement and to improve repair efficiency and accuracy.

Mechanical Measurement

CAR-O-MECH (conditions apply) mechanical measuring system is deployed for taking measurements. It shall be used with MARK - 6 collision repair bench.

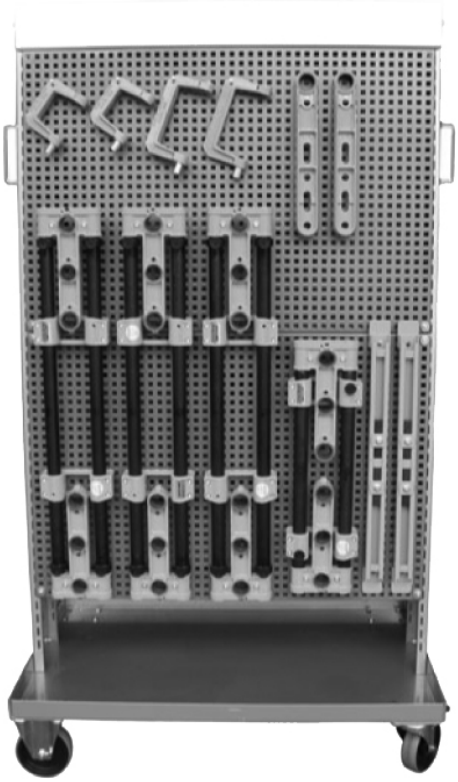
Suppliers provide and support wide range of extensive trainings in car body measurement techniques.

Measuring Bars



E113062

Measuring Slides



E113063

Slide and Bar arrangement

E113064

DESCRIPTION AND OPERATION

Measuring exercise with part out

E113065

Universal measuring slide and stylus

E113068

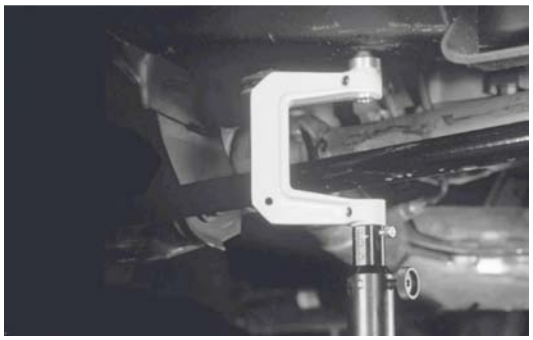
Measuring exercise with part in

E113066

Data reception and computer table

E113069

Flexible measuring bar



E113329

Electronic (Computer Based) measuring system

CAR_O-TRONIC (conditions apply) electronic computer based measuring equipment provides high flexibility, data accuracy and high reliability in body measurement. Simplifies the measuring process and measurements shall be completed quickly.

Measurement screen

E113070

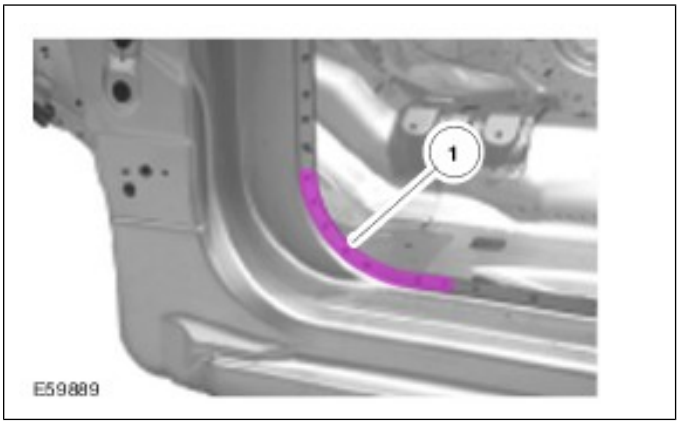
DESCRIPTION AND OPERATION

NOTE: For the floor pan and the exterior of the vehicle, measuring data is contained in the vehicle-specific repair instructions for each vehicle. Manufacturers of measuring and straightening jigs create corresponding measurement sheets for each vehicle.

Data sheets with the body frame dimensions for body measurement are specified in the model-specific repair instructions in each case.

All dimensions were measured with the aggregates removed, starting from the center of the hole, using an electronic measuring system and are specified in mm.

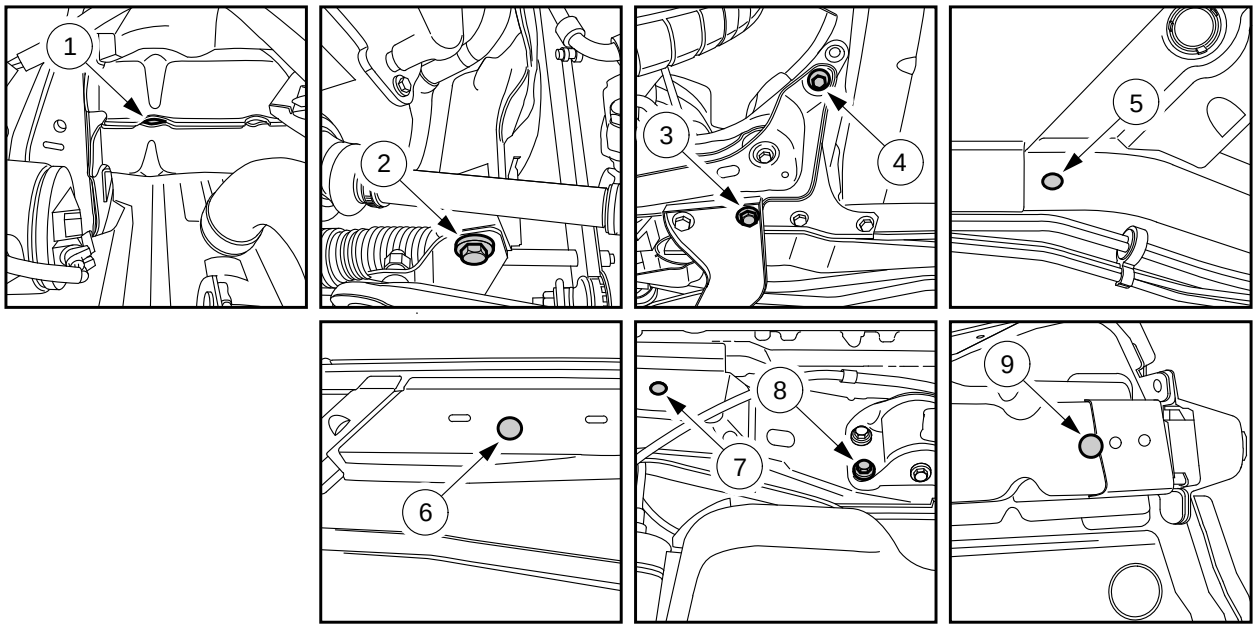
A tolerance of ± 3 mm applies to all specified dimensions. All detailed illustrations correspond to the left-hand side of the vehicle.

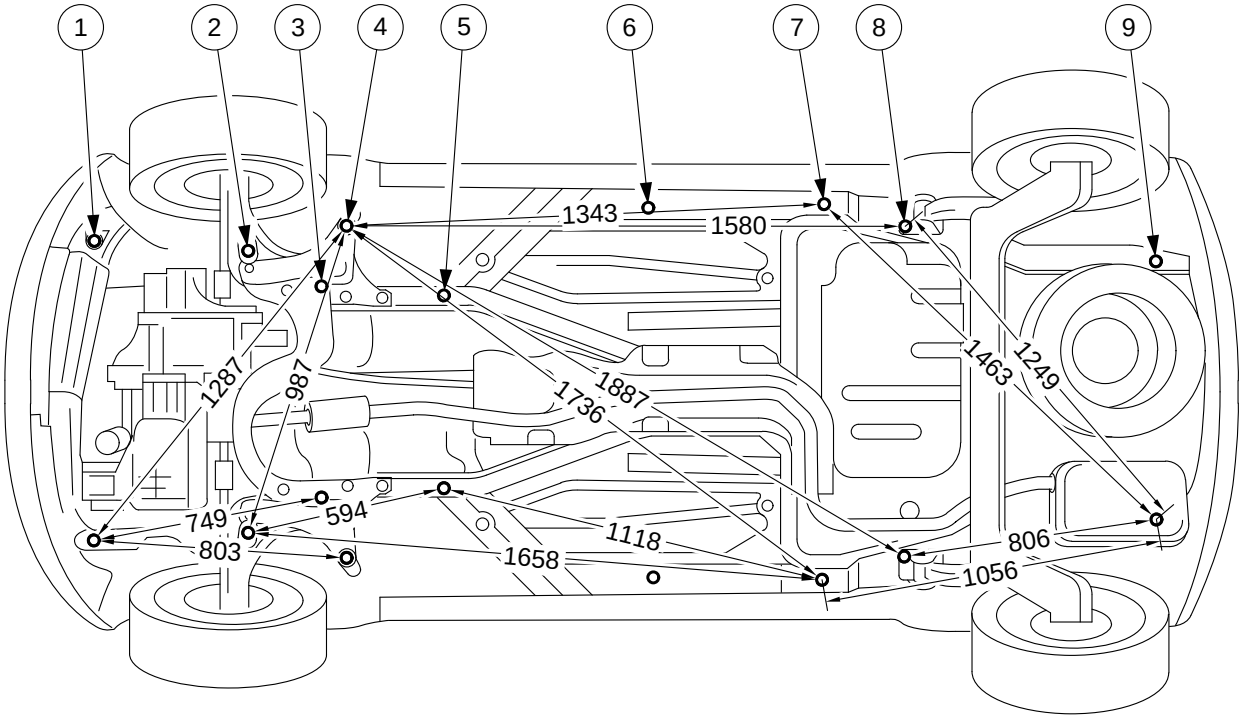


Measuring points that are specified in a curve are to be measured so that the greatest distance from the opposite measuring point is reflected.

DESCRIPTION AND OPERATION

Measuring data example

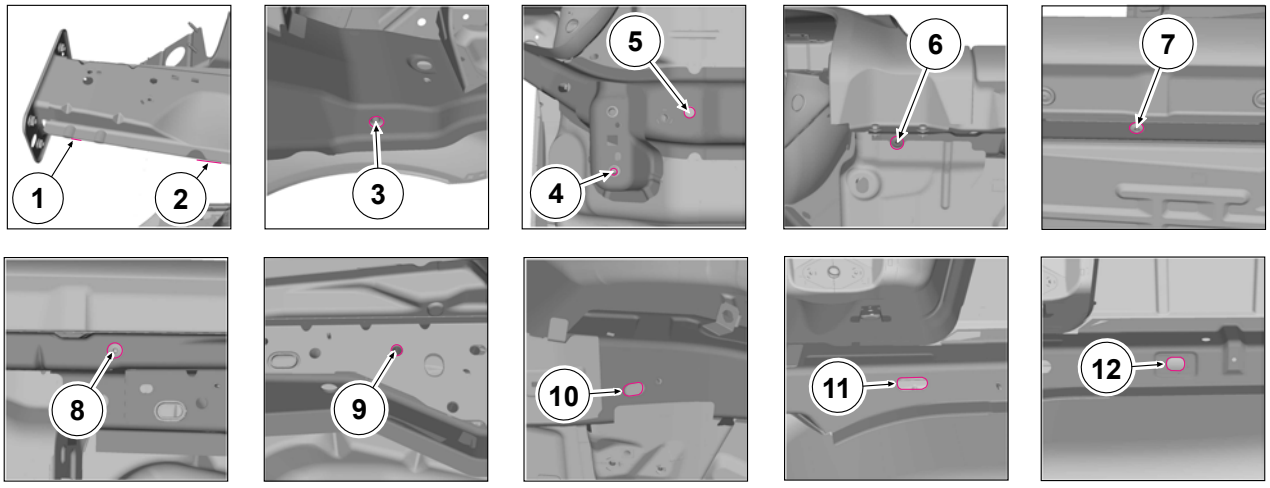


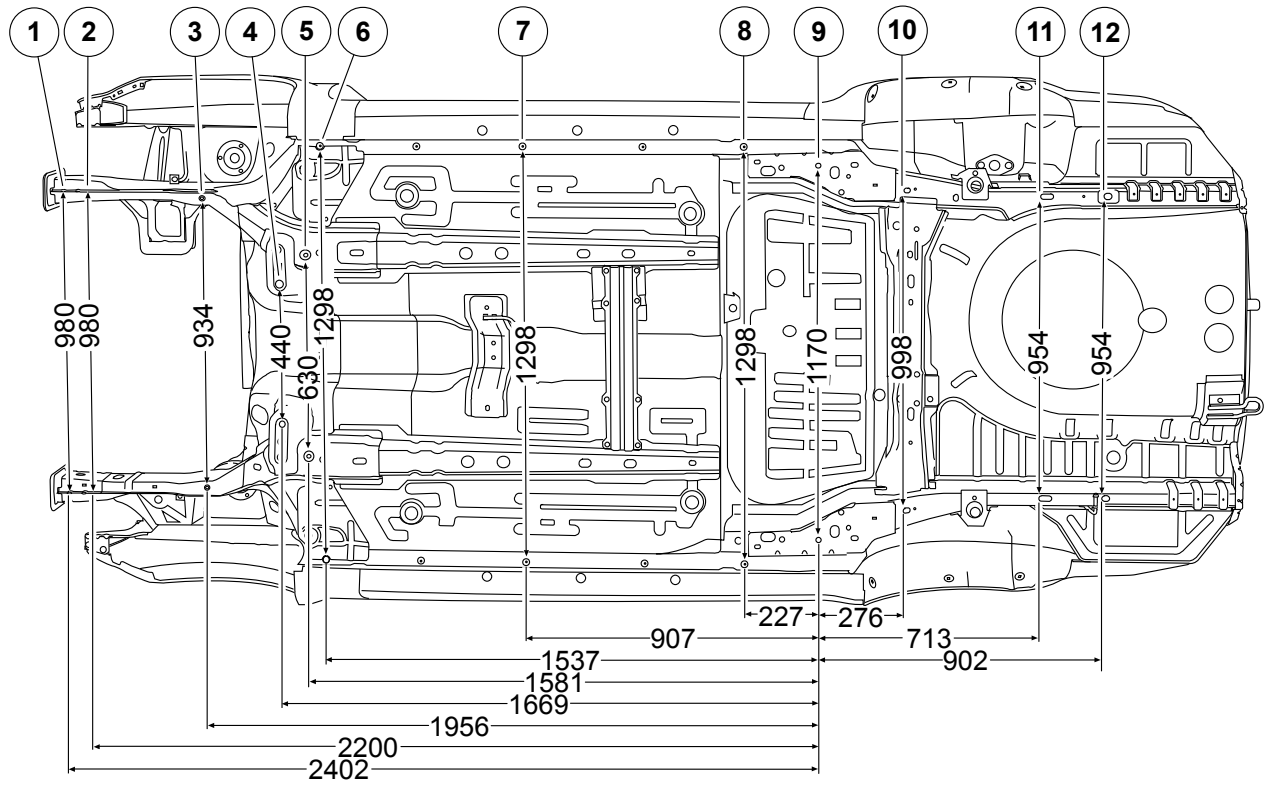


E113821

DESCRIPTION AND OPERATION

Underbody Frame Dimension





E113822

For exact determination of the measuring points, enlarged sections are shown.

DESCRIPTION AND OPERATION

Straightening

Repairing Major Damage/Collision

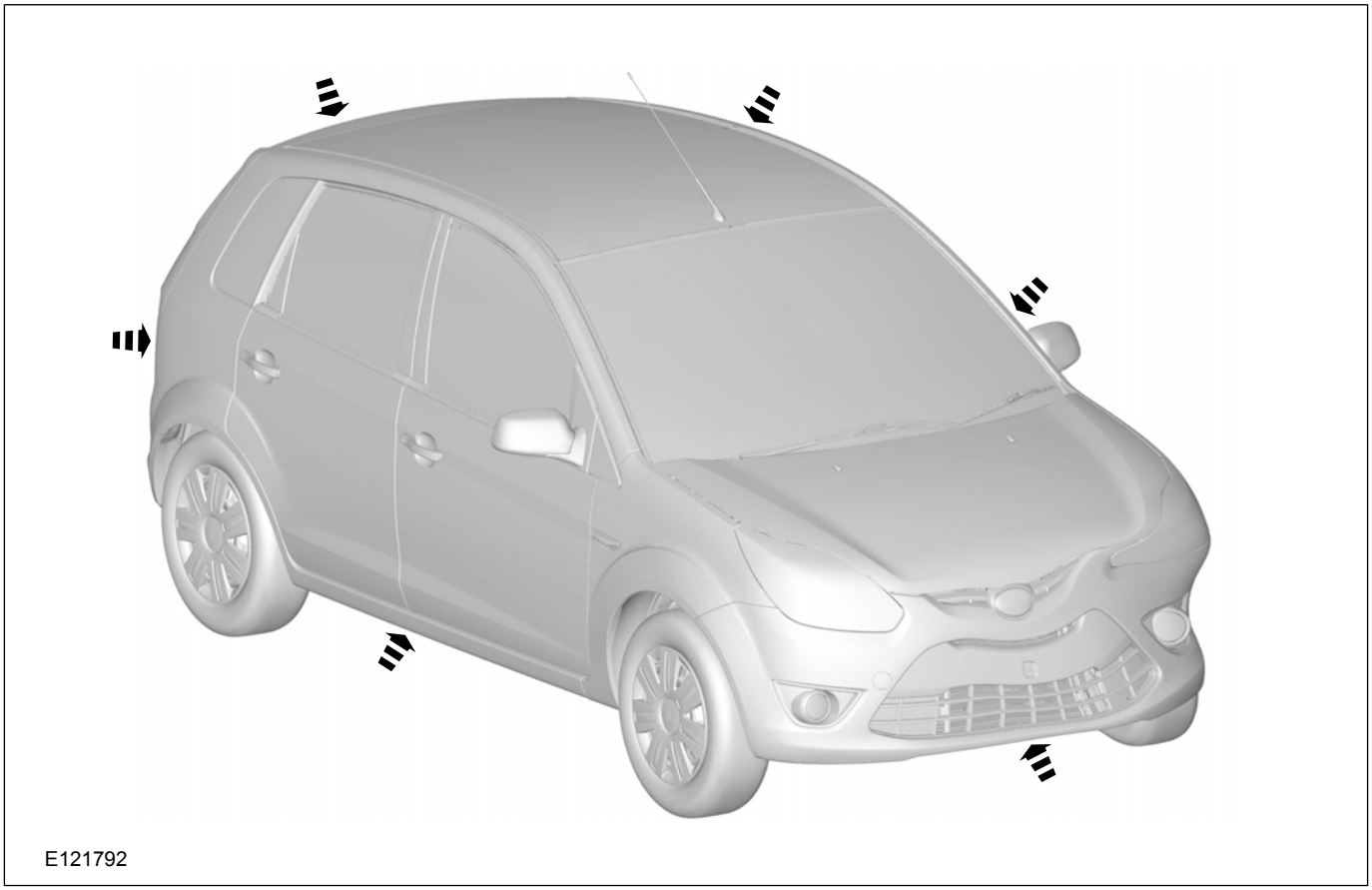
Basic Repair Work Processes

It is possible that the crash impact reaches the body's skeletal member parts and the damaged range is so extensive that the core body parts may be under bending, twisting and stress. Therefore, it may become necessary to use a large frame reforming machine. Depending upon the level of the crush, it may be also necessary to replace a large size part like an outer panel. At any rate, in repairing a major damage on a vehicle, it is vitally important to correctly diagnose the dispersions of the damages over the whole vehicle. The man/hours and repair estimation is heavily depended upon whether the preliminary diagnose is correct or not.

Diagnose Damaged Areas

Check the damaged portion of the traffic accident vehicle by eye and touch to estimate the extent of the crash damage.

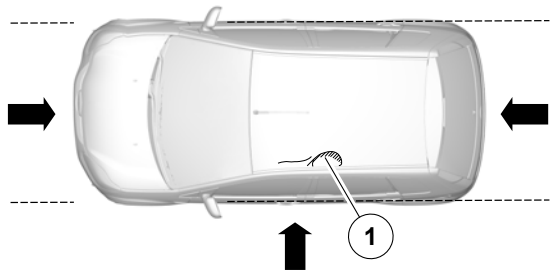
1. Know the damaged areas. Observe the entire vehicle and count the number of impacts, evaluate their magnitude and work out the damage sequence.



E121792

2. Check external flaws and deformations. Observe the vehicle from the front, rear, and sides and check lateral and vertical bends, twists, out-of-true lines, on the side view, swellings and depressions of the body. At the same time, check for deformation of the outer panel or any other connected areas away from the crashed area.

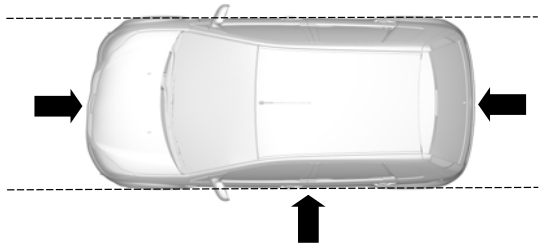
DESCRIPTION AND OPERATION



E121793

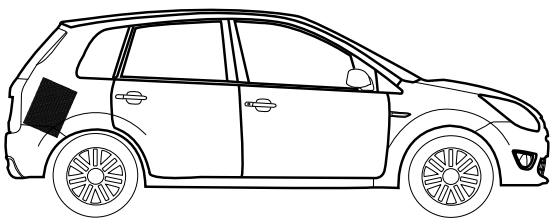
Item	Description
1	Deformation

3. Check the alignment of the exterior body parts. Carefully inspect the gap, steps, clearance, and state of opening and closing on all installing parts with hinges such as an engine hood, doors, trunk lid, or tailgate.



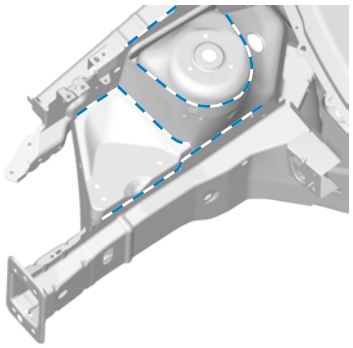
E121794

4. Check on cabin and trunk room areas. Inspect the damages caused secondary objects inside the cabin or trunk compartment due to the impact momentum. Inspect the damages on the steering column, dashboard, interior panel, seat, seat belt and other upholsteries caused by the driver or cargo.



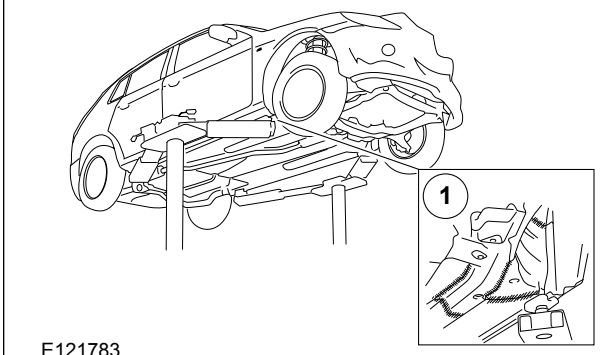
E121651

5. Check the engine compartment. Check for deformation of the engine mounts and transmission mount bracket, contact between the auxiliary system and the chassis and between wire harnesses and the chassis. Check for deformation in each part of the body and for sealer peeling off any welds.



E121879

6. Check the under body. Lift up the vehicle and check for damage in the suspension or the subframe. Check for leakage of the engine oil, transmission fluid, brake oil or radiator coolant. Check for deformation in each part of the body and for sealer peeling off any welds.



E121783

Item	Description
1	Undercoat

7. Check the functions. Start the engine and check whether any abnormal vibration noise or contact noise exists. Operate the clutch, brake, parking brake lever and the shift lever to check the vehicle functions normally. Check the function of electrical systems including on/ off function of the lights and accessories.

Measuring Dimensions

With reference to the center of the symmetry (right and left direction) of the body, measure the major

DESCRIPTION AND OPERATION

dimensions of the damaged body with the use of a universal tram gauge, a convex rule, tram tracking gauge, etc. By doing so it becomes possible numerically to evaluate the level of the damages. Particularly, the precision front body and under body that influence the wheel alignment is important. Just visual inspection is not enough.

Measuring Method

Measurement with reference to the drawing of body dimensions (incl. Actual measurement figures).

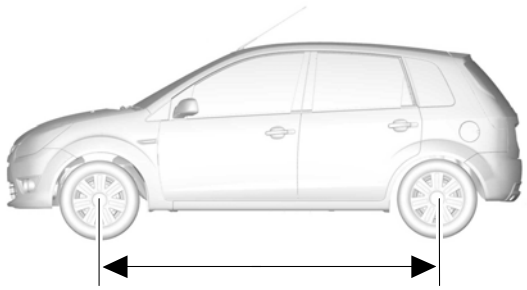
Diagonal measurements (X measurements).

Measurements with the use of a centering gauge.

Measurements with the use of a repair chart (incl. flat view data).

NOTE: It is possible to diagnose the overall level of the damages by using a single or combination of the measurement methods above.

E113078



E121343

Reference to the Drawing of Body Dimensions

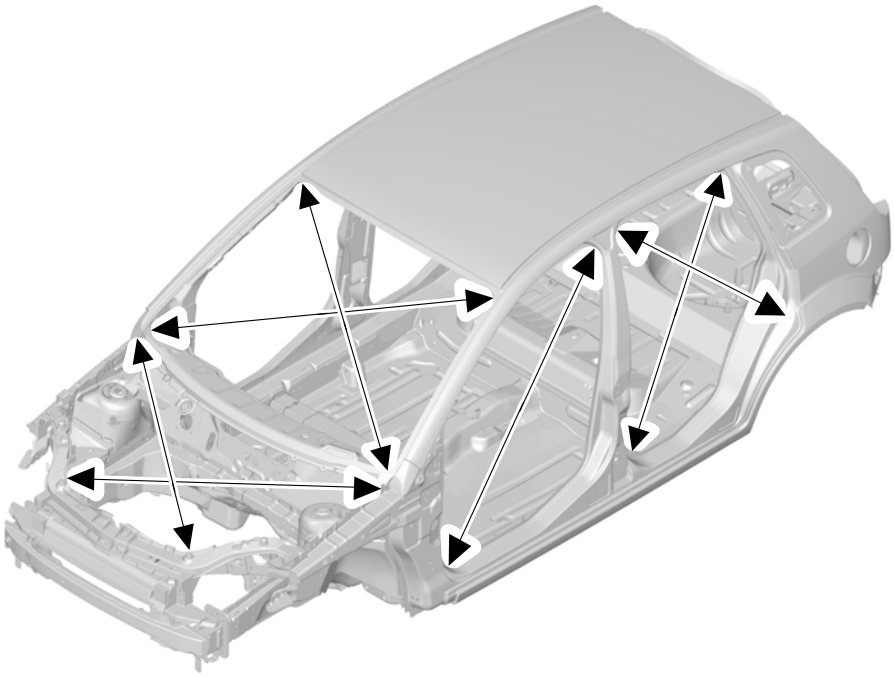
While referring to the body dimensional drawing shown in the Body Repair Manual-Models, measure the corresponding dimensions on the actual vehicle in fore and aft, right and left and diagonal directions. Compare the measured lengths with the corresponding dimensions in the manual to evaluate the level of the damages. The measured lengths from the undamaged part can also be used for the correct evaluation of the damage level.

Diagonal Measurement

Using a part installation hole or reference hole, which is one of the two positions that are symmetrical in a right and left direction as a measuring point, measure the lengths diagonally to the front body, window, cabin, trunk room or tailgate opening or under body. From this data, the deformation of the vehicle as a whole can be judged.

NOTE: Always combine the diabolical measurement with another measuring method.

DESCRIPTION AND OPERATION



E121502

Measurements with a Centering Gauge

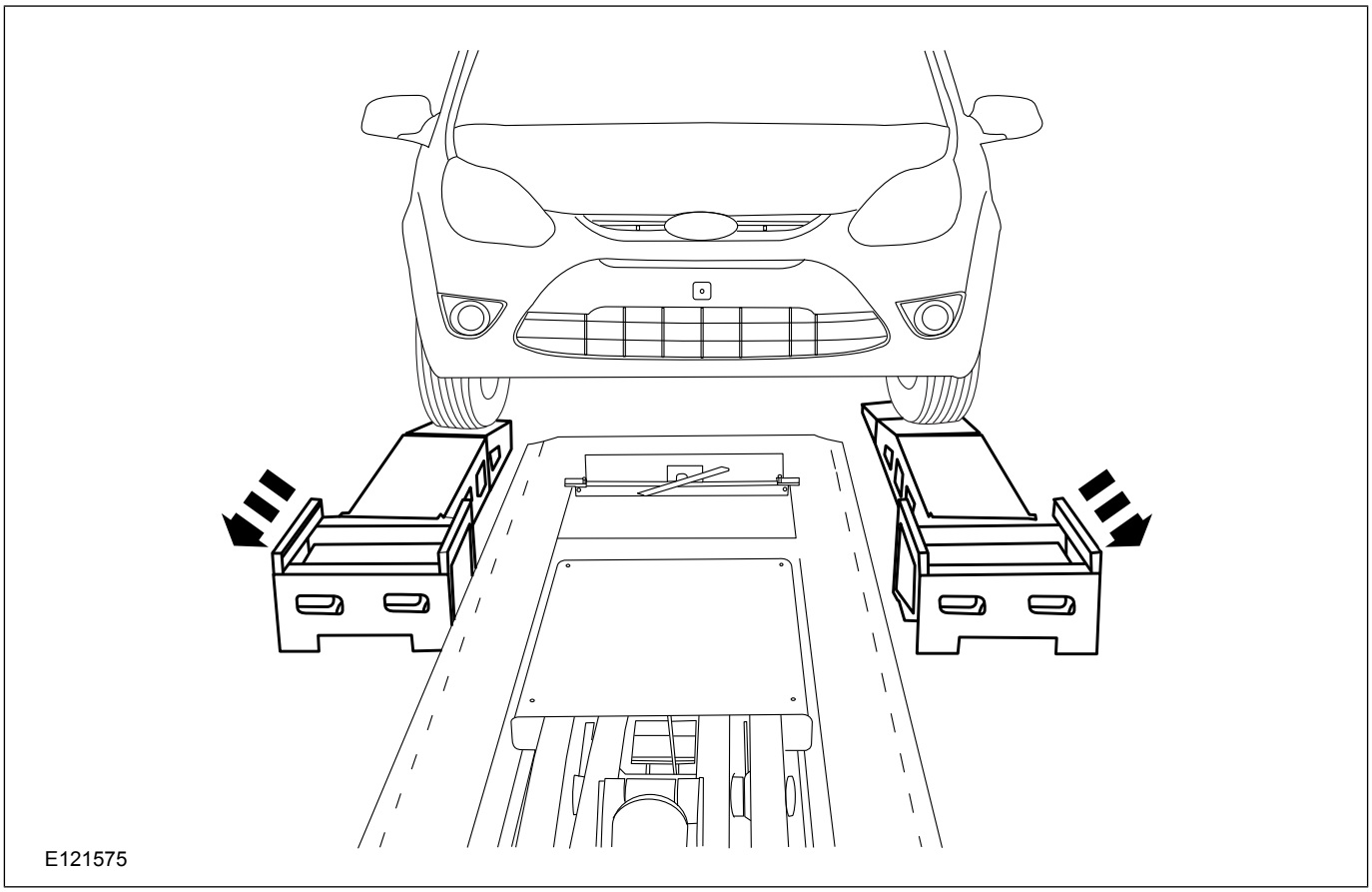
From the reference holes and part installing holes that are located in the symmetrical positions (right and left) of the under frame, hang centering gauges to inspect for the deviation of the body center line.

From the body part for which the damage did not reach, hang centering gauges and compare the gauge indications being shown by both the gauges hung from the damaged and undamaged parts to inspect for parallelism or lack of it, displacement, twist, or bending of the centering pin.

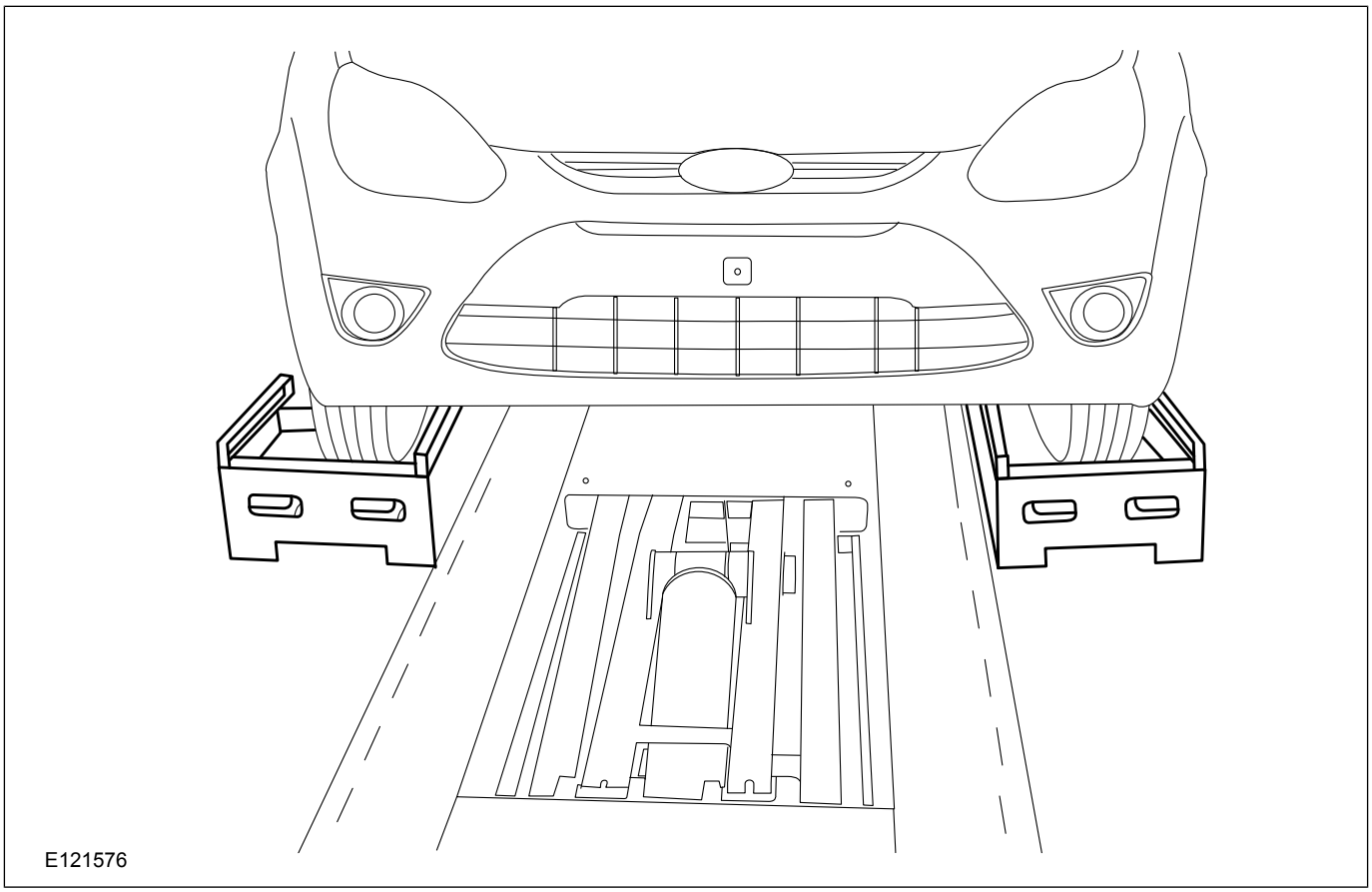
Vehicle loading in MARK 6 Collision Repair Bench

1. Position the vehicle in the ramp for loading.

DESCRIPTION AND OPERATION

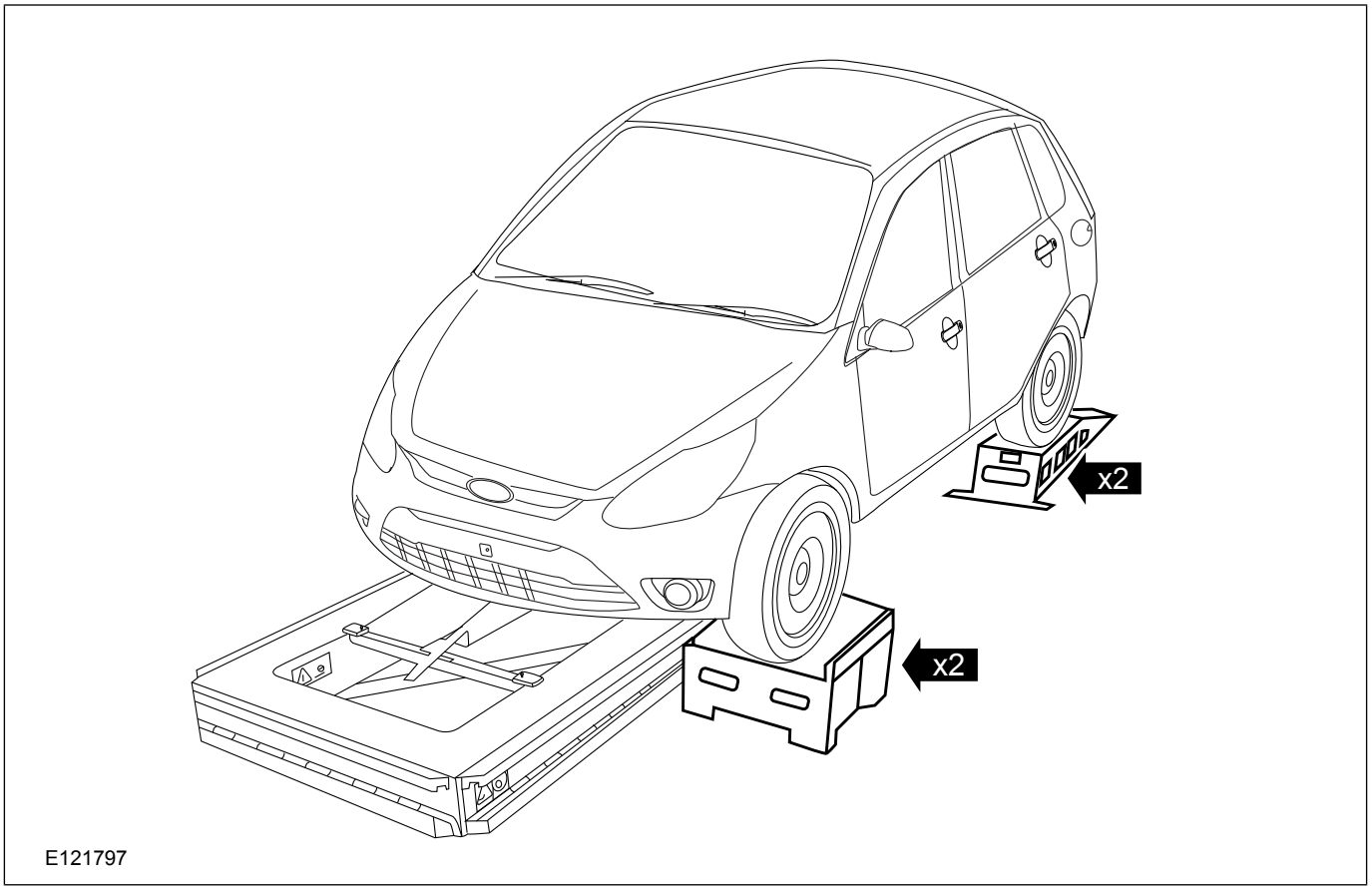


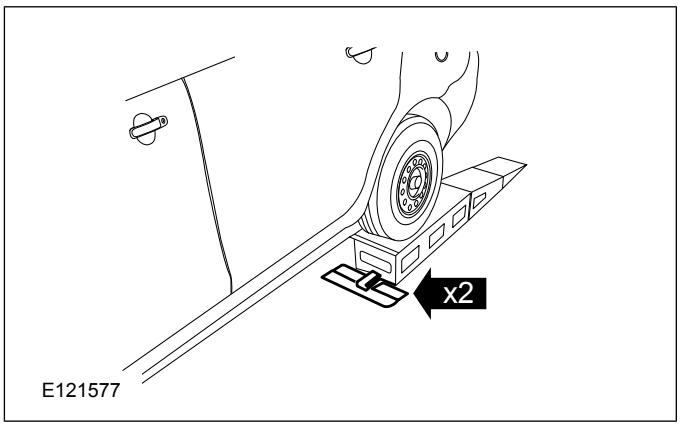
2. Move the vehicle and align the front pair of wheels on front roller stopper.



DESCRIPTION AND OPERATION

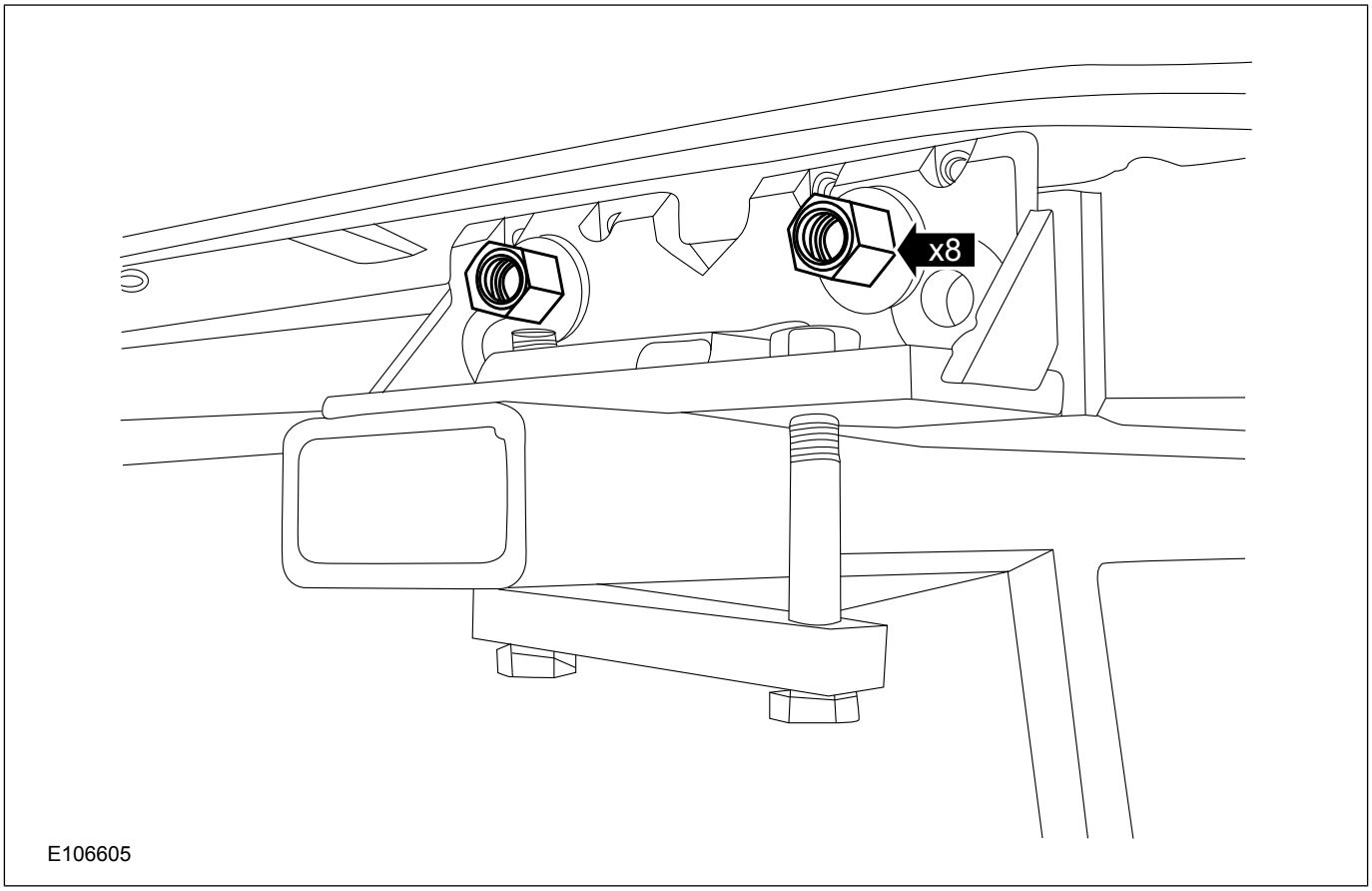
3. All the wheels are on the ramp roller stopper.



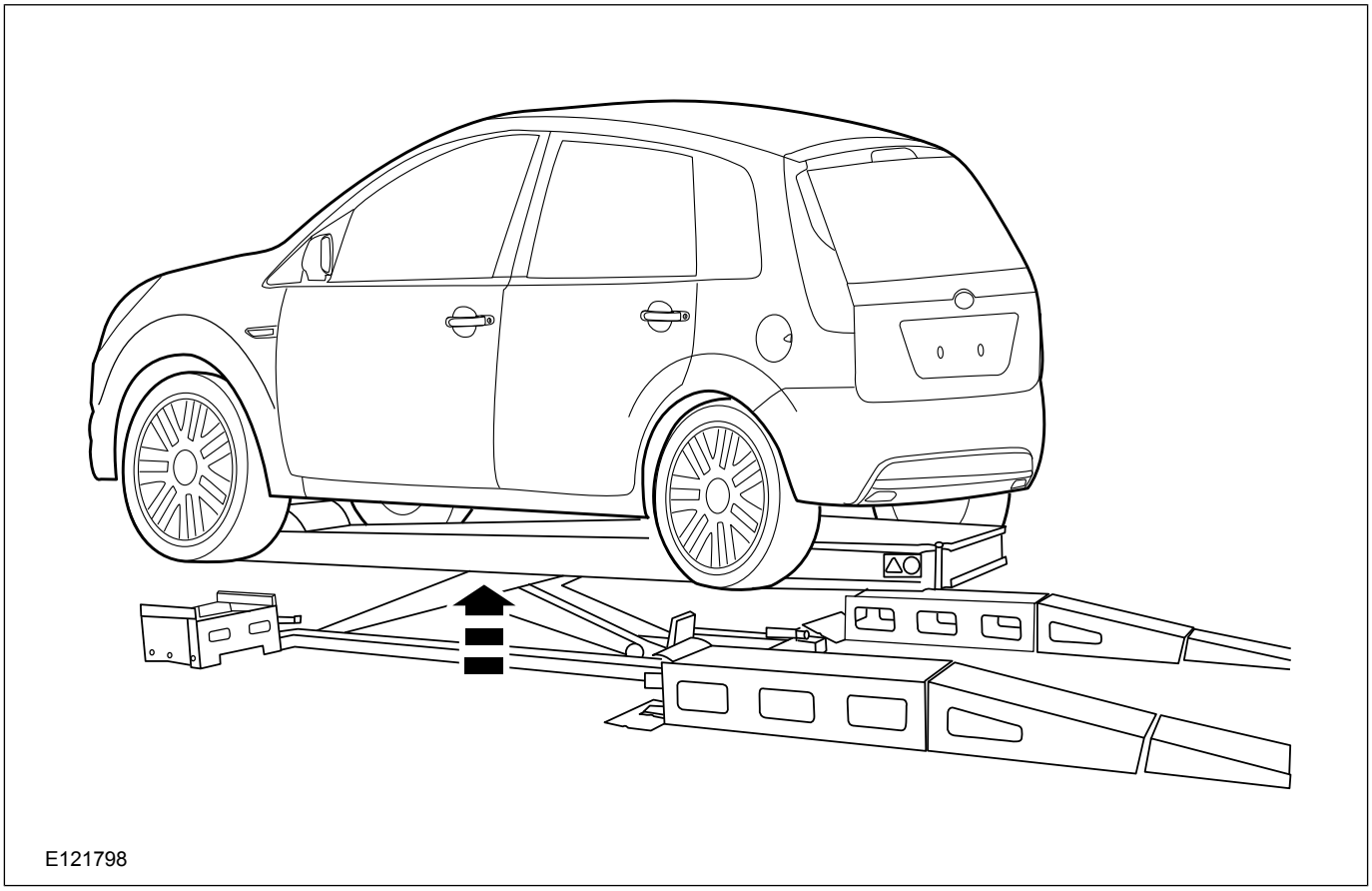


Anchor clamps to be tightened in sill at 4 locations.

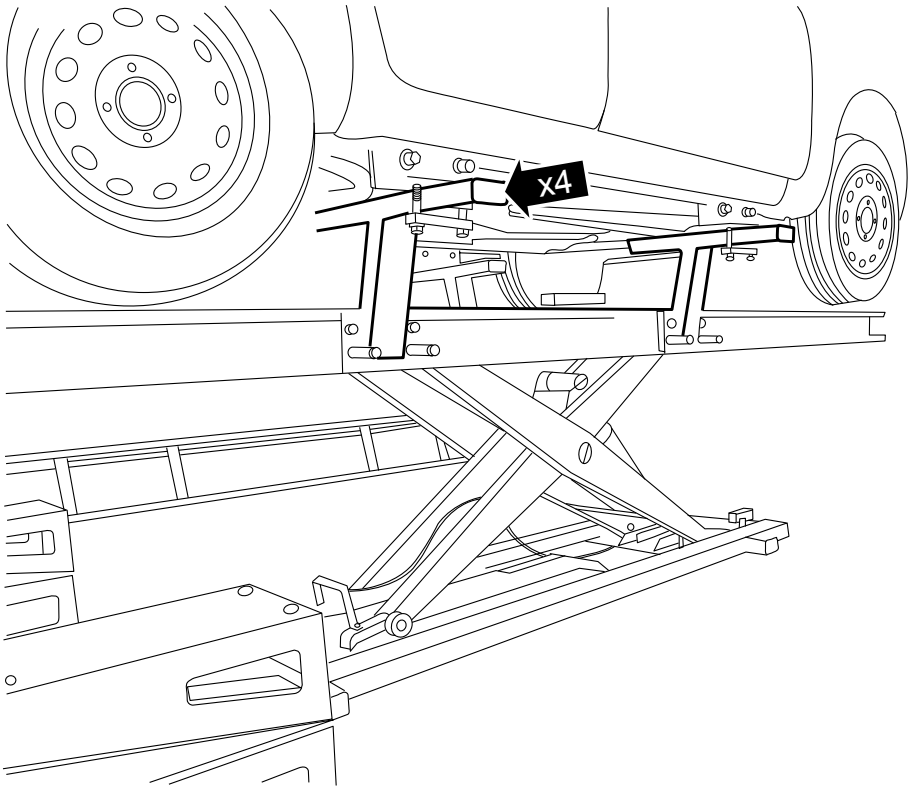
DESCRIPTION AND OPERATION



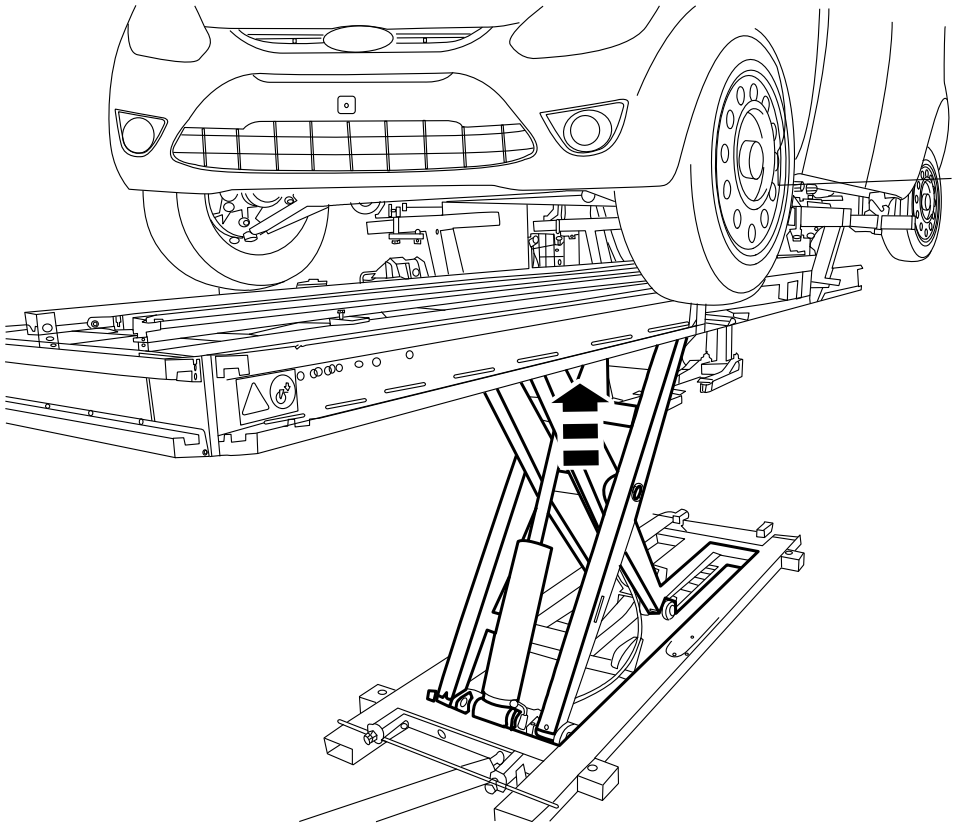
Lift the bench to required working height for repair.



DESCRIPTION AND OPERATION



E113429

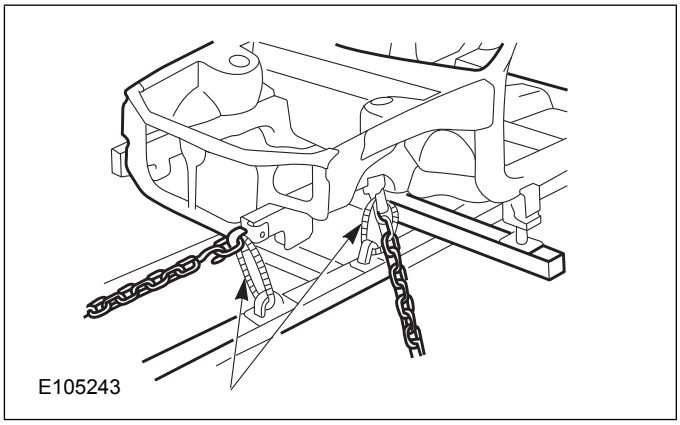


E121578

DESCRIPTION AND OPERATION

Rough Panel Reforming

In spite of the word ”rough”, this work is very important in body and panel repair. Using a frame correction machine, the deformed area of the crushed vehicle is pulled out nearly to the original shape. In order to complete this work satisfactorily, the measurements must be made correctly before beginning this work. if the body is not correct in its dimensions, the precise wheel alignment cannot be expected. If the body has not been correctly restored to the original dimensions, in spite of its satisfactory external appearance, the drivability, steering handle, movement, tire wear not only greatly influenced but also the driving safety will be greatly impaired.


E105243

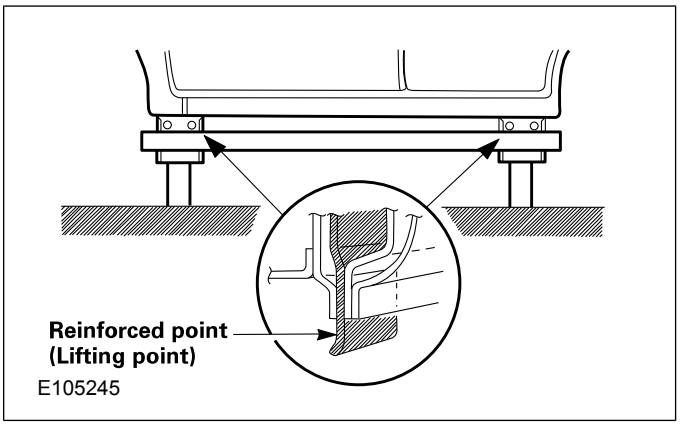
Preparation for Pulling-out

Fixing of Body

In pulling-out work using a frame correction machine, it is extremely important to fix the body firmly. It will become necessary, depending upon the state of the accident, to pull out the body from more than one direction.

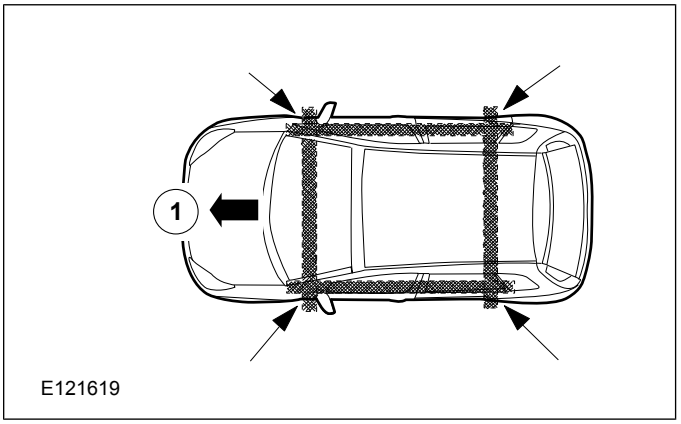
Basic anchor points:

1. It may become slightly different depending upon the state of damage, but basically, fix the body at the lifting points, which is strongly reinforced, located under the side sills.



E105245

2. Secure the body at the four reinforced points so that they can receive force evenly.



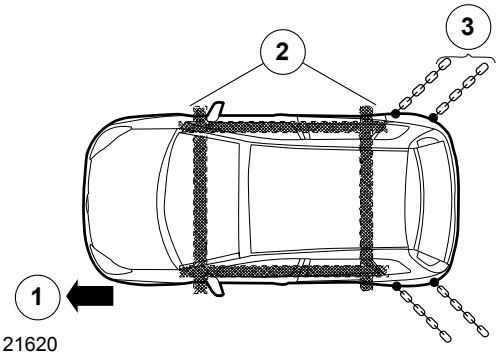
E121619

Item	Description
1	Pulling-out direction

Auxiliary anchor points:

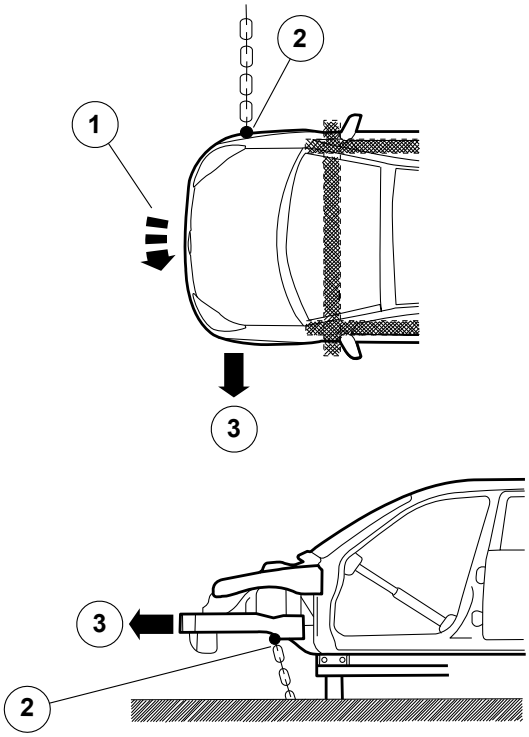
Depending on the pulling-out force and direction, auxiliary anchor points may need to be added to prevent body deformation and protect the weld points.

DESCRIPTION AND OPERATION



E121620

Item	Description
1	Pulling-out direction
2	Reinforced Point
3	Auxiliary anchor point



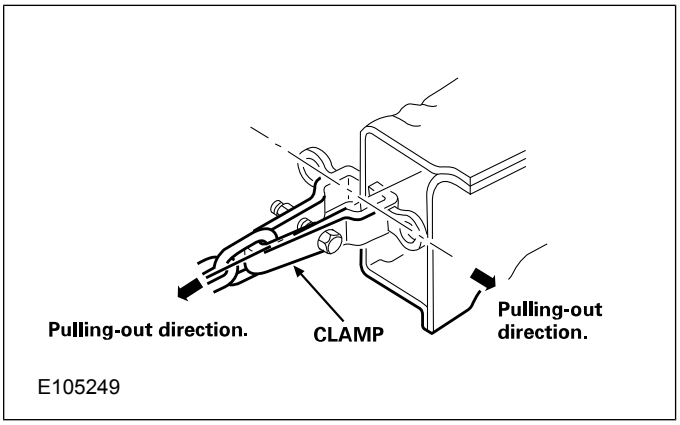
E121621

Item	Description
1	Cancel the moment
2	Auxiliary anchor point
3	Pulling-out direction

Setting Pulling-out Clamp

Install the pulling-out clamp at the impact point.

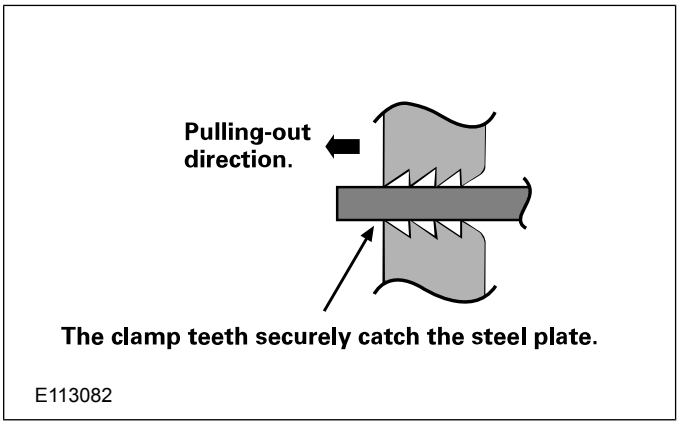
WARNING: In installing clamp, align the extended line of the pulling direction to the center of the clamp. If out of alignment, it is dangerous because the clamp may be disengaged while being pulled.



E105249

Pay attention there is no adherence to the teeth of clamp.

NOTE: Do not tighten the clamp screw excessively. Excessive tightness may result in teeth breaking.

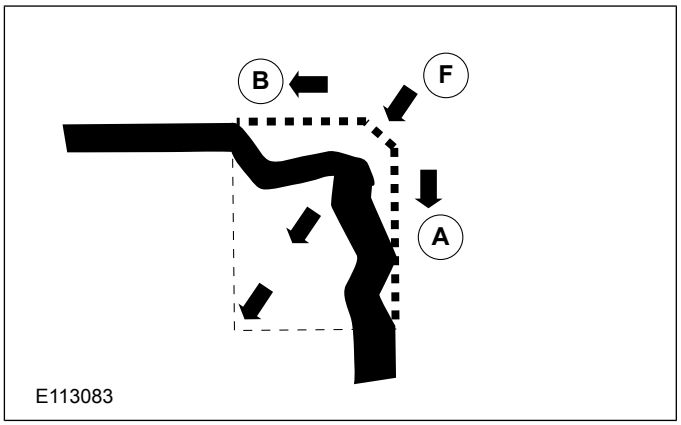


E113082

Pulling-out Direction

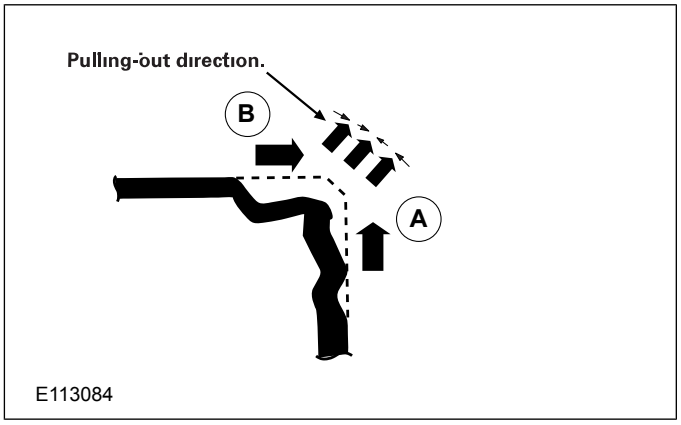
The impact force (F) deforms the body. The force (F) can be divided into elements (A) and (B). Apply an equivalent or greater force to the body from the opposite direction in order to restore the deformed shape to normal. As the body stiffness varies from section to section, it is necessary to adjust the pulling forces and directions accordingly. The pulling-out direction is determined by the worker's skill and the performance of the frame correcting machine. NOTE: Before correcting deformation of the body, read the instruction manual of the frame correcting machine and its specifications.

DESCRIPTION AND OPERATION



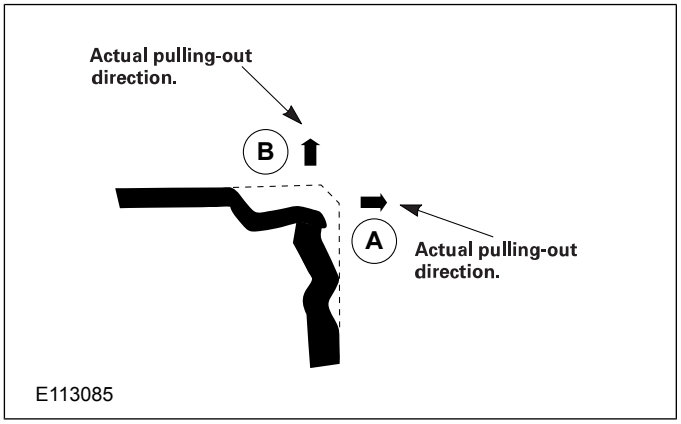
Diagonal Pulling-out

Change the pulling-out angle to adjust magnitude (A) and/or (B).

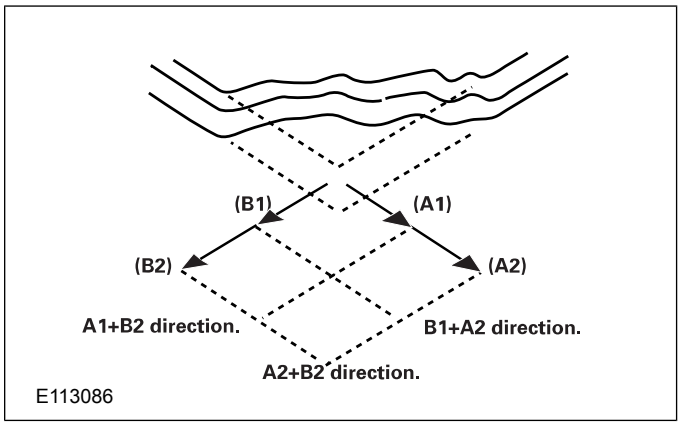


Perpendicular Pulling-out

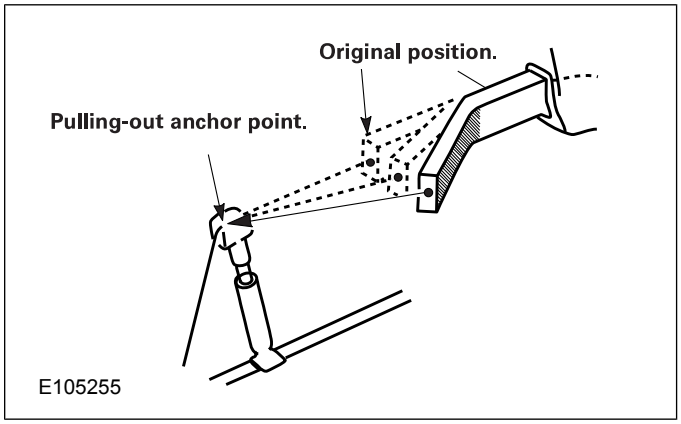
Add the pulling-out forces (A) and (B) perpendicularly while adjusting their magnitude.



By pulling-out the body from two perpendicular directions, it is easy to control the change of direction of the composite force. This allows easier, step by step restoration of the body.



On estimating the restored shape of the body, set the pulling-out anchor point on an extended line in the required direction. By gradually pulling-out that part of the body, the damaged section is finally restored to the proper shape.



Rough Panel Reforming on Front Damage

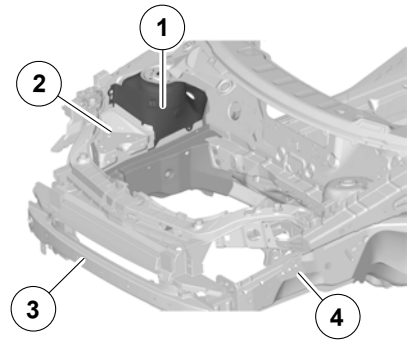
The following case as an example is that, together with the side bulkhead, the front side frame and the front wheelhouse are crushed on one side. If the impact is great, the damper housing, dashboard side member, the front pillar, and even the front side frame on the opposite side are damaged and the impact force disperses as far as the roof panel causing distortions on it.

⚠ CAUTION: Always attach a safety cable when using a hydraulic ram or a frame straightening tale; do not stand in direct line of the chains used on such equipment.

Reforming Procedures

1. Decision on how to proceed with the repair work. By pulling out the damaged area, restore the opposite side to the original position to repair. Remove the damaged part (one side) and install a new part. Repair and reform the part to which the replaced part is installed.

DESCRIPTION AND OPERATION

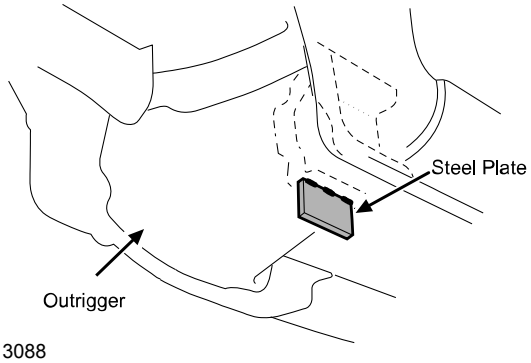


E121473

Item	Description
1	Damper Housing Replace or Reform
2	Front Wheelhouse Replace
3	Front Crossmember Replace
4	Front Side Frame Replace

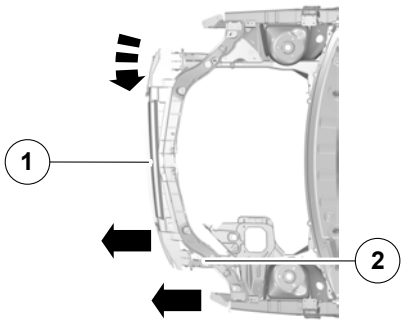
2. Fix the body. If the support point under the side sill cannot be fixed, weld a steel plate near the side sill of the outrigger to fix.

WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.



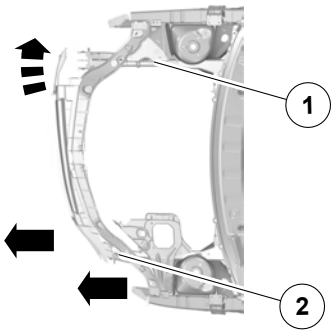
E113088

3. Determine the direction of pulling first and then pull out slowly and gradually. While pulling out, reform the joint areas where the replaced parts are installed. At the same time, reform the front side frame, front wheelhouse and the damper housing on the repaired side. If the front side frame on the repaired side is inclined toward the inside, pull out toward the front. If the front side frame on the repaired side is inclined toward the outside, pull out toward the front and side.



E121795

Item	Description
1	Front Crossmember to be repaired
2	Front Side Frame to be repaired



E121796

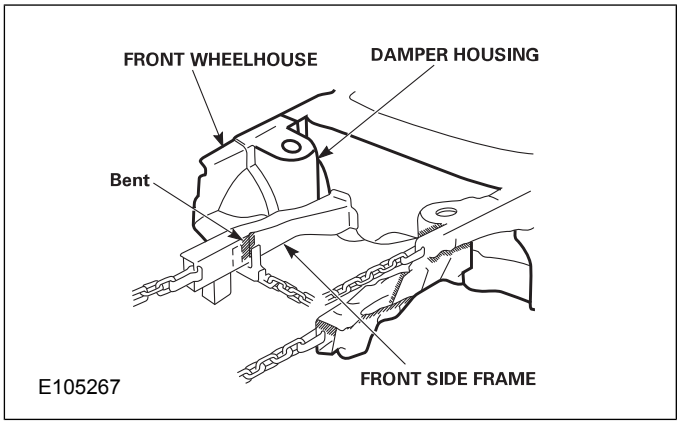
Item	Description
1	Front Side Frame repaired side
2	Front Side Frame to be repaired

4. Measure the dimensions and determine the pulled out position.

NOTE: On a subframe installed vehicle, inspect the position with the subframe placed in position.

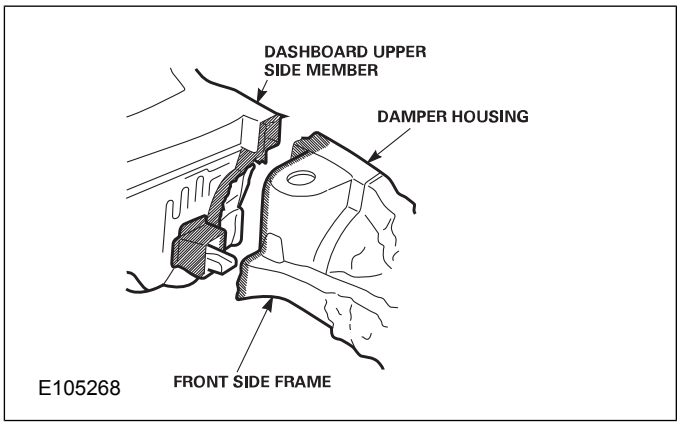
5. If the front side frame on the repaired side is bent, After almost acceptable diagonal dimensions and under body dimensions are secured by the pulling-out process, cut the front lower cross member and side bulkhead, clamp the bent area of the front side frame, and reform it then by pulling the bent area toward the front while pulling toward the inside at the same time, or pushing it from the outside. After reforming, bring the actual dimensions to the standard diagonal and under-body dimensions, by rolling the front side frame sideway. Also reform the front wheel housing and damper housing and check if they are in right positions or not on the upper body dimensions.

DESCRIPTION AND OPERATION



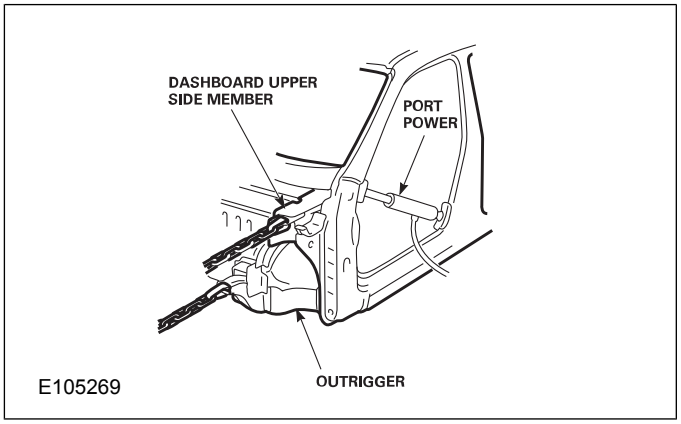
6. If the damper housing, dashboard, upper side member and front pillar cannot be fully reformed, cut the front side frame and damper housing.

WARNING: To prevent eye injury,wear goggles or safety glasses whenever cutting.



7. Pull out the dashboard upper side member and outrigger.

8. As for the front pillar, push it from the door opening side up to the standard position using a port power.



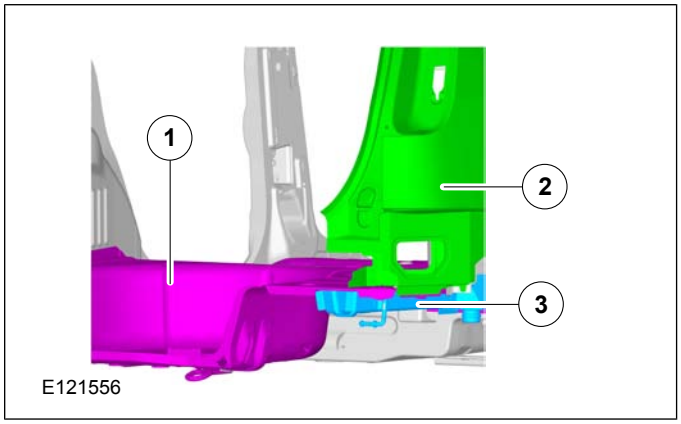
Rough Panel Reforming on Rear Damage

The following is an example of how the rear panel, the rear floor, and the rear frame are crushed. If the crash is great, the rear frame is bent at the hollowed part of the rear wheelhouse. As for the upper body, the damage will disperse as far as the rear wheelhouse, rear inner panel, and rear pillar with distortion on the roof panel.

CAUTION: Always attach a safety cable when using a hydraulic ram or a frame straightening tale; do not stand in direct line of the chains used on such equipment.

Reforming Procedures

1. Decision on how to proceed with the repair. Pull out the damaged area to its original shape. Remove the damaged part and replace it with a new part. Reform the area to which the replaced part is installed.



Item	Description
1	Rear Floor Panel Replace
2	Quarter Panel Cut and Replace
3	Rear Frame End Replace

2. Fix the body.

3. In the direction contrary to the impact force, pull out the rear panel, rear floor, and the rear frame all at the same time. While pulling them out, reform the rear floor. To repair the outer panel, do not pull it out directly.

4. If it is impossible to pull it out fully, cut the rear panel and restore the rear pillar and rear door opening after pulling out the rear inner panel and rear wheelhouse.

5. Measure the dimensions and decide the pulling out point.

6. If any of the rear frame and rear floor cross member is bent. Cut the rear floor and reform the

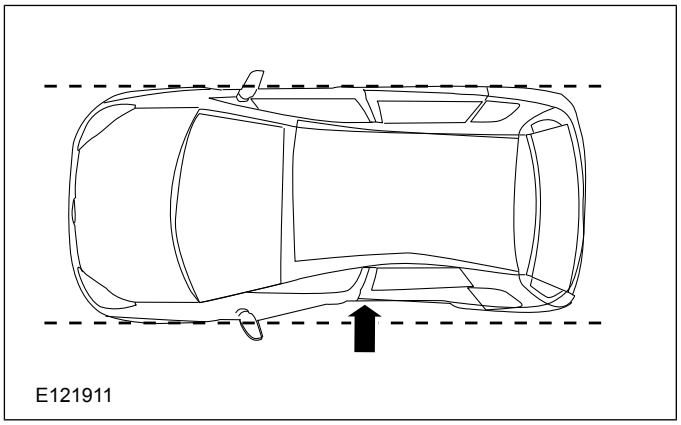
DESCRIPTION AND OPERATION

rear frame and rear floor cross member. After the re-forming, align the rear frame to the standard position. At the same time, reform the rear wheelhouse and determine the rear damper position. Determine the rear frame position using the under body dimensions.

Rough Panel Reforming on Side Damage

The following is an example of how the impact from the side, the floor is crushed together with the side sill and the center pillar is bent. The whole body is bent like a boomerang and the wheel base is shrunk. The impact is great, distortions grow on the side surface on the opposite side.

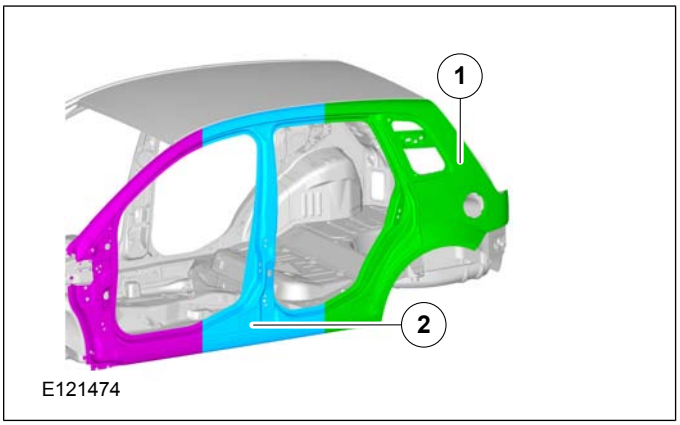
CAUTION: Always attach a safety cable when using a hydraulic ram or a frame straightening tale; do not stand in direct line of the chains used on such equipment.



E121911

Reforming Procedures

1. Decision on how to proceed with the repair work. Pull out the damaged area to its original shape. Remove the damaged part and replace it with a new part. Reform the area to which the replaced is installed.

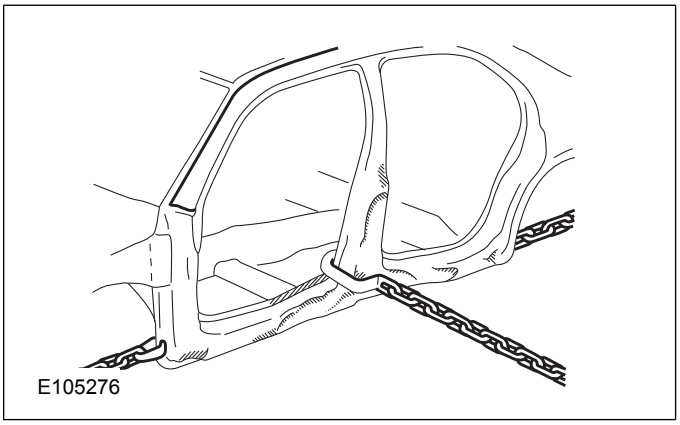


E121474

Item	Description
1	Quarter Panel Cut and Replace
2	Center Pillar Reinforcement Member Reform or Replace

2. Fix the body.

3. The most effective way is to pull it out in three directions at the same time. While pulling out the side sill and the center pillar in the direction contrary to that of the impact force, pull out the side sill in the front and rear direction. While pulling out, reform the floor panel and door opening area.



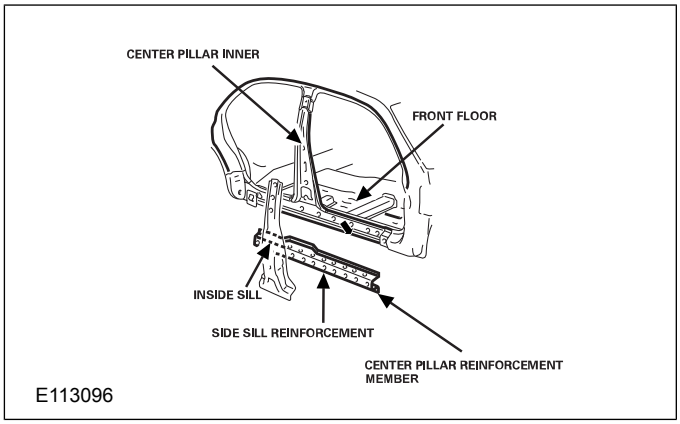
E105276

4. Measure the dimensions and determine the pulling-out point.

5. If it is impossible to pull out fully. Cut as many of the side reinforcement members as many as needed, such as the front pillar stiffener, center pillar stiffener, side sill stiffener, center pillar stiffener. Pull out from the inside sill, inner panel and floor cross member and reform them and determine their positions after making measurements.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever cutting.

DESCRIPTION AND OPERATION



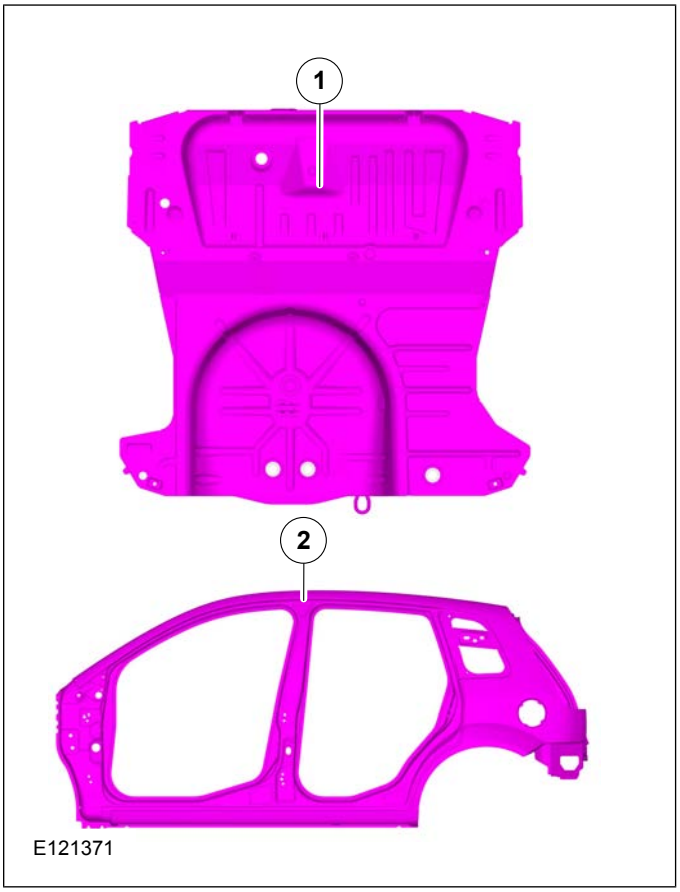
6. Measure the wheel base.

Parts Replacement Description

After the body has been restored to the original shape by the pulling -out process, remove the parts that cannot be repaired and replace them with new ones. There are two cases of replacing parts, to replace a part as a whole and to replace only part of it that would be called “cut and joint replacement.”

Cut and Joint Part Replacement

Cut and joint replacement is usually for the replacement of a large part like an outer panel or floor panel. The replacement of these large parts as a whole is usually costly and not effective because it takes more man/hours and space.

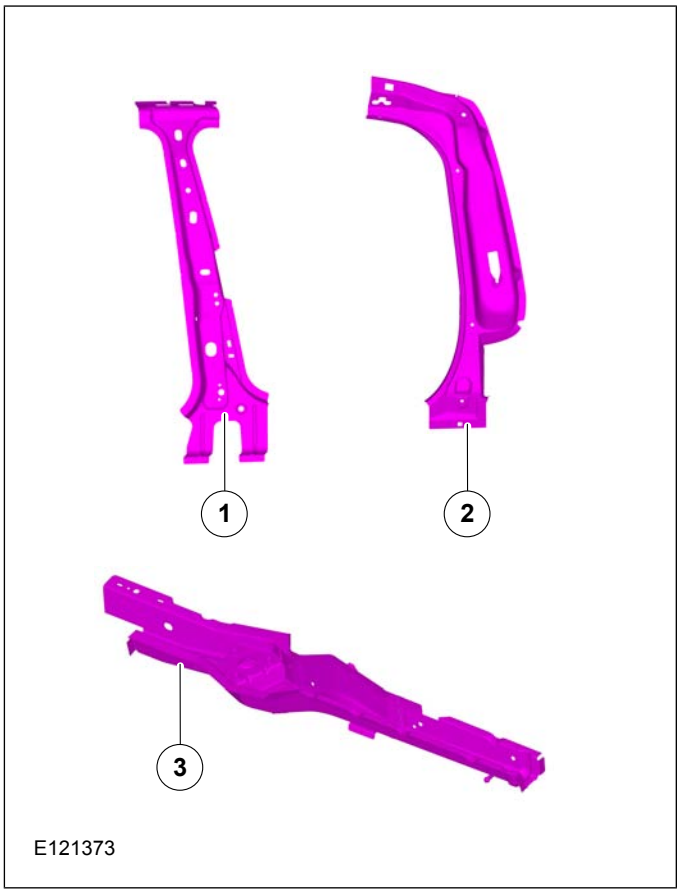


Item	Description
1	Rear Floor Panel
2	Quarter Panel

Complete Part Replacement

This complete part replacement is usually for core structural component parts such as a front side frame, rear frame (except front end replacement), wheelhouse, damper housing.

DESCRIPTION AND OPERATION



Item	Description
1	B-Pillar Inner Panel
2	Tail Lamp Support Panel
3	Rear Crossmember

Part Replacement Work

Removal

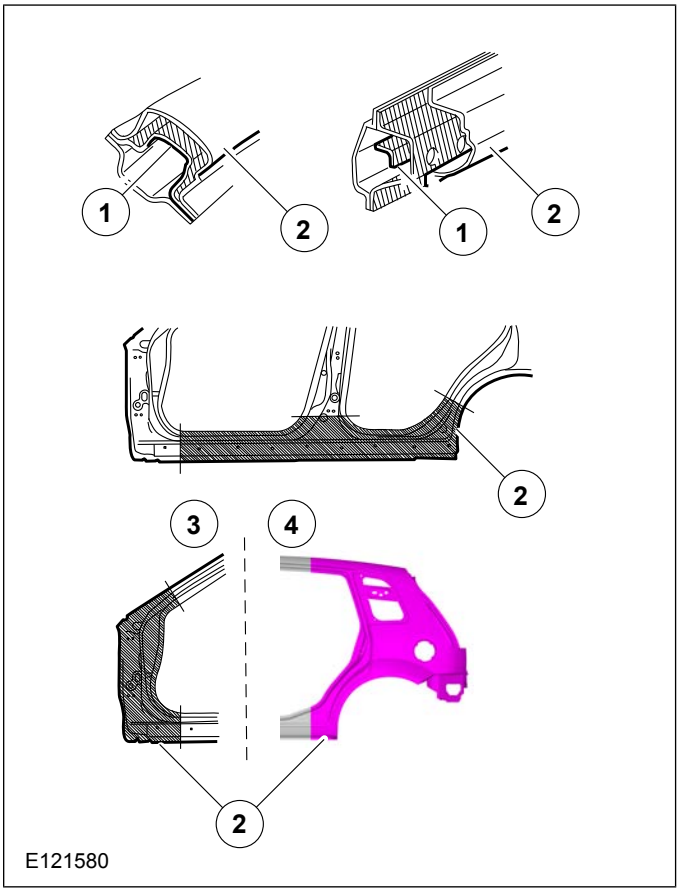
1. Selection of cut and joint point (cut and joint replacement only). In order to maintain the strength of the body, select the cut and joint point in consideration of the following points:

- Number of parts needed to be removed, as little as possible
- Easy to work with safety
- No reinforcement member inside
- Distortion hard to occur
- No stress concentration
- Less surface to be finished
- Cut and joint point hidden by external part

2. Rough cutting on damaged side (removal)

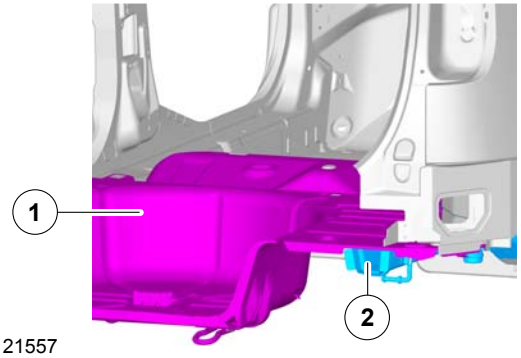
- In order to perform speedy work, cut off the replaced part except the welding flange with a cutter.
- Use the most appropriate cutter according to the type of parts.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever cutting.



Item	Description
1	Reinforcement Member
2	Outer Panel
3	Front Pillar
4	Rear Side

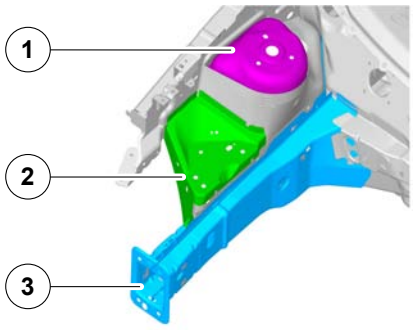
DESCRIPTION AND OPERATION



E121557

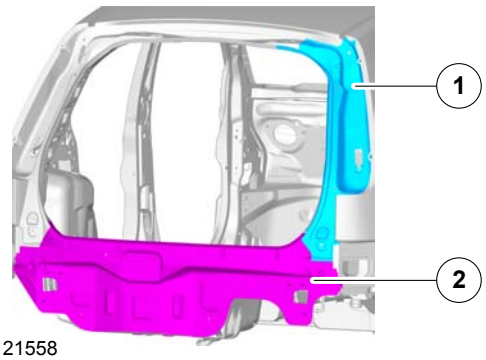
Item	Description
1	Rear Floor Panel
2	Rear Frame

Complete Parts



E121408

Item	Description
1	Damper Housing
2	Front Wheelhouse
3	Front Side Frame



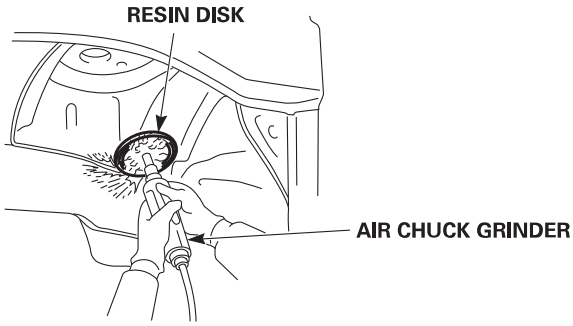
E121558

Item	Description
1	Rear Gutter
2	Skirt Panel

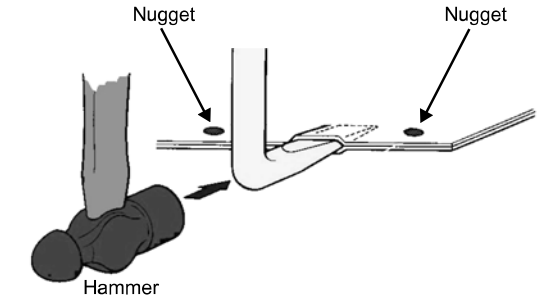
3. Decision on where to weld

- Because it is impossible to identify the welding spots (nuggets) in the area where undercoat or sealer is applied, remove the undercoat or sealer with a plastic sanding disk attached to the air chuck grinder.
- If the welding spots (nuggets) cannot be identified even after the paint layer has been removed, insert a chisel into the welding joint area.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever cutting.



E105284



E113102

4. Cut off welded area.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever cutting.

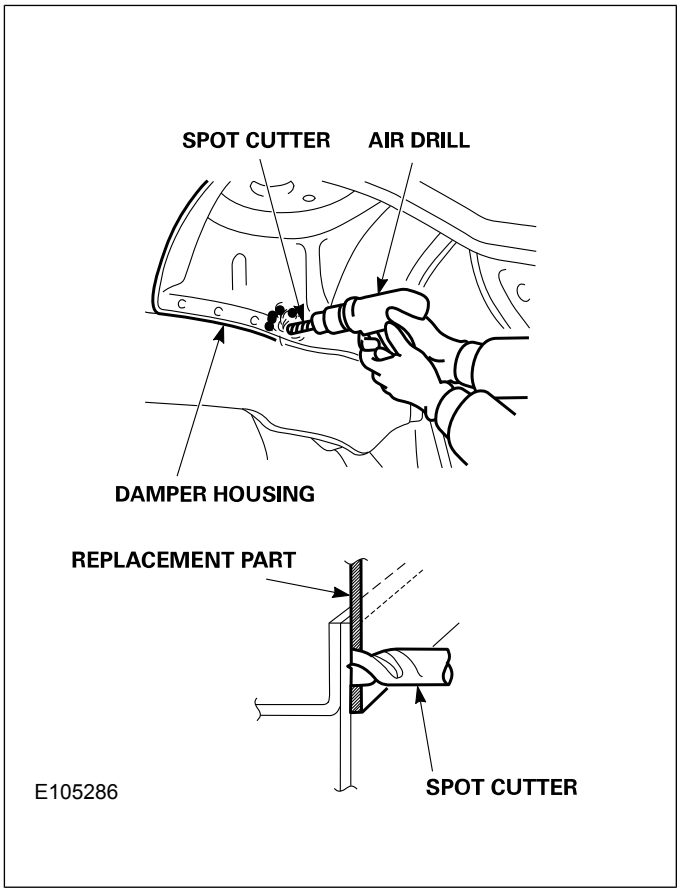
- Cut off welded areas left after the rough cutting.
- Most of the welds are made by spot welding, the remaining being by MIG welding on a mass-produced body.
- In cutting off the welded areas, use a drilling tool or peel off tool depending upon the state of welding joint.

NOTE: Check the panel structure so as not to damage the welding flange of the mating part.

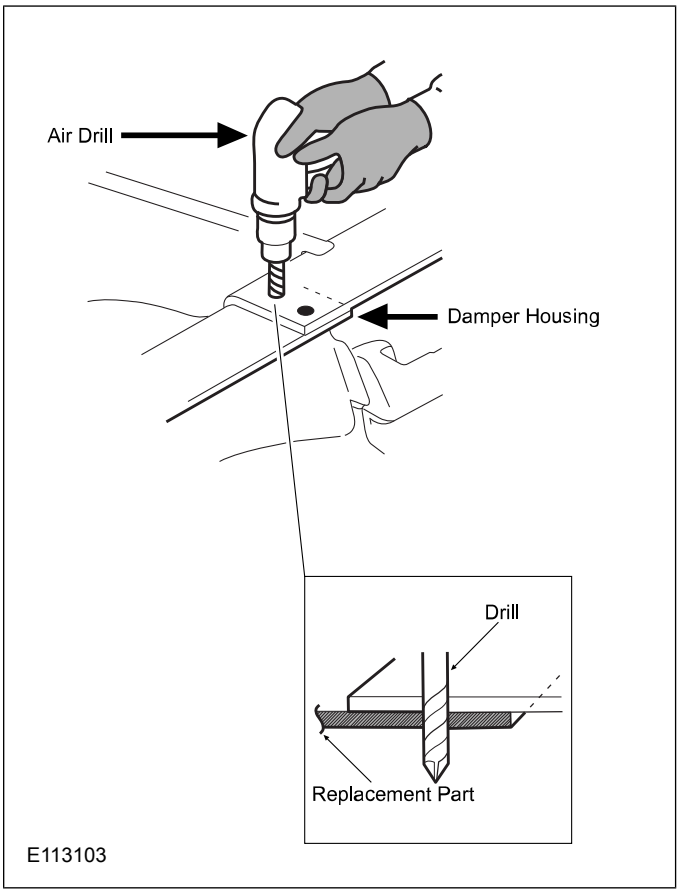
DESCRIPTION AND OPERATION

Cutting off of spot welded area:

If the part to be replaced is welded above the welding nugget, cut it off with a spot cutter.

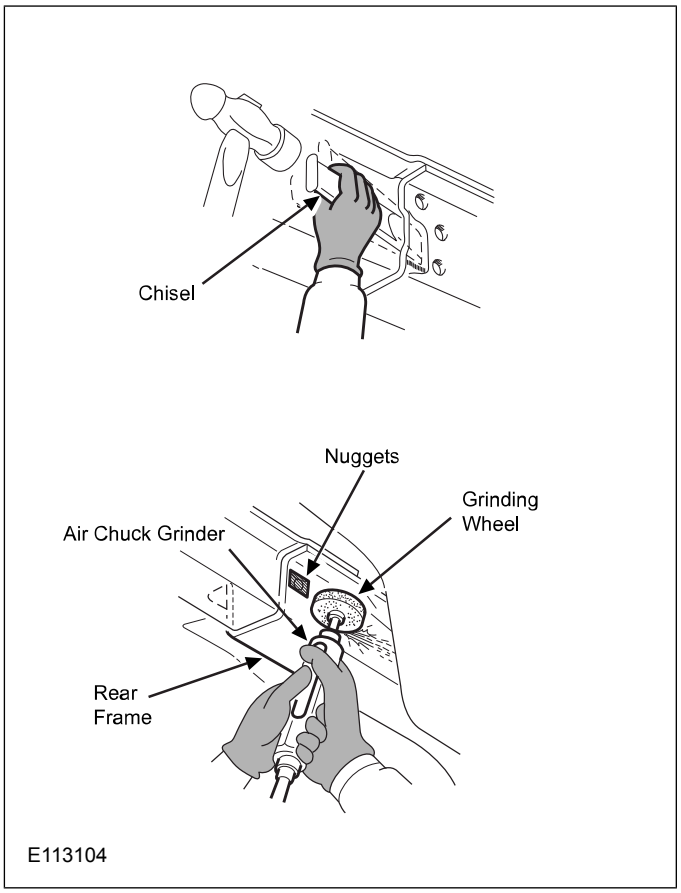


If the part to be replaced is welded below or in between the welding nugget, drill it through.

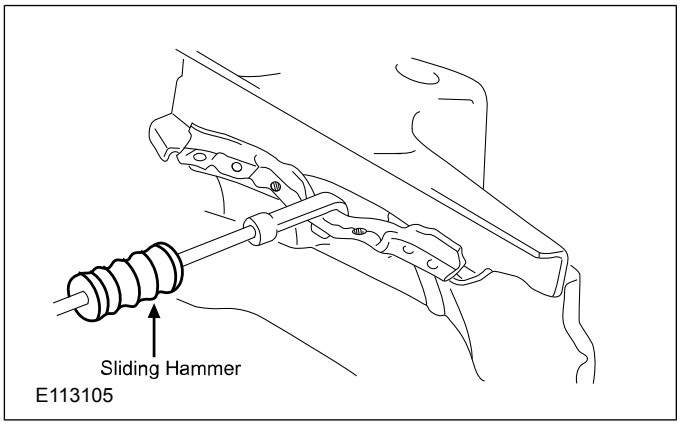


If the welding flange is located where it is impossible to use a drill, cut it off with an air chuck grinder. When the nugget comes to the surface, strike the chisel in between the panels to separate it off.

DESCRIPTION AND OPERATION

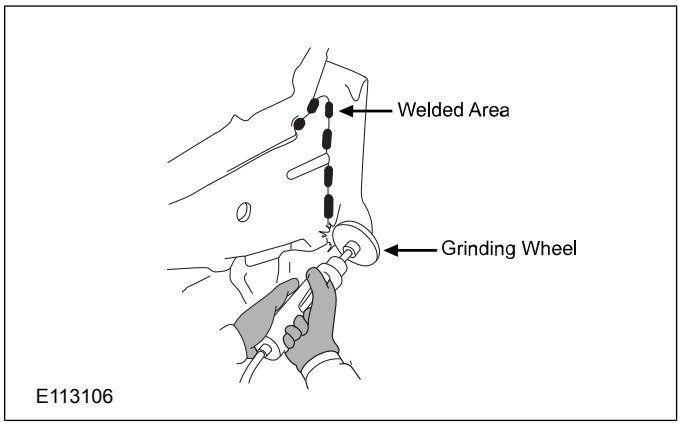


To separate a wide or long area, grind off the nugget completely and separate the panels with a sliding hammer.

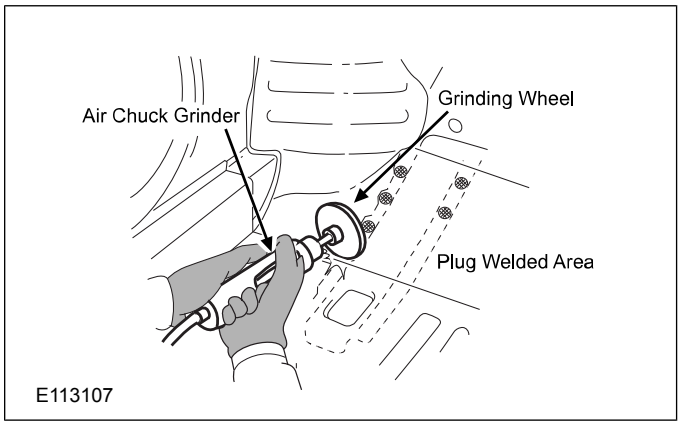


Cutting off carbon de-oxide arch welding (MIG Weld) area:

If the fillet welding is at the corner, cut off the welding bead with an air chuck cut grinder or a disk sander.



For the plug welded area, grind it off with a grinding wheel.



Preparation for Installation

1. Reforming and anti-rust treatment on a part installing area.

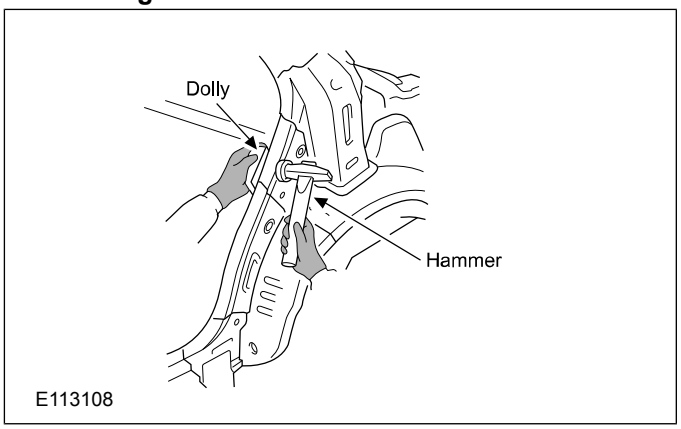
- Reform the welding flange on the part installing side with a hammer and dolly. If a hole or crack is found, reform it by plug welding.
- Sand both sides of the welded area with a disk sander or belt sander to get rid of undercoat layer, rust, or dirt.
- Apply electro-conductive spot sealer evenly to the welded joint area.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever sanding.

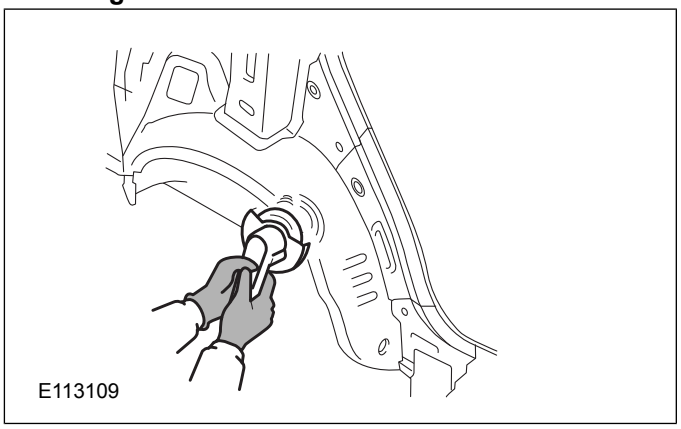
NOTE: Do not grind too much.

DESCRIPTION AND OPERATION

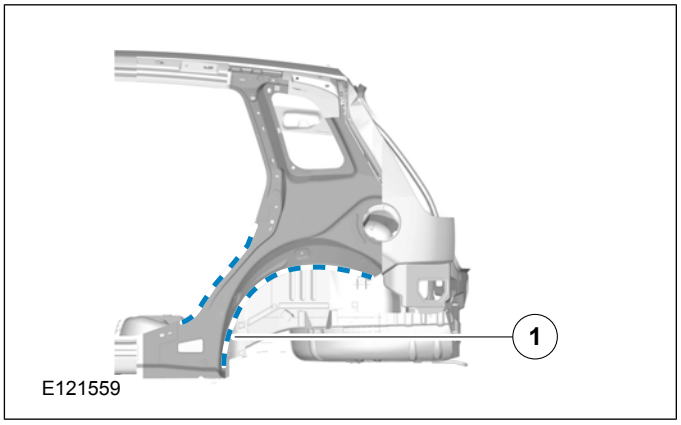
Reforming



Sanding



Anti rust treatment

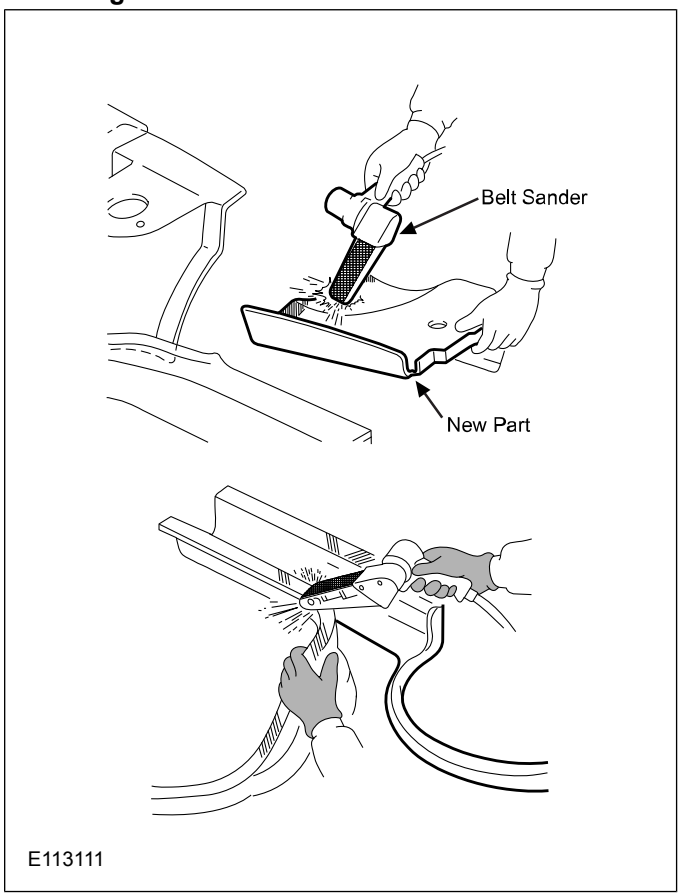


Item	Description
1	Spot Sealer

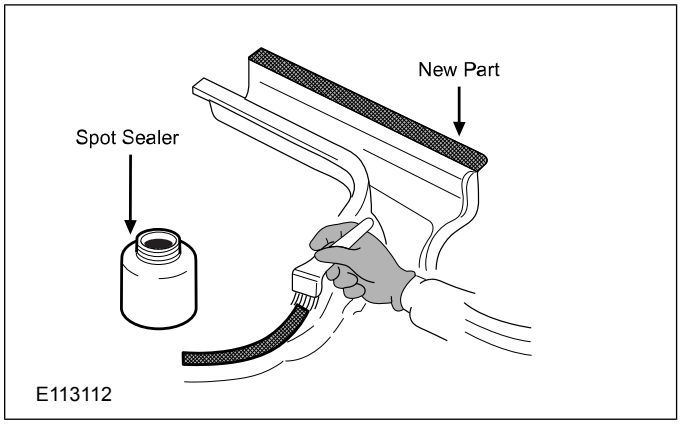
2. Anti-rust treatment and processing of a new part
To spot weld the new part:

- Remove the undercoat layer. Because new parts are all painted with an undercoating, they are not electro conductive when welded. Before welding it, be sure to remove the paint layers from both sides. Remove the paint layer using a belt sander.
- Apply electro-conductive spot sealer evenly on the mating surface that has had the paint layer removed. Wipe off the excess.

Sanding



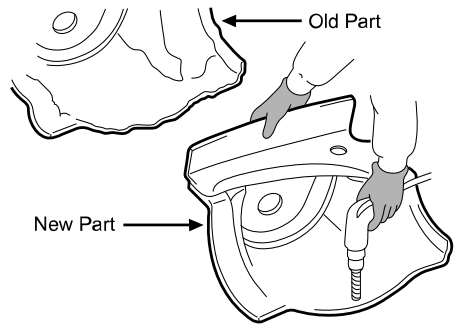
Anti-rust treatment



3. Make drill holes or punch holes for plug welding a new part. Plug-weld on the new part about 20 to 30 % more than the welding spots on the old part. Determine the number of spots referring to the

DESCRIPTION AND OPERATION

Body Repair Manual, for welding diagram, if available, or the old part itself.

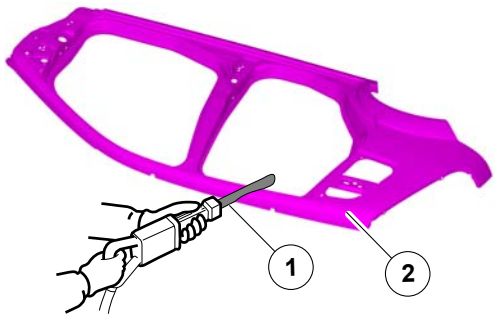


E113113

4. Rough cutting of the new part (cut and joint replacement). As for a new part to be cut and jointed such as an outer panel, cut the old and new parts, using an air saw or air chuck grinder, so that the joint area can be overlapped about 20 to 30 mm (0.8 to 1.2 in.).

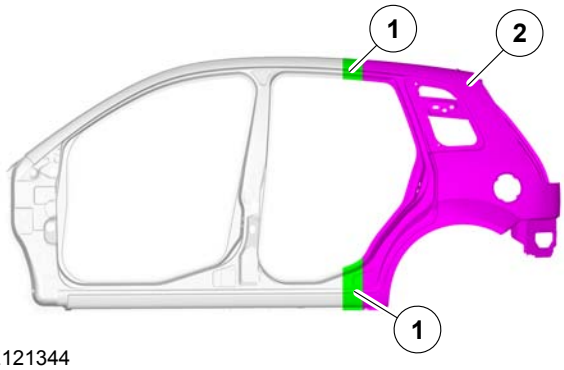
WARNING: To prevent eye injury, wear goggles or safety glasses whenever sanding.

If the overlapping margin to the body side is too much, it may become hard to put the mating parts, like a door, in position.



E121570

Item	Description
1	Air Saw
2	Outer Panel New Part



E121344

Item	Description
1	Overlapping
2	Outer Panel

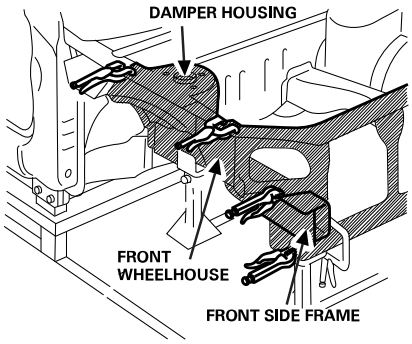
5. Positioning the new part. Align the new part to the reference hole or old part position and fix it to the body with the use of a vise, grip wrench, or screw clamp. In case fixing tools cannot be used due to lack of space, fix the new part with bolts or tapping screws. It is extremely important to fix the frame and damper housing to the correct positions because they influence the wheel alignment. The well-fitting of the outer panel and the rear panel to the externally attached parts is also very important, influencing the external appearance, too.


E113078

Complete Part Installation

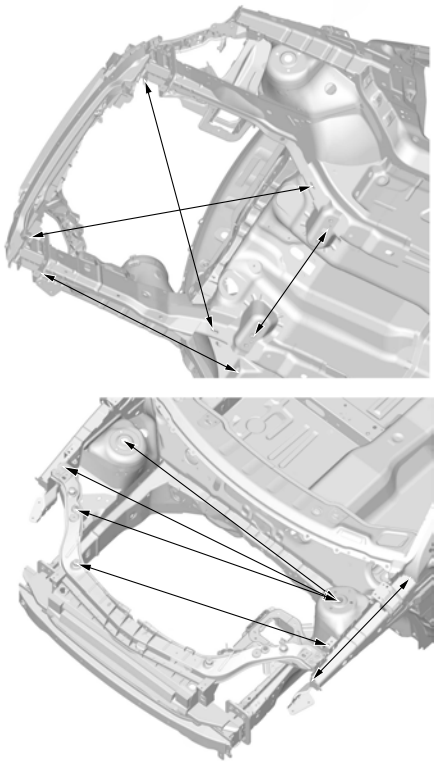
1. Fix the new part.

DESCRIPTION AND OPERATION



E113115

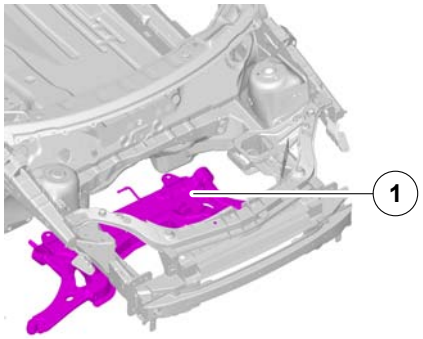
2. Measure the dimensions and determine the position. Measure the under body in different directions and determine the positions of the front side frame and front lower cross-member. Measure the upper body in different directions and determine the positions of the damper housing and front bulkhead.


E121491

3. Temporarily weld the new part.

WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

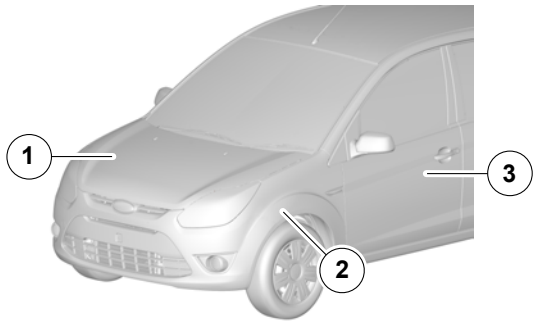
On a subframe mounted vehicle, determine the position of the new part in the state of the temporarily positioned subframe.



E121581

Item	Description
1	Sub Frame

4. Check the fitting of the external attachment parts Temporarily install the front fender, headlight, bumper, engine hood and door and see if the clearances, steps, or operations are proper or not.



E121345

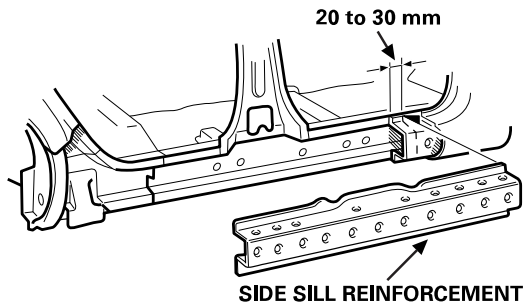
Item	Description
1	Hood
2	Fender
3	Front Door

Cut and Joint Part Installation

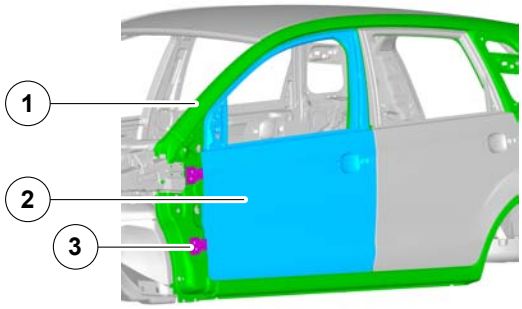
1. Rough-cut the new part (reinforcement) leaving about 20 to 30 mm (0.8 to 1.2 in.) margin to be overlapped with the body side. Overlap the cut new part (reinforcement member) with the body and, after confirming the position, weld it temporarily.

NOTE: Carefully install the front pillar stiffener and center pillar stiffener in correct positions because they have the door hinges. Unless they are properly installed, the smooth opening and closing of the doors are not expected.

DESCRIPTION AND OPERATION

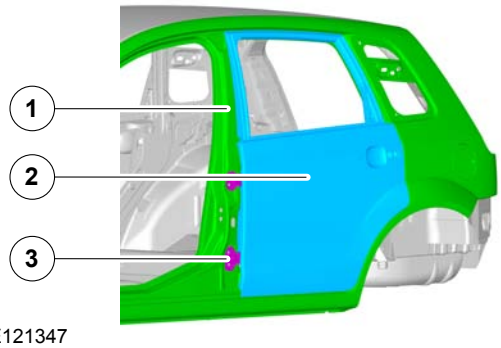


E113118



E121346

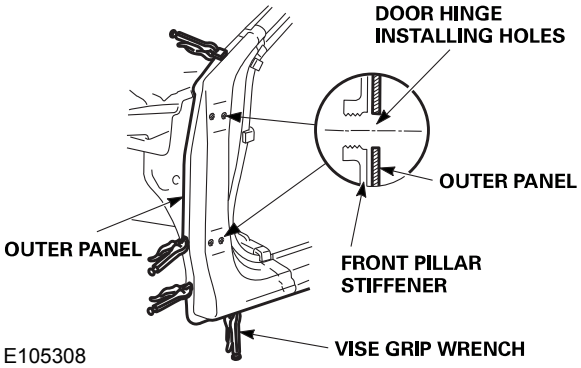
Item	Description
1	Front A-Pillar
2	Front Door
3	Door Hinge



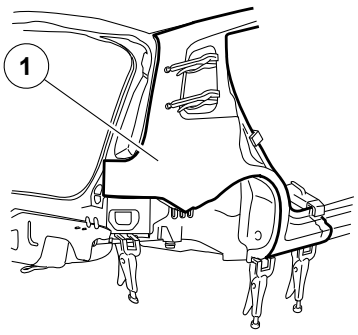
E121347

Item	Description
1	Front B-Pillar
2	Rear Door
3	Door Hinge

2. After rough cutting, fix the outer panel (new part). Make sure that the door hinge installing holes of both the front pillar and center pillar are aligned. Considering that the door is temporarily installed in position, fix the door opening at an angle of 90° using a vise grip.

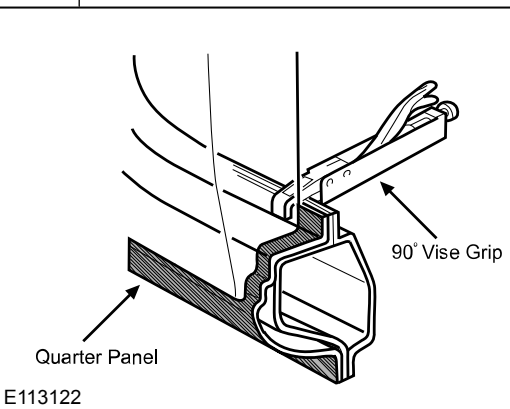


E105308



E121912

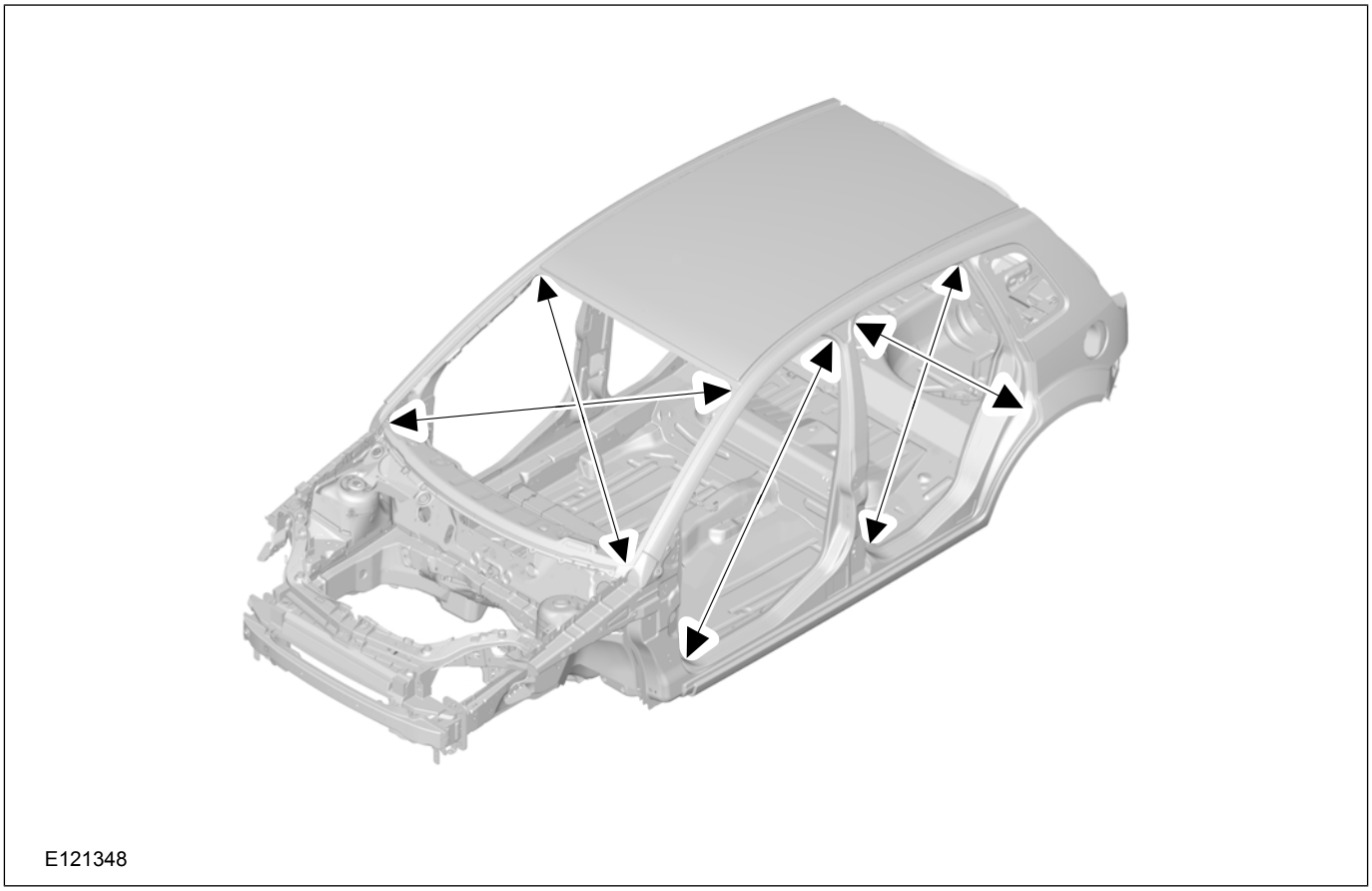
Item	Description
1	Quarter Panel



E113122

3. Measuring the diagonal dimensions on the door opening, determine the position of the outer panel.

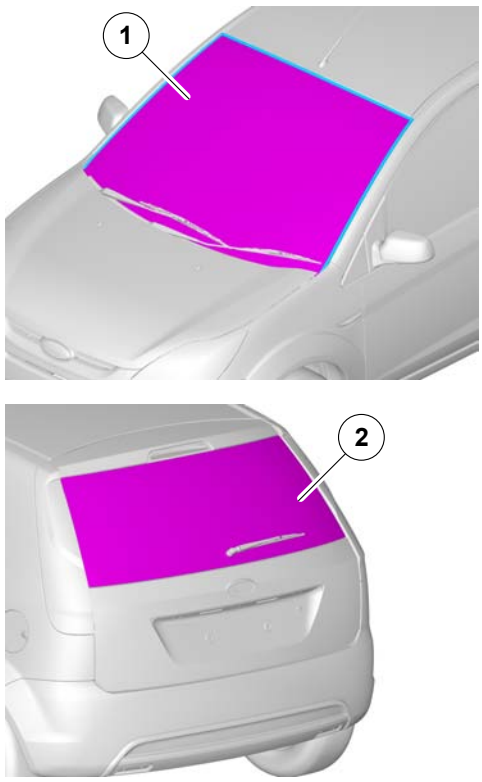
DESCRIPTION AND OPERATION



E121348

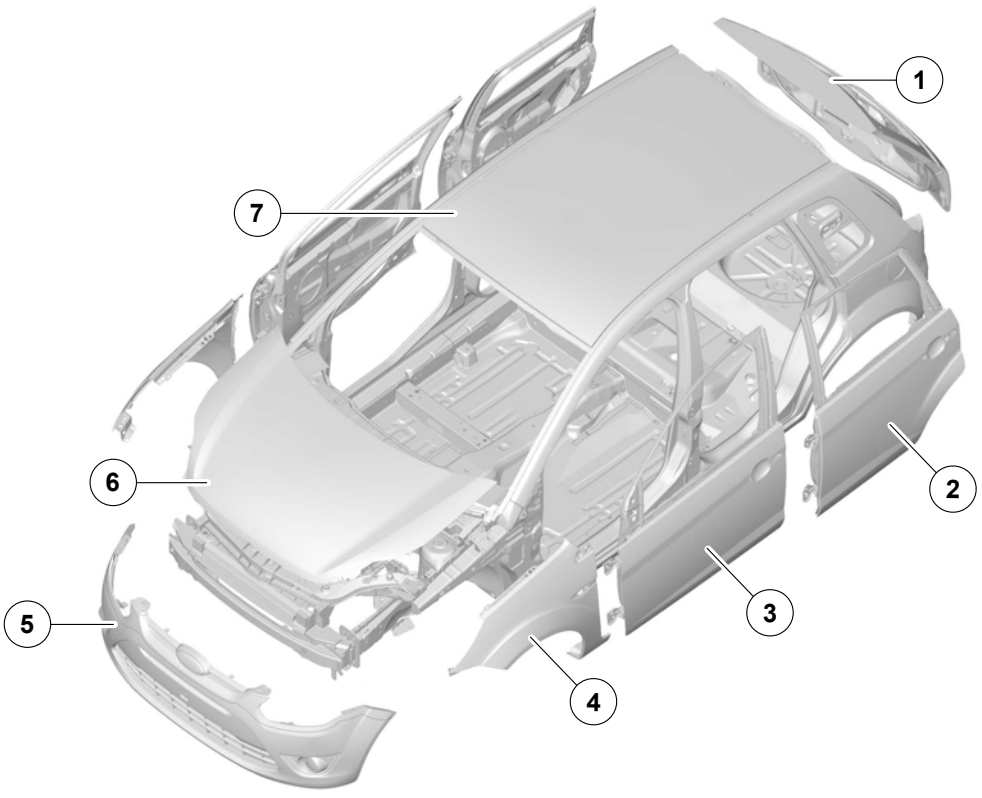
4. Check fitting of external attached parts. Inspect the clearances and steps between the body and the front window glass or rear window glass to determine proper alignment. Temporarily install the front fender, hood, door, trunk lid, and tailgate to check if the clearances, steps and the movement of opening and closing are appropriate. Install the headlight, taillight, and bumper temporarily to inspect if the clearances, steps are appropriate. Inspect to determine if the external bodylines are within the standards.

DESCRIPTION AND OPERATION



E121349

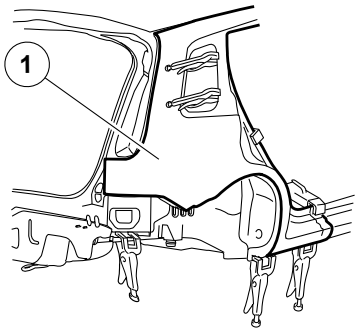
Item	Description
1	Wind Shield
2	Rear Window Glass



E121350

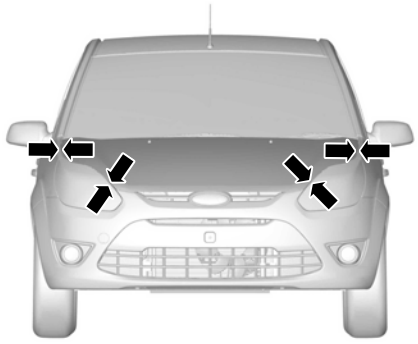
DESCRIPTION AND OPERATION

Item	Description
1	Trunk Lid
2	Rear Door
3	Front Door
4	Fender
5	Front Bumper
6	Hood
7	Roof

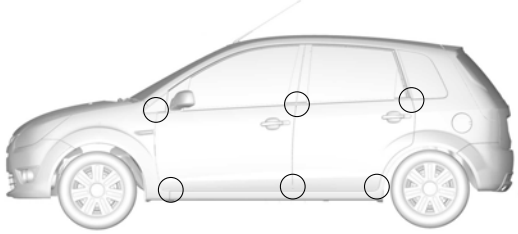


E121912

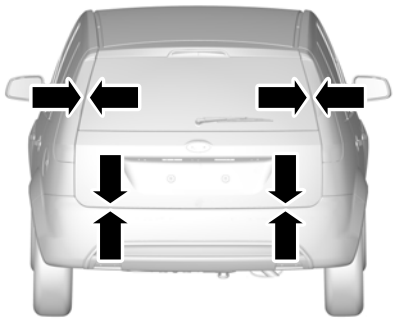
Item	Description
1	Quarter Panel



E121351



E121352

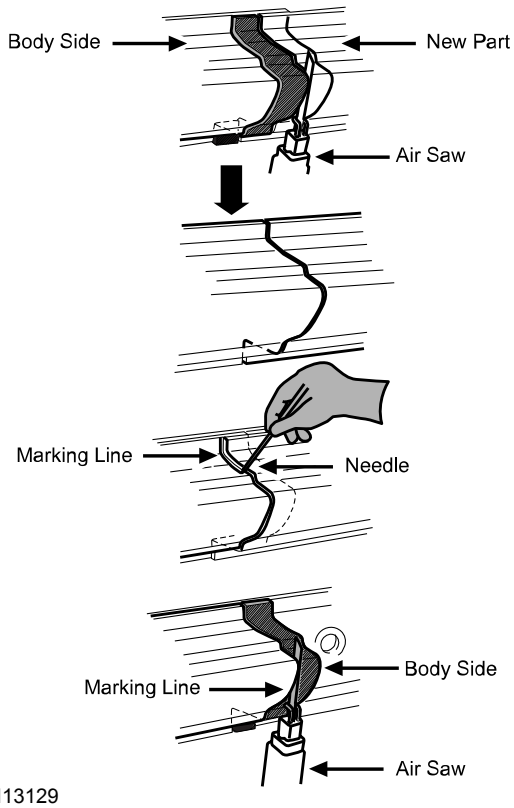


E121353

5. Cut off the cut and joint areas and make butt-welding connection.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever cutting.

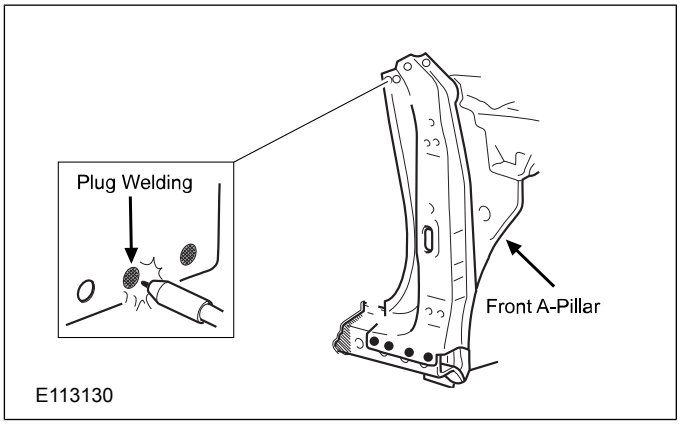
- After making sure that the fitting is satisfactory, cut off the cut and joint areas of the front pillar and side sill and rear pillar.
- Carefully cut so that no overlapping area or cutting gap remains.
- If the overlapping area cannot be cut off because of the reinforcement inside, cut the body side after the making line is drawn.
- Cut along the marking line with an air saw.

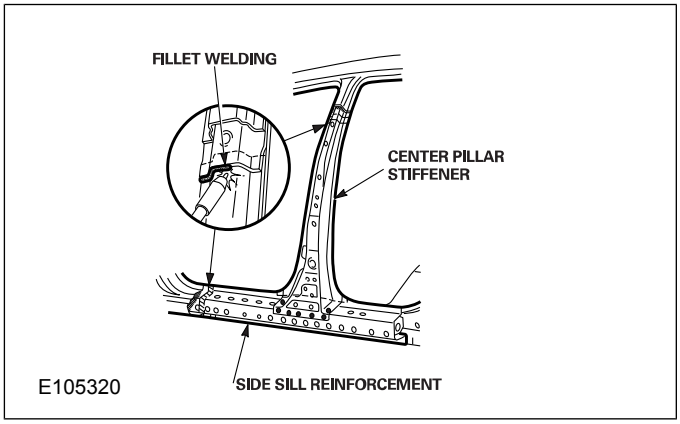


E113129

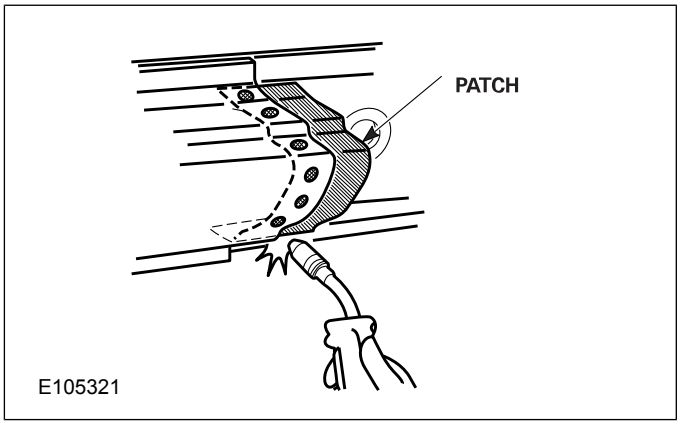
DESCRIPTION AND OPERATION

6. Remove the outer panel and weld the reinforcement members to the body. After installing the outer panel, weld where it was impossible to weld with the outer panel in position. Plug-weld the upper and lower portions of the front pillar stiffener and center pillar stiffener. Fillet weld the overlapped area along the edge.

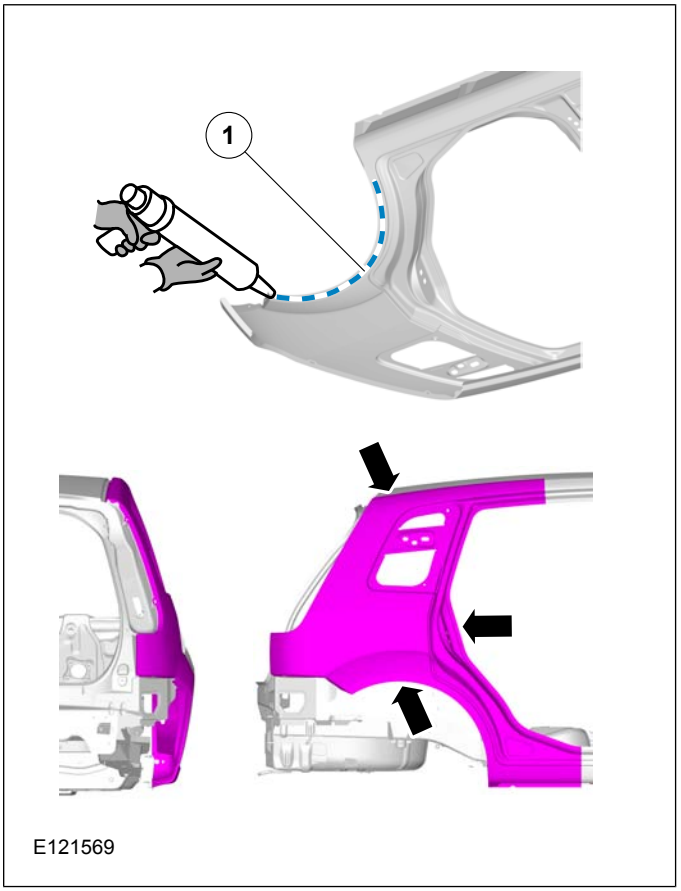




7. Weld a patch (reinforcement plate) to the cut and joint area of the outer panel. For the patch, use a plate cut off from an old or new part. Make a 5 to 6 mm (0.20 to 0.24 in.) plug hole in the outer panel on the body side and plug-weld the patch.



8. Fix the new part that has been positioned again to the butt joint position. Before fixing the rear side outer panel to the body, apply body sealer to the rear wheel arch and fuel adapter. After installing the outer panel, view the whole body once again to make sure that the bodylines are satisfactory viewed from any angle.

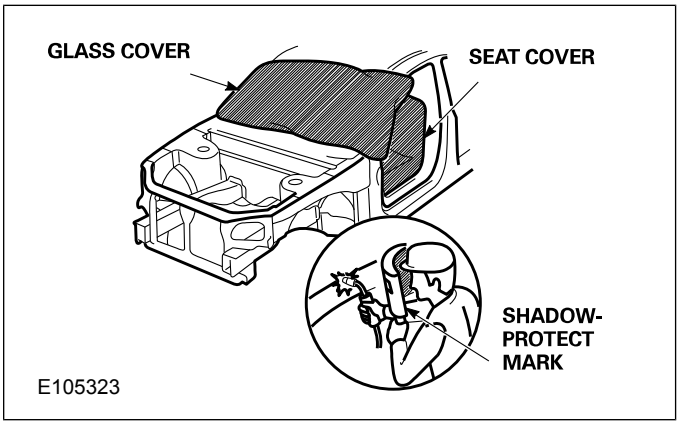


Item	Description
1	Body Sealer

Main Welding

Weld the new part.

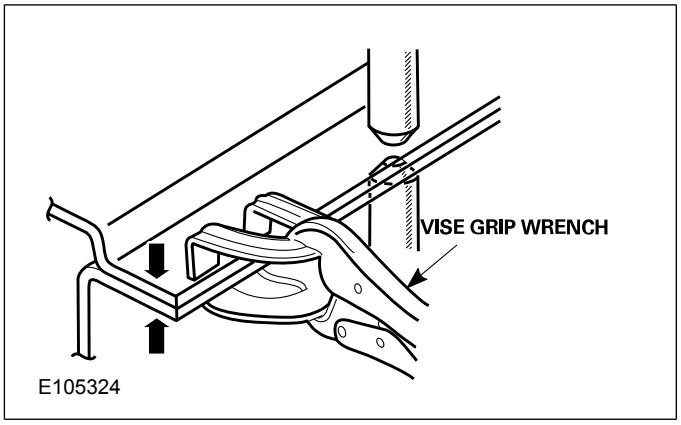
NOTE: Before starting the welding work, protect the glasses, and painted surfaces in the cabin with heat resistant covers (splatter covers).

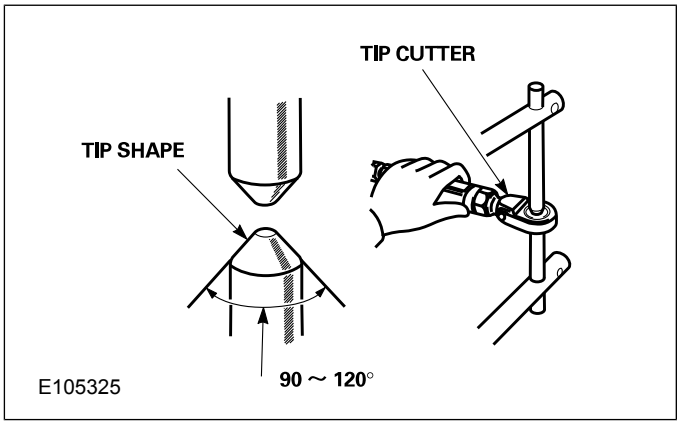


Key points in spot welding:

DESCRIPTION AND OPERATION

- Make the contact surfaces tight with the use of a vise grip or the like.
- Avoid old welded points as much as possible for new welding points. Weld at the same space.
- Increase the number of welding spots about 20 to 30 % more than those of the mass-production body.
- Where spot welding cannot be done, use the MIG welding for plug or fillet welding.
- If the part to be welded is of zinc-plated steel sheet, raise the welding current about 10 to 20 % or lengthen the welding time.
- Use a welding arm as short as possible. Do not use an unnecessarily long one.
- Always keep the tip in a correct shape using a tip cutter.
- In stead of welding continuously, allow the tip to cool every 5 to 6 spot welds.

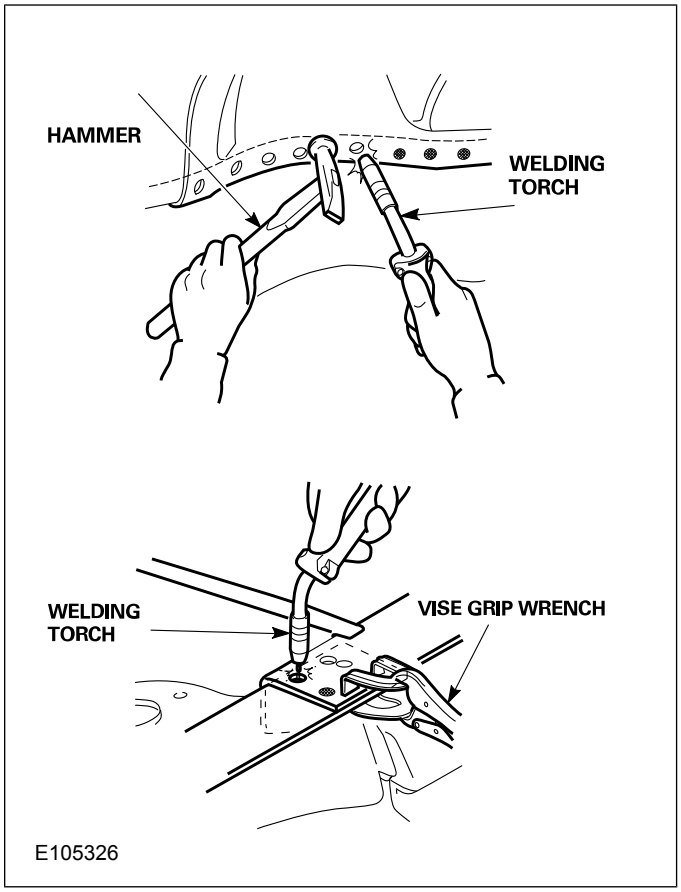




Key points in MIG welding:

NOTE: Be sure to attach the ground cable to the welding machine. Attach the ground cable as close as possible to the point where it is being welded. If it is attached to a place other than the body, there is a possibility that the electric components may be damaged.

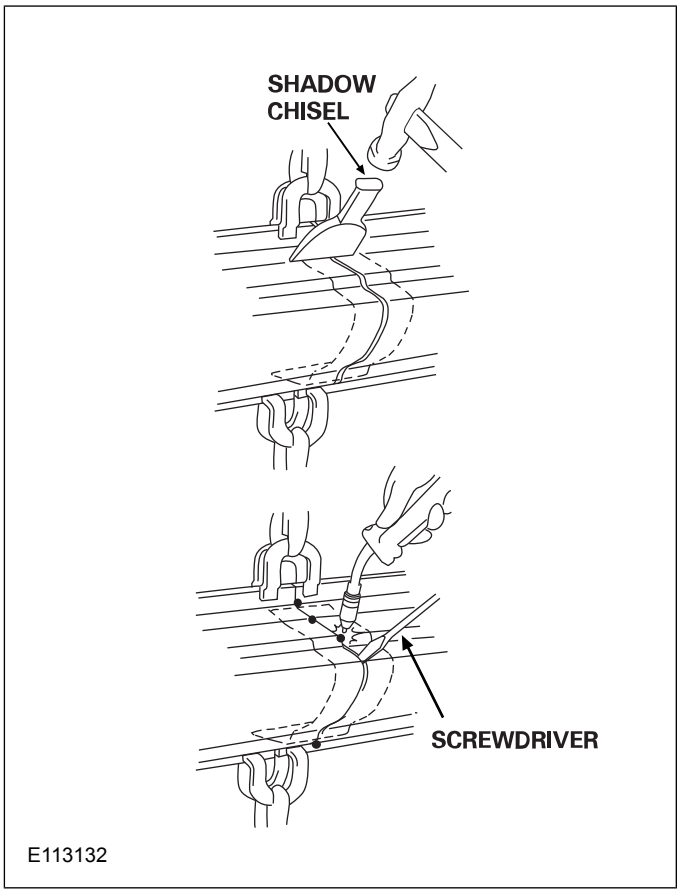
- Using a vise grip or the like, make the welding point tight contact with no gap.
- Where a vise grip cannot be used because of the space available, make tight contact using a hammer and dolly.



Welding Steps and Finishing

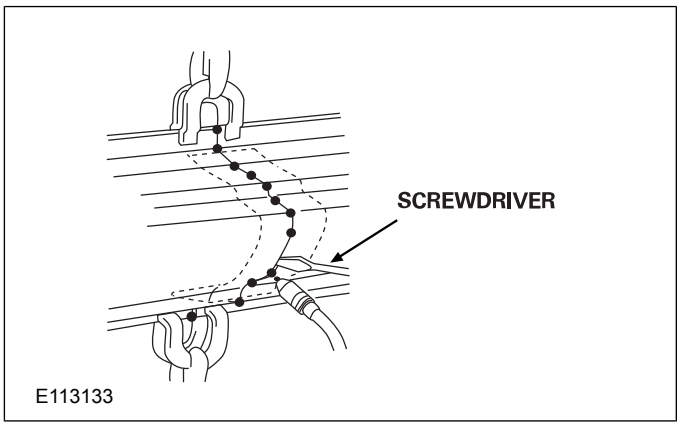
1. Align the press lines using a shadow chisel.
2. Align the butt joint area by lightly plying a screwdriver and temporarily weld the press line corner starting from the end in spots.

DESCRIPTION AND OPERATION

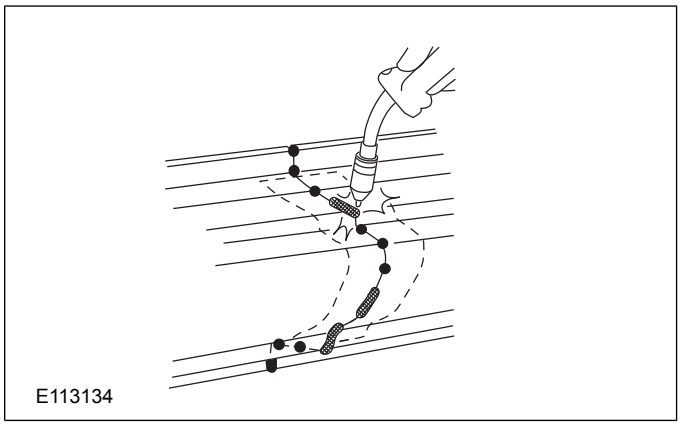


3. Temporarily weld the mating surface while plying with a screwdriver.

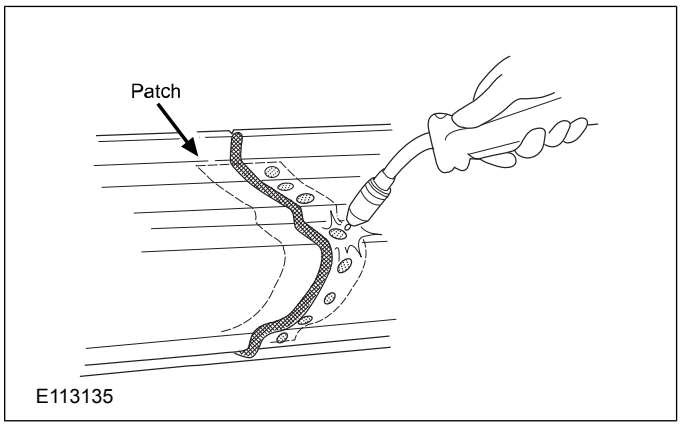
NOTE: The welding pitch is about 15 to 30 times the plate thickness.



4. Weld permanently between the temporary welding spots. Do not weld from one point continuously.

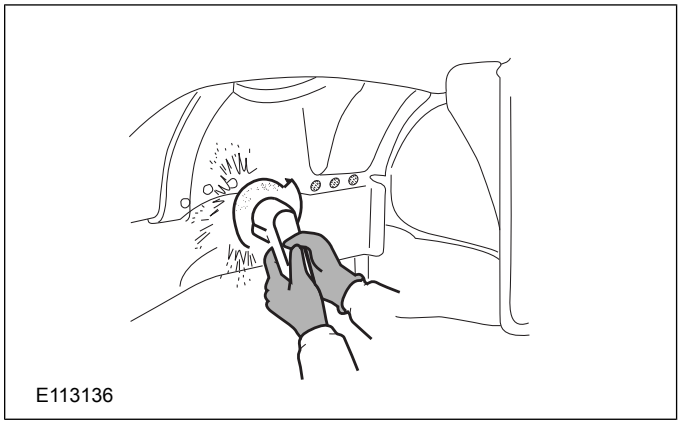


5. Weld the patch to the new part.



6. Conduct a welding strength test. When a reinforcement member is replaced, inspect, before finishing the welded area, that the corresponding part is firmly welded.

7. Finishing the welded area. To finish, grind the plug or joint welded area with a disk sander or equivalent. Where a glass pane contacts, completely remove any steps or projected areas. If the welded areas are hidden beneath the undercoat or behind the attached part, they should be lightly grinded.



DESCRIPTION AND OPERATION

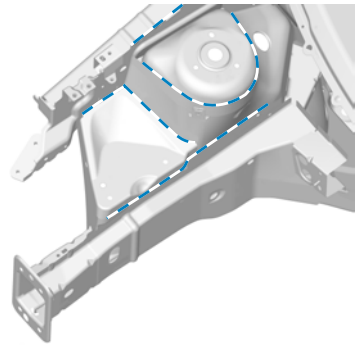
Anti-rust Treatment before Painting Process

Sealing

To prevent entry of water and rust, apply sealer where the panels are put together. As for where sealer should be applied, refer to the Body Repair Manual-Models or see the corresponding parts on the opposite side of the vehicle.

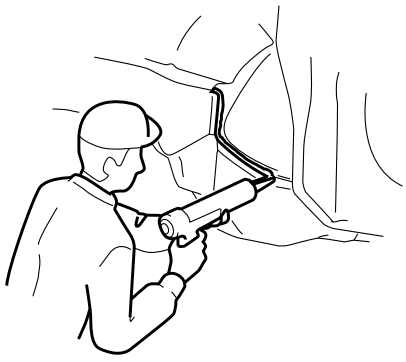
1. Remove grease, oil and fat with grease remover and clean the area where sealer is applied. If excess spot sealer is on the area where the sealer is to be applied, remove it with thinner, apply primer and then sealer.

2. Apply sealer evenly on the outer panel, engine compartment, and trunk gutter that influence the external appearance of the vehicle. If needed, use masking tape.



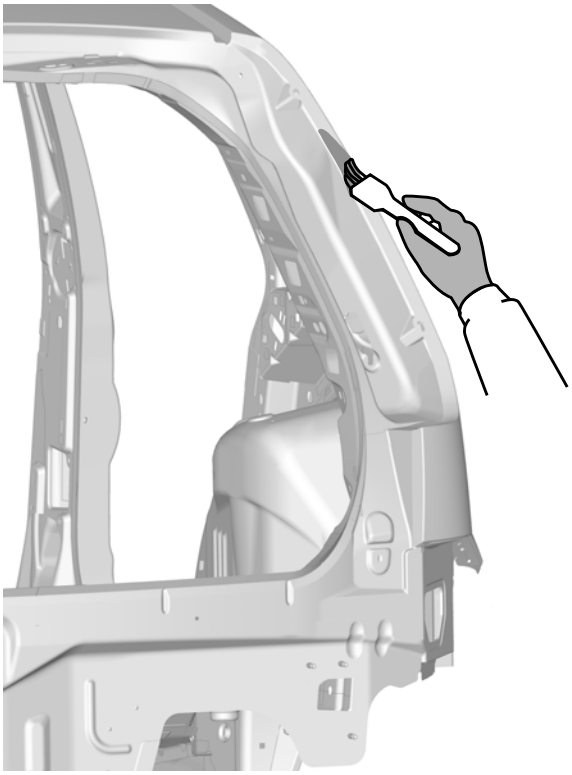
E121879

3. Attach a sealer cartridge to the sealer gun and apply sealer without gaps.



E105333

4. For a part installing surface for the taillight or like, be careful of the height of the sealer applied surface. Where necessary, make the sealer flat using a brush.



E121501

Underbody coat

In order to prevent damages caused by road debris or flying stones, apply undercoat over the surfaces of the under body and wheelhouses.

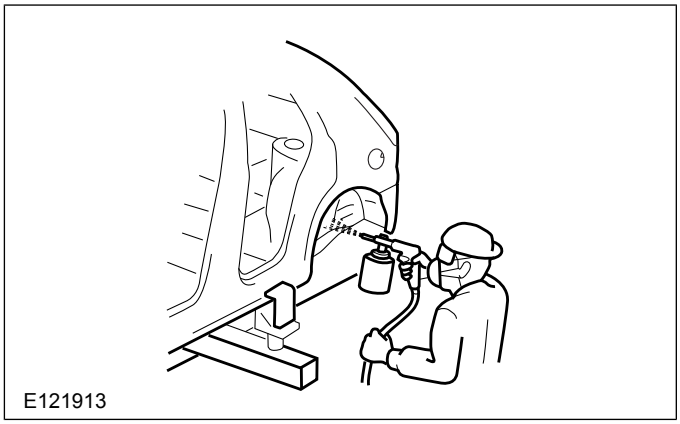
As for where sealer should be applied, refer to the Body Repair Manual-models for the vehicle you are repairing.

1. Remove grease, oil with grease remover and clean the area where undercoat is applied.

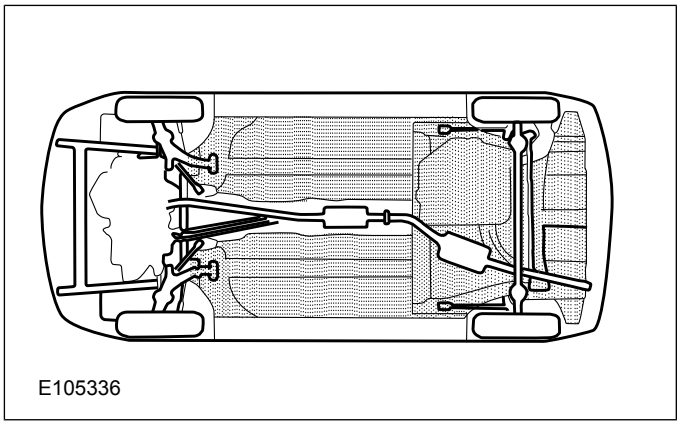
2. Use a masking tape, where necessary, to prevent undercoat from being applied to the suspension, drive and exhaust related parts and parts installing surfaces.

3. Apply undercoat with the use of its exclusive gun.

DESCRIPTION AND OPERATION



E121913



E105336

General Straightening sequence

Body straightening requires practice and experience. Before starting, the exact direction of impact must be determined.

The straightening force must have the exact opposite direction of the impact force. Only in this way can it be guaranteed that the original shape will be achieved again.

The pulling forces only work with their full impact if the pulling direction is direct. Using the wrong pulling direction could lead to additional deformation, which is difficult to correct afterwards.

Please note the following points:

- Secure the pulling unit with a safety cable.
- Do not remove bonded glass prior to straightening.
- Never apply heat during straightening.
- If necessary, open doors or hoods/lids/liftgates during straightening.
- Check dimensions and gaps continuously during straightening.
- High-strength steel panels have a stronger tendency to retain their deformed shape.
- During the straightening repairs, monitor the attachment of the pulling unit to the vehicle.
- Carry out the straightening work in several stages, never in one pulling process. This prevents the risk of overstretching and of joints tearing out.

During individual straightening steps (under a pulling load), relieve tension by striking the deformed areas with an aluminum hammer while they are still under tension.

Off-road vehicles

Straightening repairs on off-road vehicles are different to repairs on normal bodies due to the two-part construction of the vehicle.

This means there are two areas that must be taken into consideration separately:

- Straightening the body.
- Straightening the body with chassis frame.

Straightening the body

If only the body is damaged in an accident, light straightening repairs can be carried out.

NOTE: With strong straightening forces, these bolted connections may be damaged. Monitor the bolted connections continuously during the straightening work.

If a straightening jig is used for straightening work, the holding clamps or alignment angles must be attached directly to the chassis frame. During the straightening work, the pulling forces must not become too high. The bolted connections are to be monitored continuously.

Straightening the body and chassis frame

NOTE: High-strength steels must not be heated.

If the body and chassis frame have to be straightened, they must first be separated from each other.

The following conditions must be met:

- The repair must be economically justified.
- The quality and stability of a frame after production must be restored after carrying out the repair.
- In principle, the driving and operating safety of the vehicle is paramount.

DESCRIPTION AND OPERATION

- Cold straightening of deformed areas with sharp edged folds cannot be carried out.
- Straightening with the application of heat (welding torch) requires much experience and accurate knowledge of the behavior of steel panels when heated.
- The temperature and duration of application of the heat are to be considered in particular.
- Individual components of the frame, such as cross members, brackets, etc. can be replaced.

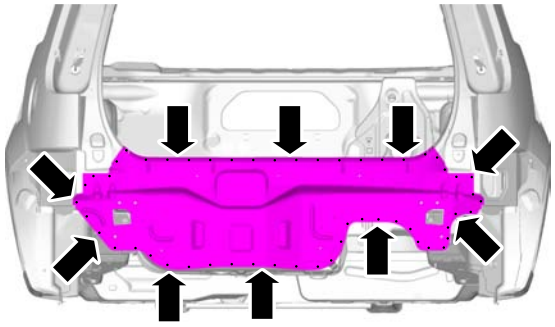
DESCRIPTION AND OPERATION

Complete Panel Replacement/Partial Replacement

Repairs always mean intervention in the body shell structure and thus also intervention in the vehicle's passive security system. The use of complete replacement or sectional replacement as the best solution must always be weighed up before starting a repair.

Complete replacement

In a complete replacement, the original connections are largely reused.



E120513

A complete replacement is advantageous if the damaged body part can be detached from its original connections and a completely new part can be fitted without creating additional joints (e.g. liftgate).

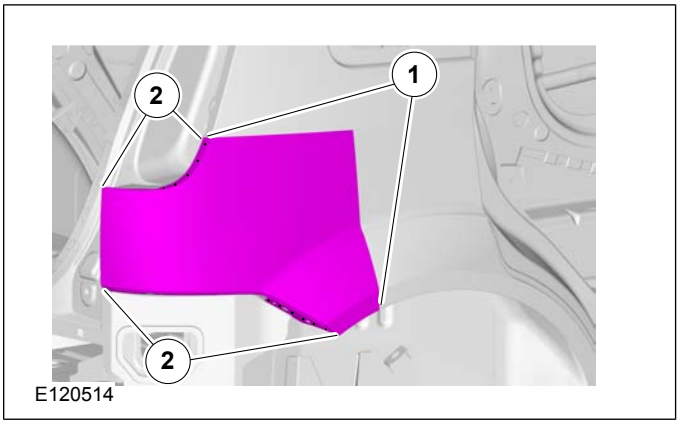
A complete replacement is necessary if there is no sectional replacement solution.

Sectional replacement

Sectional replacement (sectional repair) means the replacement of a section of the body shell structure.

NOTE: Basic and advanced training is offered for the following contents. For an overview of all training courses offered, please refer to the Ford Service Organisation's training course brochure.

Sectional repairs fulfill their purpose above all if the replacement of a complete part is too time-consuming and thus not economical.



E120514

Item	Description
1	Join area
2	Original welding

Approved sectional repairs are clearly defined in the model-specific body literature. These requirements must be complied with.

Advantages of sectional repair

Sectional repair offers many advantages for correct repair of accidental damage.

- Repairs can be made both in the outer panel area (e.g. side frame) and in the inner areas (e.g. structural member, trunk floor).
- The repair can be limited to the actual damaged area.
- Reduction of repair costs, as aggregates and other components can usually remain in the vehicle.

For the sectional repairs approved by the factory and described in the model-specific body workshop literature/technician's information, some spare parts (service parts) specially prepared for sectional repairs are offered via the spare parts sales department.

Decision-making criteria

Depending on the type and extent of the damage, the advantages of carrying out sectional replacement in the area concerned must be weighed up against complete replacement.

The following are always crucial for the decision:

DESCRIPTION AND OPERATION

- How economical the repair is.
- Retention of the original join.

In addition, Ford must have given its approval for a sectional replacement solution in the damaged area.

Depending on the damaged areas, further facts are to be taken into account when deciding for or against sectional repair:

- Severance cuts should be as short as possible.
- The effort for follow-on work on the connections must not be too great.
- It must be possible to reproduce the optical path of visible edges on door openings.
- Inner reinforcement panels must not restrict the straightening repair.
- Inner reinforcement profiles in the pillar areas must allow for separation.
- The Ford regulations on sectional repairs on supporting frame sections must be taken into account.
- The large surface welding seams at the connections must be restored.

Repair or Replace

This is a critical decision often practised in the bodyshop. Depending upon nature and severity of the damage this decision is taken.

Often this decision is influenced by various factors:

- Severity of the damage
- Availability of the parts (Body panels) as serviceable
- Estimated cost of overall repair
- Time required to complete the repair
- Body shop capability in carrying out the repair
- Manufacturers direction

Ford has made list of serviceable parts exclusively to improve the quick turn around in the body repair and thus reduce the overall repair cost burden to customers.

All panels are available as a replacement and it is essential to replace them to complete the repair quickly and economically. However, the damage is small it is better to perform spot repair and rectify the damage.

Country specific insurance policies and governance also plays pivotal role in deciding the repair or replace the component during repair.

An experienced bodyshop manager in association with Body repair manual and parts guidelines can take decision to improve quick turn around and increase the satisfaction of customers.

DESCRIPTION AND OPERATION

Corrosion Prevention

The corrosion protection provided in production must be carefully maintained and reproduced during body repair work, in order to ensure the long-term warranty for Ford vehicles.

NOTE: Please take the notes in the model-specific repair descriptions into account. Please also note the manufacturer's instructions when handling the different anti-corrosion agents.

Only Ford original bodywork components and Ford approved repair materials are to be used for body repairs. The Ford logo is stamped onto every Ford original spare part.

Panel coatings and corrosion protection

Body steel panels are provided with a coating for corrosion protection purposes. The coating material is predominantly zinc in a variety of composition forms. Aluminum is also used to some extent. Basically, all types of steel sheet can be coated.

A variety of coating processes are used:

- Hot dip zinc coating (no longer used in vehicle construction).
- Electrolytic zinc plating.
- Organic coating.
- Hot dip aluminum coating.

NOTE: Welding fumes are harmful to health. Make certain that the workspace is well ventilated and use welding fume extraction.

The following points must be noted when welding:

- Zinc starts to melt at about 420°C.
- The zinc vaporizes at a temperature of about 900°C.
- The amount of heating determines the damage to the zinc coating, and therefore to the corrosion protection.
- Resistance spot welding is particularly suitable for welding zinc-coated panels, because no widespread warming occurs.
- With electrolytically zinc-plated panels there is no need for any special preparation because the zinc coating does not need to be removed.

NOTE: Coated panels have a higher electrical resistance, but this can be compensated for by increasing the welding current by 10 - 20% .

Corrosion protection measures during repair work

CAUTION: Always be extremely careful when handling solvents, sealants and adhesives. Some products contain substances harmful to health or give off harmful or poisonous vapors. Always follow the manufacturer's instructions. If there is any doubt as to whether a particular solvent is suitable, it must NOT be used.

All Ford bodywork components have a cathodic primer. Moreover, most parts are zinc-plated on one or both sides. If possible, these protective layers must not be damaged.

Before welding

Interior surfaces of new bodywork components which will no longer be accessible after installation must be painted beforehand. The welding flanges are treated with a special welding primer. The joint areas are not always accessible from inside later. Therefore, prepare these areas so that no soot is produced by burning paint during welding.

NOTE: In order to ensure that the corrosion protection produced in production is not destroyed, the working area must be kept as small as possible.

NOTE: Do not touch cleaned bare metal any more with the bare hands. The dampness of your hands will corrode the metal.

Procedure:

- Remove the primer or paint/zinc layer in the welding area using a tress wire brush to prevent the formation of soot from the paint.
- Thoroughly clean the welding area with a metal cleaning agent and rub dry.
- Coat the welding flange with welding primer on all sides and allow to dry.

NOTE: The welding primer must only be applied thinly to the spot welding area, to minimize spattering when welding.

After welding

During repair work, body panels are often heated at very high temperatures, which results in the destruction of the corrosion protection.

DESCRIPTION AND OPERATION

Reworking of the affected areas is therefore vital:

- Grind the welded seams flat and clean thoroughly with silicone remover. Dry with a lint-free cloth.
- If the join area is accessible from the inside, the transition area to the paint must be abraded for all types of join so that good adhesion of the primer is achieved later.
- If the join area is not accessible from the inside, the cleaning and sanding work is not done. For this reason, ensure that there is as little contamination as possible in the area of the repair. This allows the cavity wax applied later to penetrate the join area without hindrance.

NOTE: Only apply a small amount of panel cleaner to the cleaning cloth when cleaning the repair area. Make sure that no cleaner reaches the connecting flange, so that the welding primer is not washed away again.

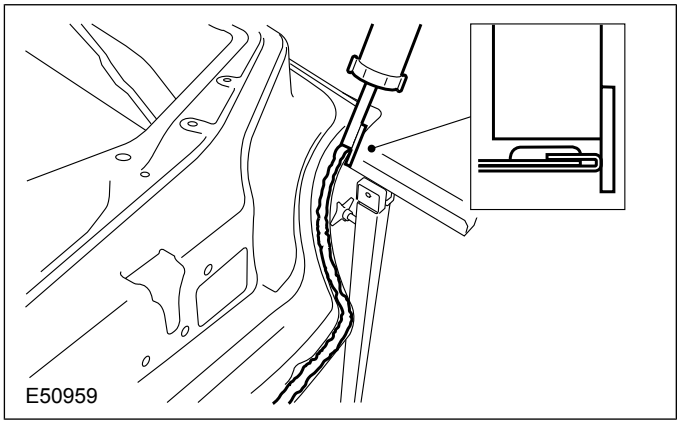
Priming after welding

Primer is applied to the welded flanges after cleaning. A check must also be made that the production corrosion protection is present in the area of the flanges. Any damage must also be re-primed.

Sealing work

Depending on the type of repair, the clinched flanges on the hood, doors, tailgate and trunk lid must be sealed with clinched flange sealer.

Clinched flange protection with flat nozzle



Clean the clinched flange area of the new component with silicone remover and dry with a lint-free cloth.

The sealant must be applied to the dry primed surface (i.e. dip priming as for delivery).

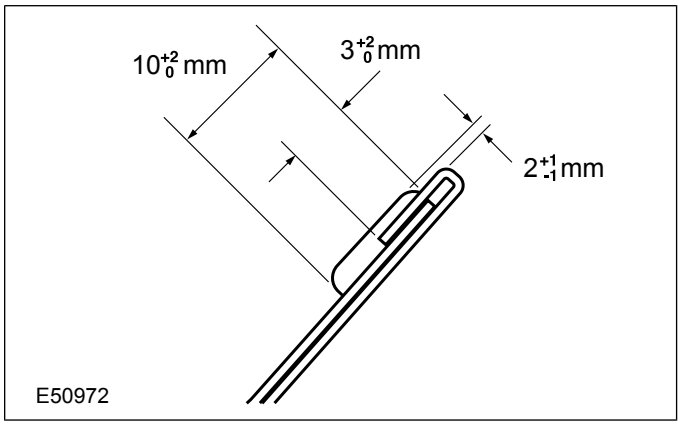
Apply clinched flange protection to the clinched flange using one of the flat nozzles supplied. The nozzle must be cut to the necessary width beforehand and the guide stop cut as required.

During application the clinched edge must be covered with an overlap of at least 3 mm. The beginnings, ends and edges or interruptions in the sealer bead need to be reworked by forming with a brush or a spatula, to ensure a 100% tight sealing of the flange.

The speed and angle of application are decisive for a good appearance and a bubble-free bead. Always apply the sealer with as few as possible interruptions to avoid sealer rework. Never use solvents or thinners as this will considerably slow down the hardening process of the sealer.

For an application thickness of 3 mm of the clinched flange sealer it is recommended to allow to dry over night at room temperature. A minimum hardening time of 5 hours is required anyhow before a 2-component primer can be applied.

Clinched flange protection applied to the correct width and thickness.



Underbody protection/stone chip protection

The underbody protection is used as corrosion protection and must also be applied such that it matches the original condition, from a visual perspective.

Two main application methods are used in production:

- The underbody protection is applied as a sprayable sealing compound.
- In the area around the structural members, the underbody protection is sprayed on and spread across a wide area.

DESCRIPTION AND OPERATION

Because of the coarse surface structure of the stone chip protection material, it is recommended to only perform a repair over the whole surface, if there is damage over visible areas. Otherwise there is the danger of serious irregularities on the surface.

The thickness and appearance of the underbody protection and stone chip protection must be matched to the original. Special spray guns are used to work the materials for this reason. A test spray must always be performed beforehand however, to determine the correct appearance and layer thickness.

Cavity protection

After painting work has been completed, a general check is made of the work that has been done. Before final reassembly of the vehicle, the cavity wax protection in the area of the repair must be renewed. Cavity wax protection must be performed carefully so that the quality of the repair conforms with Ford standards:

- Guide the cavity wax probe carefully in the area of the repair so that targeted corrosion protection is achieved.
- Pay special attention to edges and swage line on stepped joints, the wax must cover the inner edge areas.
- The cavity wax must flow along the stepped sheets so that the wax is drawn between them by capillary action.

A hole may be drilled in a suitable place for areas which are not accessible for the application of cavity wax. The diameter depends on the size of plugs available. When this is done it is vital to make sure that no drilling swarf remains in the cavity (rust will form if any remains). The edge of the hole must be treated with cavity wax. Finally close with a plug and seal with underseal.

Only on components with clinched flange edges:

After painting, the inner clinched flange edge must be sealed as far as is possible with cavity wax. For this, the repaired component should be positioned upright and corrosion protection wax sprayed into the water drainage holes and/or the thread holes for the hinges in both directions (50 ml corresponds to about 20 seconds spraying time).

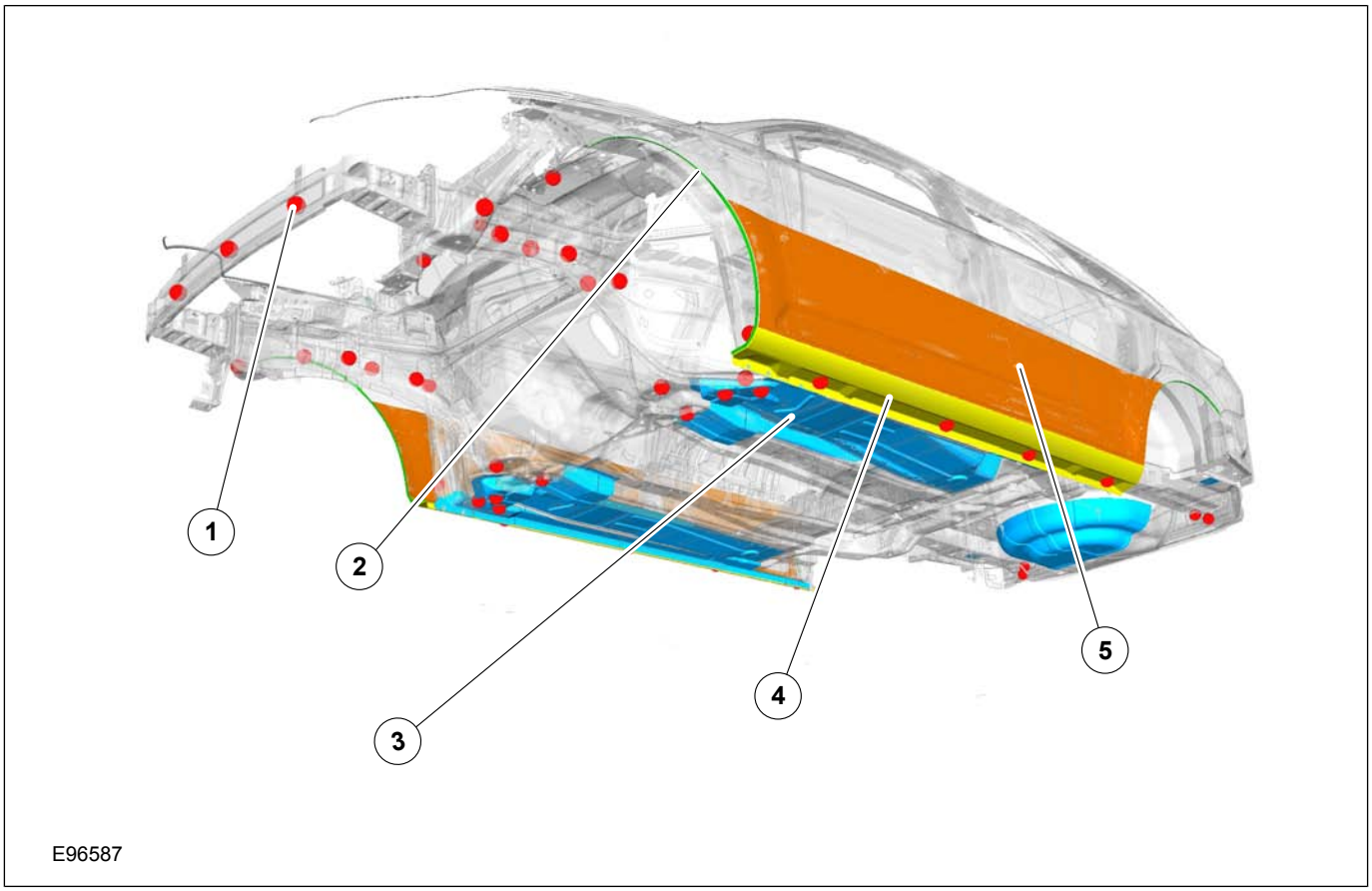
For doors, tilt and turn the component to spread the corrosion protection wax over the whole edge of the flange.

Wax application

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

Corrosion protection for the floor pan (example)



Item	Description
1	Injection points for cavity wax protection
2	PVC stone chip protection at the wheel arches
3	PVC underbody protection
4	PVC stone chip protection
5	PU primer

DESCRIPTION AND OPERATION

Corrosion Damage/Corrosion Repair

Modern vehicle bodies are protected from corrosion by elaborate measures. Multilayer coatings on the panel surface prevent direct contact between the metal and oxygen, and so protect it from corrosion.

In the long-term however, corrosion on a vehicle cannot be completely prevented.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range of training in the Training Brochure issued by the Ford Service Organization.

What is corrosion?

Corrosion is destruction of a subsurface caused by chemical or electrochemical effects which operate from the outer surface.

If the protective layers become damaged, electrochemical conversion processes are initiated, which allow the metal to oxidize. This leads to the formation of corrosion.

The following factors lead to corrosion:

- Mechanical damage such as stone chips and scratches which penetrate through to the steel panel.
- Damp interiors.
- Unfavorable weather or environmental conditions, as may occur in areas with high humidity, high salt content in the air or serious air pollution due to aggressive gases and dusts.
- Insufficient corrosion protection after repairs.
- Lack of care by the vehicle owner of the painted and corrosion proofed surfaces or areas on the vehicle.

In order to maintain long-term corrosion protection, the vehicle must be checked at regular intervals.

In doing so, the follow areas must be inspected and any damage rectified:

- Damage to the paint surface cause by scratches or stone impact must be suitably rectified according to the specifications.
- Damage to the PVC underbody protection or the PU stone chip protection must be refinished.
- Damage to the PVC underbody protection or the PU stone chip protection must be refinished.
- Incomplete or damaged sealing at clinched flanges must be renewed.
- Check the cavity protection and renew it if incomplete.
- Poorly installed or damaged covers and stone chip protection fixtures must always be renewed.
- Check seals and seal carriers for wear and correct mounting. Any damaged seals must be renewed.
- All rubber grommets and blanking plugs must be present and correctly installed.
- A damp or wet floor inside the vehicle indicates that there are leaks in the bodywork. The interior must be dried out and the leaks must be completely rectified.

The corrosion formation can vary in extent.

With rust film or edge rust formation, the surface of the paint has small traces of corrosion present. The traces of corrosion can possibly be removed in such cases by polishing the paint surfaces. If this is not possible however, the traces of corrosion must be rectified by using a touch-up technique.

If the corrosion is just starting, with up to 1 mm rusting below (in the form of a dot or a line) the damage is rectified as follows:

- Clean the defective location.
- Mechanically remove the rusting which is starting below the surface.
- If the area is small, apply primer and allow it to dry, then use the paint pencil to touch up the area - if not, respray the damaged area.

If rust is already under the paint finish to the steel panel, then the whole paint finish in the affected area must be sanded away.

Furthermore, the existing traces of corrosion in the body panel must be carefully and completely removed.

Finally a new paint finish must be applied in this area. In the case of rusting through, the affected body panel is already completely destroyed. Such damage requires complete or at least partial replacement.

NOTE: : In the general section there are several chapters which present the techniques necessary for a professional corrosion repair.

The outcome of this is the following repair sequence:

- Remove the rusted-through part.
- Remove the remaining traces of corrosion.
- Offer up the new part.
- Prepare the joint areas.

DESCRIPTION AND OPERATION

- Weld the new part into place.
- Produce the corrosion protection.

For a professional repair it is essential to reproduce the corrosion protection during and after the repair.

DESCRIPTION AND OPERATION

Sealer, Underbody Protection Material and Adhesives

Sealants, adhesives, cavity wax and underbody protection materials are used during the various body repairs. In this area Ford offers a range of products which have been tested and matched to each other.

CAUTION: Always be extremely careful when handling solvents, sealants and adhesives. Some products contain substances harmful to health or give off harmful or poisonous vapors. Always follow the manufacturer's instructions. If there is any doubt as to whether a particular solvent is suitable, it must NOT be used.

Clinched flange protection

This is a 1-component PU adhesive sealant applied through a flat nozzle. It is fast setting and is very resistant to ageing. After application it is easily sanded and stretched and it can also be painted over.

Seam sealant T Anthracite

This is a 1-component sealant material for sealing joints and seams. It is also suitable for gluing HVH elements into position in their respective body areas. It is a solvent-free, odourless adhesive which does not contain silicone or isocyanate.

Body sealant T beige

This sealant, which contains solvent and has a long service life, is particularly suitable for visible seams. It can be painted after it has set.

Underbody protection

Underbody protection is necessary for permanently elastic corrosion protection of vehicle underbodies. It is very durable and has good resistance to abrasion,

Cavity wax

This touch-proof, transparent corrosion protection wax is used for the preservation of cavities and flange joints.

Anti-corrosion wax

Anti-corrosion wax is a coating material which can be applied in fine spray, forming a very thin and grease-like protective film, therefore offering very good corrosion protection.

Metal adhesive

For joining metal to metal and plastic to metal. The adhesive reduces droning noises and improves corrosion protection.

1-component window glass adhesive kit

For direct glazing. The vehicle is ready to drive after 6 hours (passenger airbag). Prevents contact corrosion.

2-component window glass adhesive kit

For direct glazing. The vehicle is ready to drive after 1 hour (passenger airbag). The adhesive is not an electrical conductor and permits interference-free radio reception. Prevents contact corrosion. Using a 150ml additional cartridge, the adhesive can also be used for large windows or to produce a double seam of adhesive.

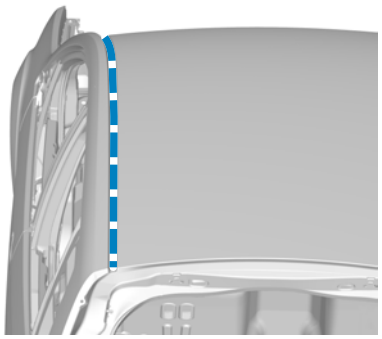
Sealer Application in Critical Area

NOTE: Pin holes and gaps should be avoided while applying the sealer to avoid water ingress.

Roof

Apply **WSKM4G325 A2** heat selaer using sealer application gun in bead form.

- Suggested bead diameter : 3 mm.



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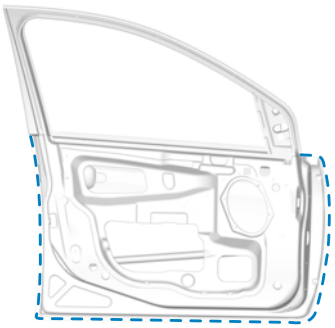
DESCRIPTION AND OPERATION

Sealer Application in other Areas

Front and Rear door

Apply **WSS M2G300 A2** glass bead epoxy adhesive in bead form.



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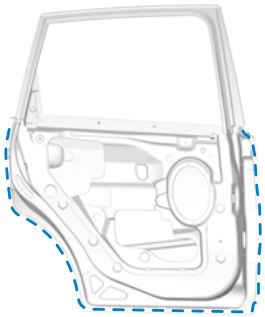

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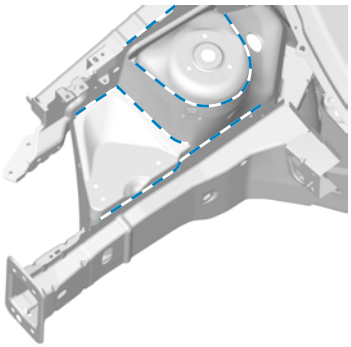
Frontside Apron Panel

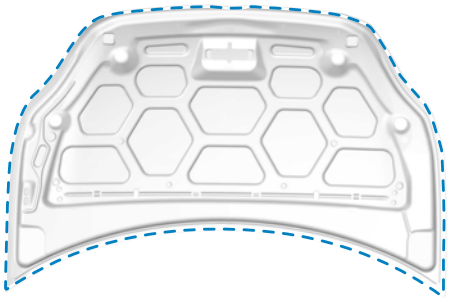
Apply **WSKM4G334 A3** duplex sealer in bead form.



E121879

Hood

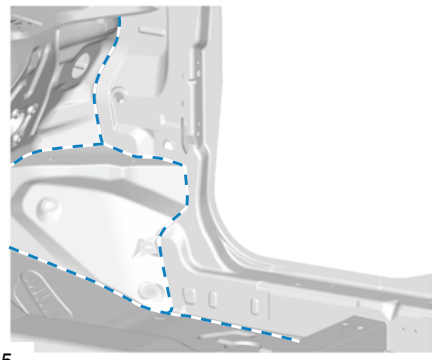
Apply **WSKM4G334 A3** duplex sealer in bead form.



E123998

A-Pillar Inner

Apply **WSKM4G334 A3** duplex sealer in bead form.



E124625

Back Door

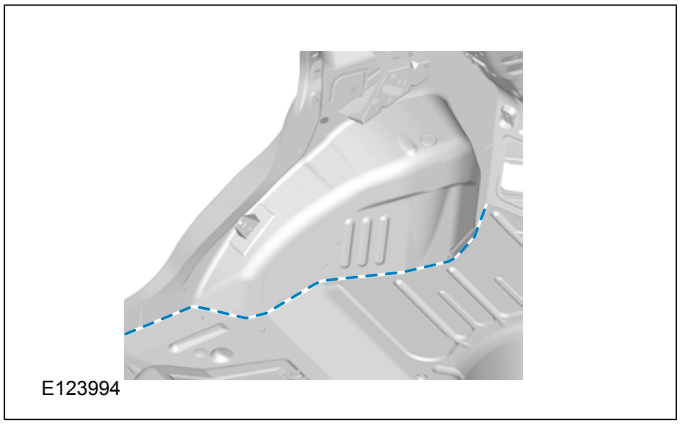
Apply **WSKM4G334 A3** duplex sealer in bead form.

E124012

DESCRIPTION AND OPERATION

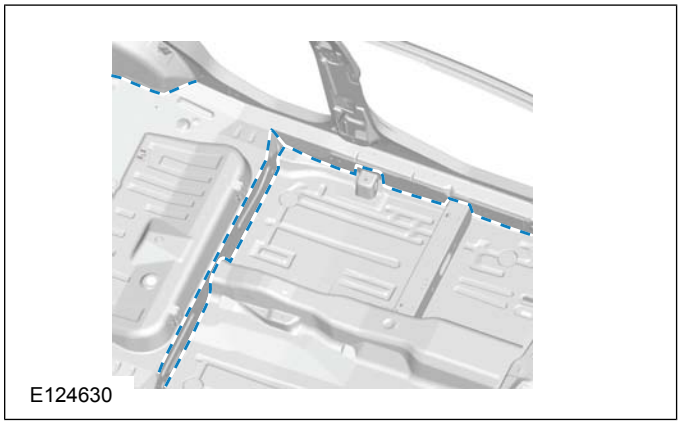
Panel Quarter Wheelhouse Inner

Apply **WSKM4G334 A3** duplex sealer in bead form.



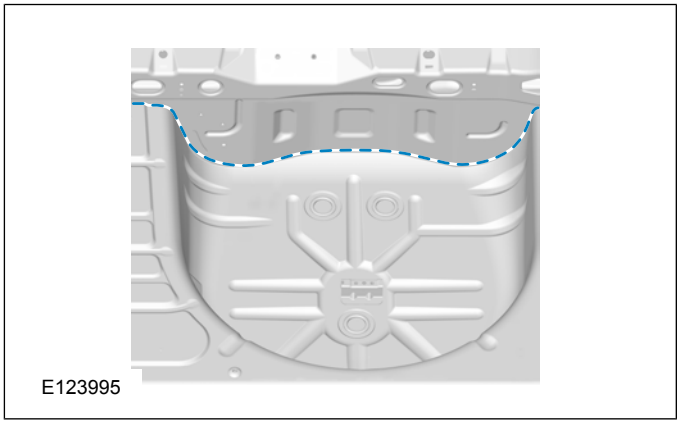
Rear Floor Panel

Apply **WSKM4G334 A3** duplex sealer in bead form.



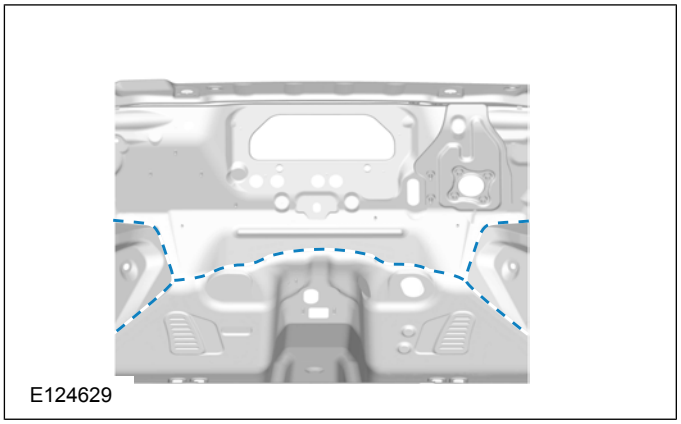
Rear Skirt Panel Area

Apply **WSKM4G334 A3** duplex sealer in bead form.



Dash Panel

Apply **WSKM4G334 A3** duplex sealer in bead form.

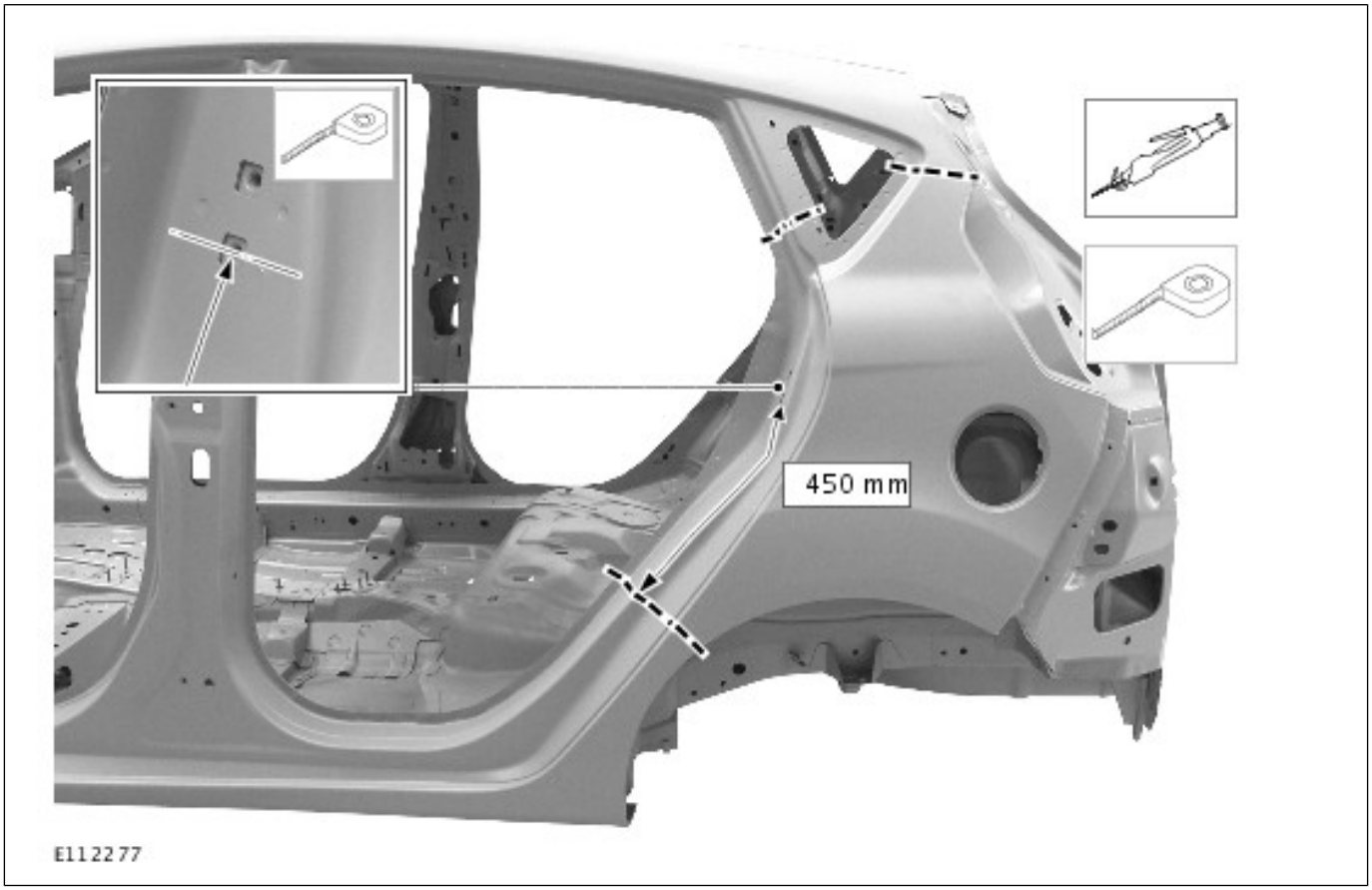


DESCRIPTION AND OPERATION

Cutting Technique

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

Possible cut lines (example)



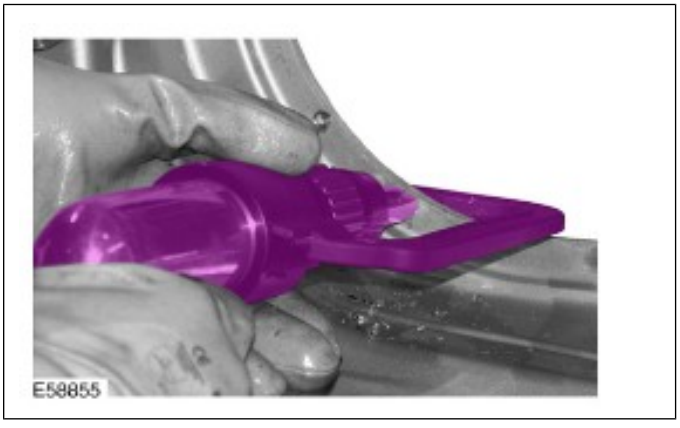
NOTE: After all separation work, make certain that the metal swarf is completely removed from the vehicle body.

Depending on the separating tools used, there are some fundamental points to bear in mind:

- Only start the cutting work once the new part is to hand.
- Compare the new part with the old part for shape and size.
- The straightening work must be completed before any body components to be replaced are cut out.
- Before separation work is started, all welded connections which cannot be seen must be freed of underbody protection, sealant etc.

Spot weld milling tool

Resistance spot welds are separated using a spot weld drilling machine or a spot weld milling tool.



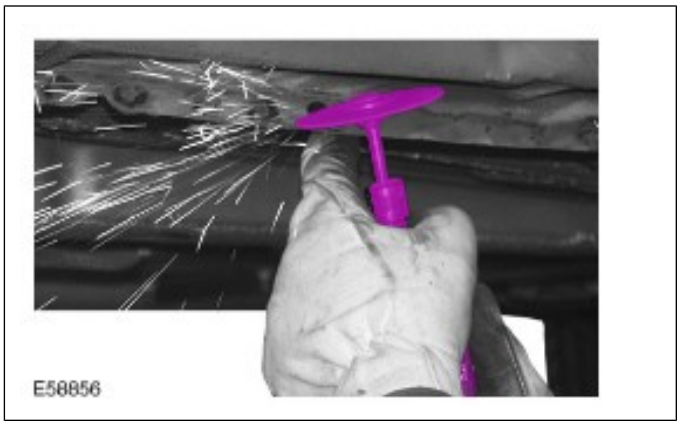
NOTE: Steplessly variable machines increase the working life of the cutting tool. Use of a suitable lubricant can increase this even further.

A spot weld milling tool usually has an adjustable depth stop and a safety fixing system. These prevent the machine from drilling too deep and the cutter from slipping while working.

DESCRIPTION AND OPERATION

Rod sander

Another option for separating resistance spot welds is to use the rod sander.



If spot welds and MIG welds are difficult to reach, a rod sander may offer an alternative.

Short stroke saw

The short stroke saw is suitable for separating vehicle body components and for making a separating cut for partial repairs.

NOTE: In order not to damage panels, wiring harnesses, hoses or similar components which lie behind, remove them beforehand as necessary.

The narrow design of the saw blade permits cutting in tight curves. Straight cuts require a relatively great deal of practice.

Orbital saw

Where use of the short stroke saw is difficult because of the body construction, the orbital saw can be used.

The cutting depth of the orbital saw can be set. This allows separating cuts to be made, despite panels or other components lying in danger behind. Straight cut lines can be more easily made using the orbital saw.

DESCRIPTION AND OPERATION

Panel Beating Technique and Smart Repairs

General

Smaller scale body repairs, where damaged panels do not need to be replaced, can often be carried out by realignment work. Whether the repair is economical however, often depends on the accessibility of the affected body area.

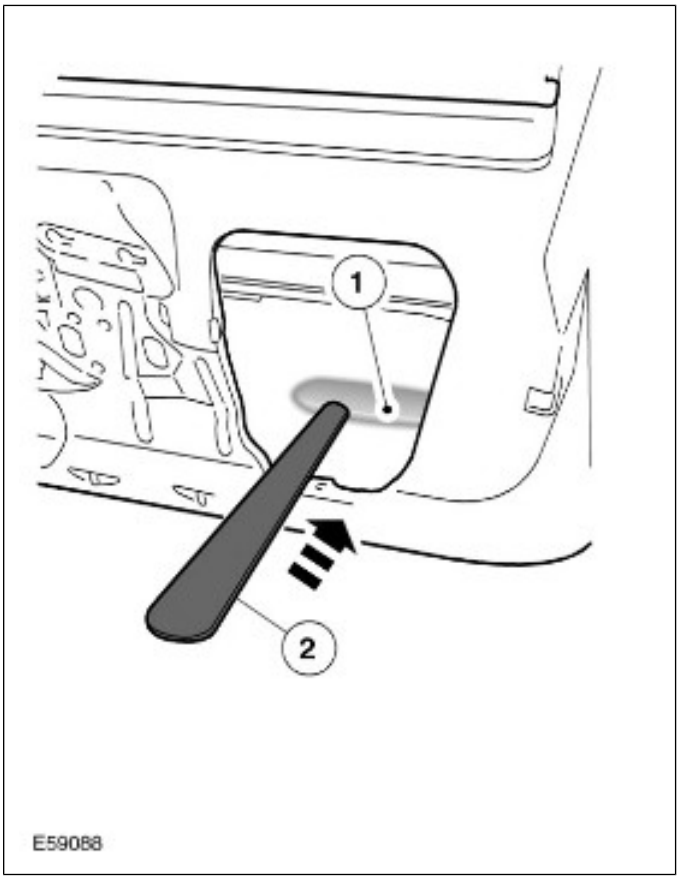
NOTE: Basic and in-depth training courses are offered on the topics which follow. An overview of the complete range of training offered is provided by the Ford Service Organization Training brochure.

During damage assessment, the following technical points must be taken into account:

- Small mild dents (without damage to the paint), which are in areas that make access from the inside possible, can be rectified using undamaged paint panel beating.
- If the inner side of the damaged area (with paint damage) can be accessed, then conventional panel beating techniques can be used.
- If the damaged area has no access from inside, then it can only be rectified using outside panel beating techniques.

Hollow leveling (removing dent without a dolly)

Hollow leveling can only be used on areas which are accessible from the rear.



Item	Description
1	Center of dent
2	Spoon

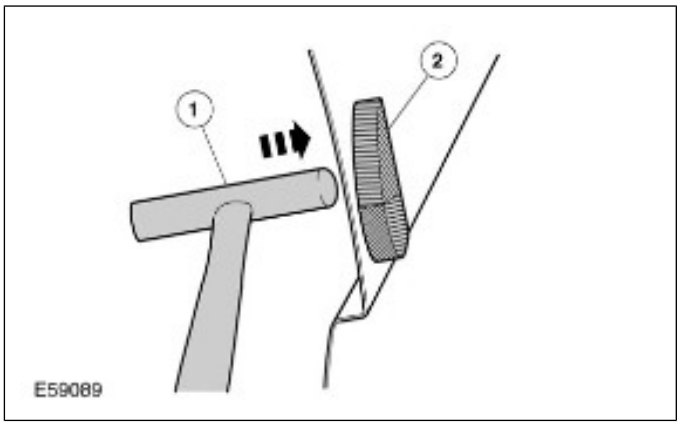
During hollow leveling, the dent is removed from the inside a using suitable panel beating tool and applying knocking or pressing movements. High spots around the edge of the dent area are flattened with blows from the aluminum or wooden headed hammer.

The usual tools are for instance hammers of various designs, dollies, levering irons and various spoon irons. The correct choice of tool is made depending on the shape of the dent and the access which is possible.

Dent removal using hammer and dolly

Panel beating can only be performed using a hammer and dolly if access can be gained from the rear side.

DESCRIPTION AND OPERATION



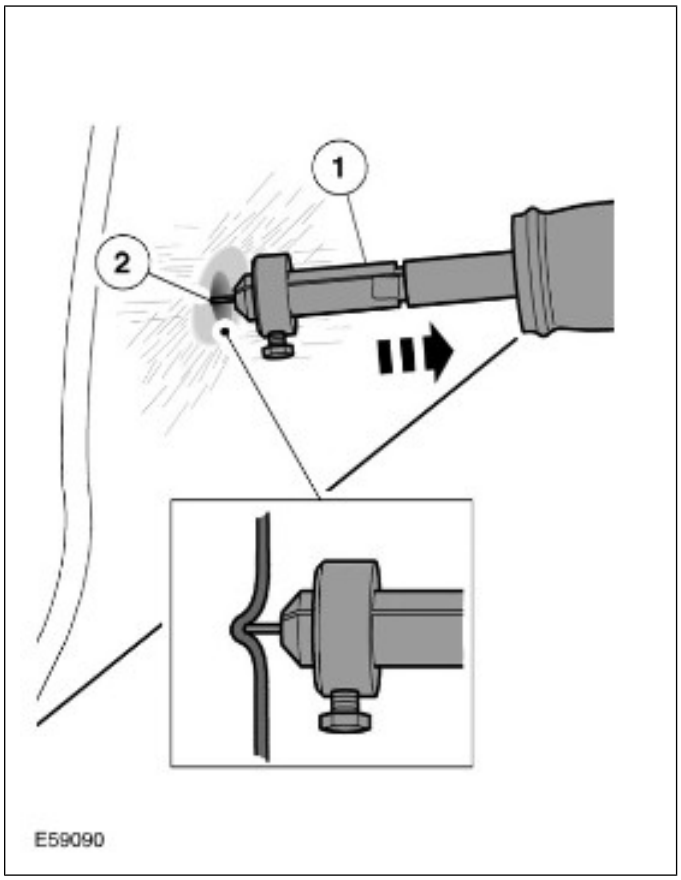
Item	Description
1	Aluminum hammer
2	Box file

The purpose of the dolly in this case is to transfer the force of the impacts from the hammer to the steel panel which is in between. As this is done, the deformed body panel is smoothed (dressed) and the tension fields in the body panel are removed.

The favored tool for this repair process is the aluminum hammer and as opposite support the universal hand dolly. To rectify minor panel damage, the box file should be used as opposite support. Because of its serrated surface, the box file prevents normal stretching of the body panel which would otherwise occur.

Dent removal from the outside using the slide hammer

The slide hammer technique is mostly used when a dent is not accessible from the rear, or a relatively large amount of disassembly would be needed to make it accessible.



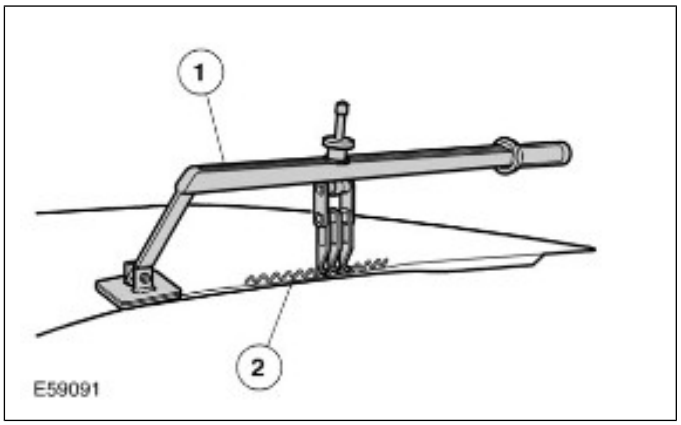
Item	Description
1	Slide hammer
2	Pulling electrode

By welding pulling rings or pulling electrodes into position using a special welding gun, dents can be removed from outside using the slide hammer.

Dynamic puller with counter bearing

The repair possibilities are much greater than with the slide hammer method. Because of the versatile puller and the variable counter bearing, a wide variety of damage can be worked and rectified using this repair method.

DESCRIPTION AND OPERATION



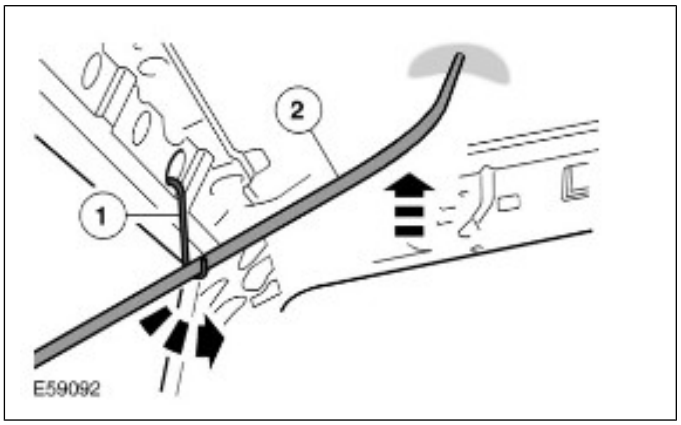
Item	Description
1	Puller with counter bearing
2	Corrugated wire as counter bearing

Because of the mechanical lever operation, the variable counter bearing and the optimum controlled application of power, this external dent removal system allows dents in almost all vehicle body areas to be pulled out.

Depending on the application area and the damage, the fixing options to the panel being worked can be corrugated wire, pulling bits or U-washers which are spot welded into position.

Dent removal using special panel beating levers

This panel beating technique with pressure is mainly used to rectify smaller dents as a result of hail impact, transportation or parking, without the paint being damaged.



Item	Description
1	Deflection by a hook arrangement
2	Pressure tool

Small dents are removed from the inside of the body panel by pushing them outwards in a mechanical process using panel beating levers.

Because of the great variety of shapes of these levers, it is possible to use this panel beating technique on almost all areas of the vehicle body.

Heat working of panels

This repair method allows small and mild dents to be rectified without additional panel beating.

During the repair process, a flame is used to selectively warm areas of the panel to relieve the stresses in the metal. This can cause the dented area to return to its correct shape.

NOTE: Before this method is used, for economy reasons you should check whether it is in fact possible to use the undamaged paint pressure techniques to rectify the problem.

This method can only be used when the dent:

- is not too large and sharp edged.
- shows no signs of the material having stretched.
- is in a surface of the body which curves outwards.
- is not in a repair area which is too structurally solid.

Heat-induced material shrinking

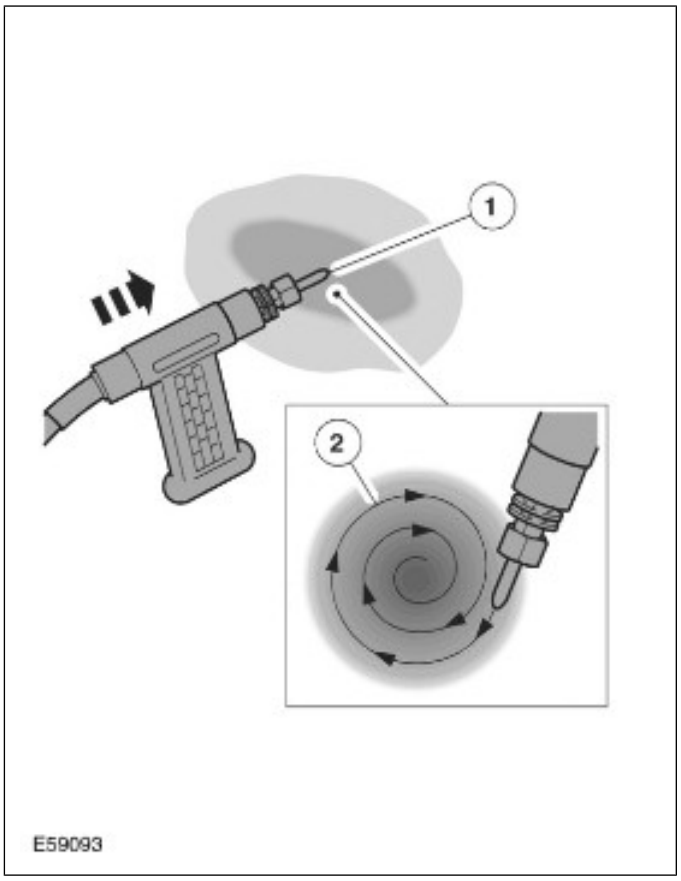
Material shrinking, also called settling in, can be performed in a variety of ways depending on the extent of the damage and the access to the repair area.

These repair processes differ depending on the type of heating and subsequent working of the heated surface. They sub-divide into two basic processes:

- Heating using a carbon electrode.
- Heating using the oxy-acetylene torch.

In the carbon electrode process the working is done exclusively by warming. In this case the access to the repair position is only from the outside.

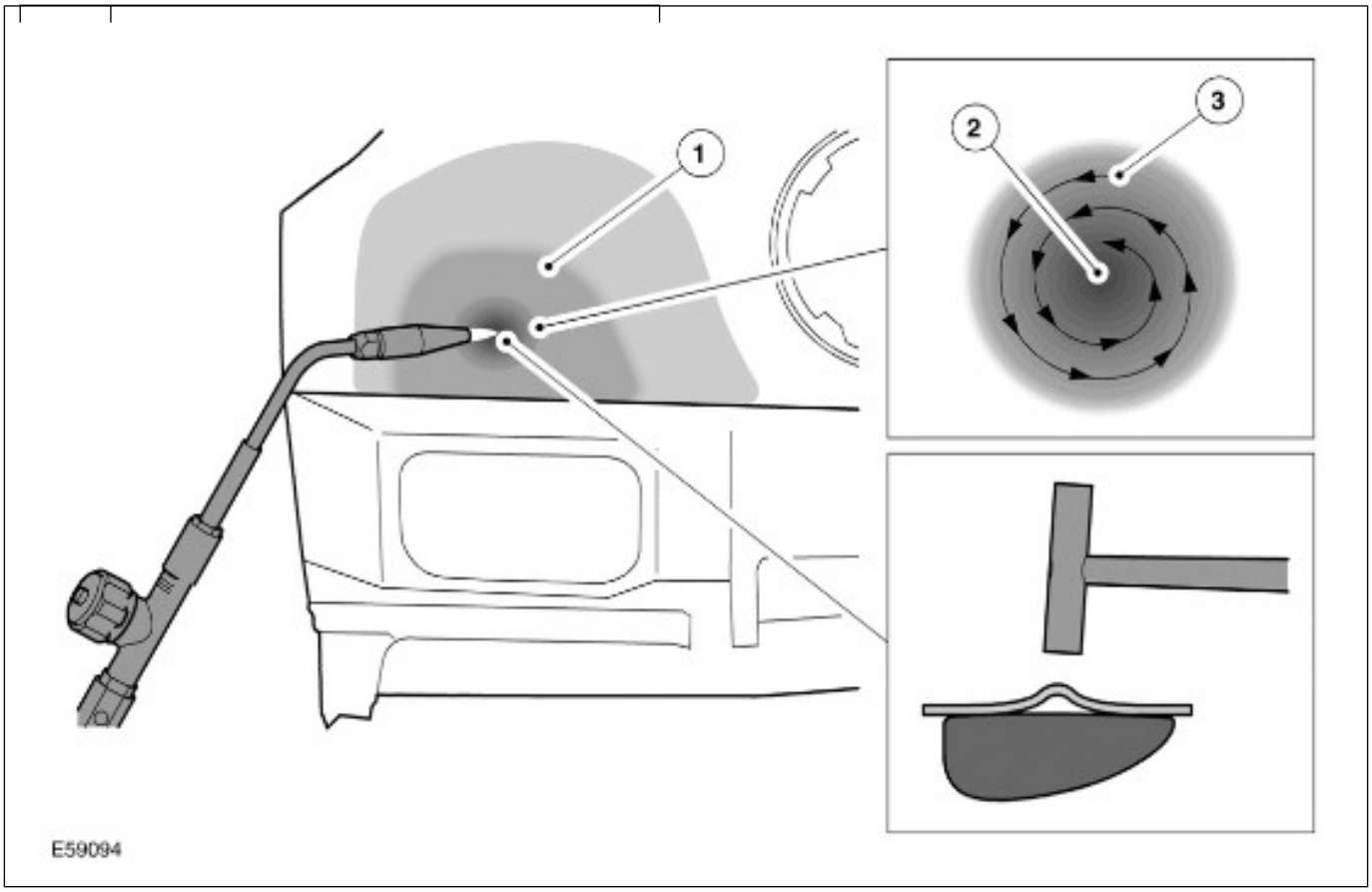
DESCRIPTION AND OPERATION



Item	Description
1	Carbon electrode
2	Spiral shaped heating pattern

If the damage is concentrated in a spot and is in the form of a more rigid raised area, then the carbon electrode must be replaced by a copper electrode. As heat is applied, slightly more pressure is applied to the raised area.

In the method using heating by the oxy-acetylene torch, material shrinking is achieved by a combination of heat and mechanical working of the damaged area.



DESCRIPTION AND OPERATION

Item	Description
1	Overstretched area
2	Point heating using the oxy-acetylene torch
3	Spiral shaped knocking back with dolly

The repair area must always be accessible from both sides, so that the heated area can be properly worked mechanically.

The combination of heating and mechanical working is very effective.

As soon as the warm point is established, hammering is immediately started using the aluminum hammer together with a suitable dolly on the inside of the repair surface, working in spiral movements towards the warm point. This causes material to build up in the center of the warmed area.

Lead loading

Despite good external panel beating techniques, it is not always possible to rectify every surface unevenness. For this reason, application of lead loading is an important part of panel beating.

NOTE: You will find additional important advice on the topic of lead loading in the joining techniques section.

For corrosion protection and adhesion reasons, on body components subject to more demands, such as doors or hoods, it is preferable to apply lead loading rather than stopper.

In addition, lead loading application is suitable for creation of surface contours when the options for panel beating are limited.

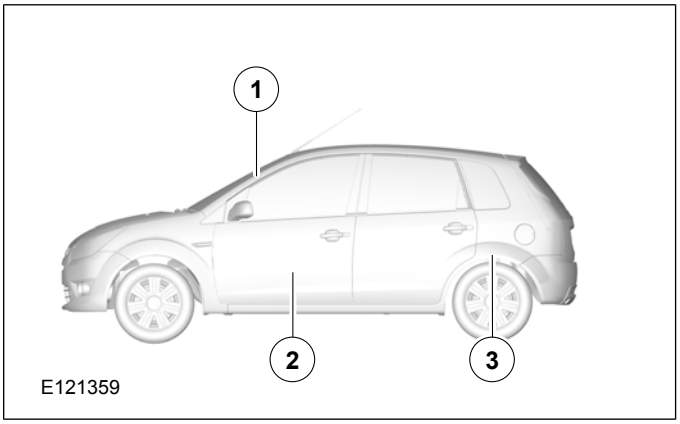
Typical application areas:

- Body components with limited or no access from the rear.
- Body components with very narrow cross-section.
- Body components which are particularly exposed or which can move.
- Weld seams of partial repairs.
- Rocker panel areas, wheel arch edges, side panel areas.
- Doors, hood, luggage compartment lid.
- Swage lines and joint areas.

Minor panel repair by washer welding process

This method of repairing is used to repair recessed areas where hands cannot reach such as a door panel, pillar, side sill, and rear wheel arch.

Because the heat generated while welding washers impair the paint layer inside the panel, it is necessary to treat the area with anti-rust process after the repair.



Item	Description
1	Front Pillar
2	Front Door
3	Rear Wheel Arch

WARNING: To prevent injury to your hands, wear gloves whenever hammering work.

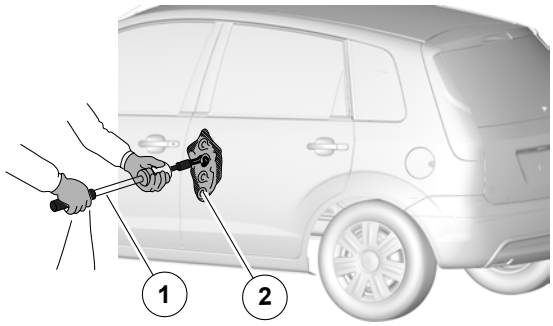
CAUTION: Always attach a safety cable when using a hydraulic ram or a frame straightening tale; do not stand in direct line of the chains used on such equipment.

In repairing by washer welding, there are two ways. One way is to pull-out with a sliding hammer and another way is, a shaft going though washers and using a frame corrector, pull-out the recessed area. Depending upon the damaged condition, one of the two methods is employed.

Pulling out with a sliding hammer

The repair according to the method is rather easy because the area where washers are welded can be regionally pulled out, but, if the area that requires repair is extended widely, this method does not fit for this type of work, in addition, it is impossible to do hammering work while being pulled out.

DESCRIPTION AND OPERATION

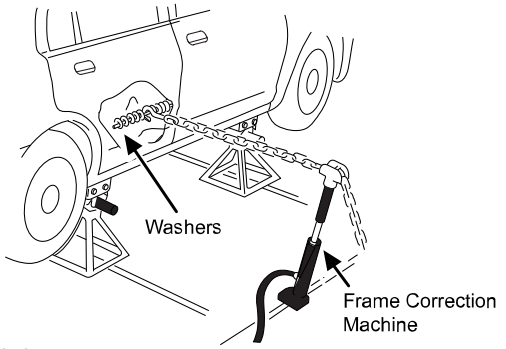


E121360

Item	Description
1	Sliding Hammer
2	Washers

Repair using frame corrector

As the use of the shaft makes it possible to apply force on many washers all at the same time, it is possible to repair a wide damaged area with minimum deformation of the washer welded area. It is also possible to do the hammering work while the damaged area being pulled out.



E113141

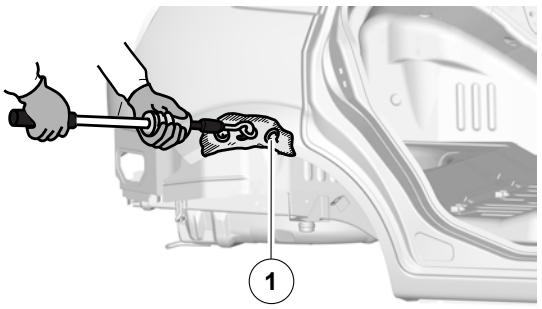
Damaged area pulling out

1. To pull out a panel part with a hollow such as a side sill or rear wheel arch, weld may washers because of the high rigidity of the panel.

E121361

Item	Description
1	Washers

2. If the deformation is not serious, hammer it out regionally.

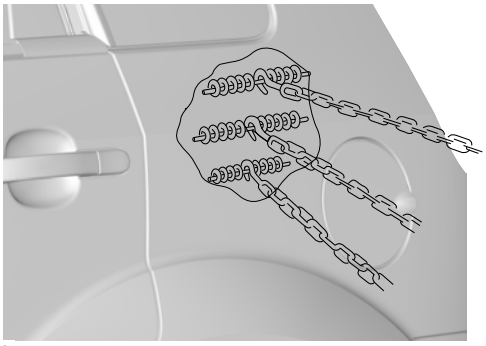


E121405

Item	Description
1	Washers

3. If the deformation is extensive on the door or outer panel, use more than one pulling point to pull it out.

NOTE: It is more effective to pull out the pressed line and plain surface simultaneously.


E121406

DESCRIPTION AND OPERATION

Repair Procedure

1. Confirm range of damage. Before starting repair work, be sure to completely confirm the deformed area of the damage. For example, in a case that the impact is directed to the center of the door (mole area), the impact dispersion causes plastic deformations at the areas of the door above and beneath the mole.

In combination with the deformation of the press line running under the mole, this deformation makes these upper and lower projected damages (elastic deformations) impossible to return to the original configurations. By repairing the pressed line and upper and lower deformations, the damaged area can be naturally returned to the original configurations.

E121407

Item	Description
1	Plastic Deformation
2	Elastic Deformation

2. Remove the paint layer on the steel panel. Scrape off the paint layer around the damaged area with a sander.

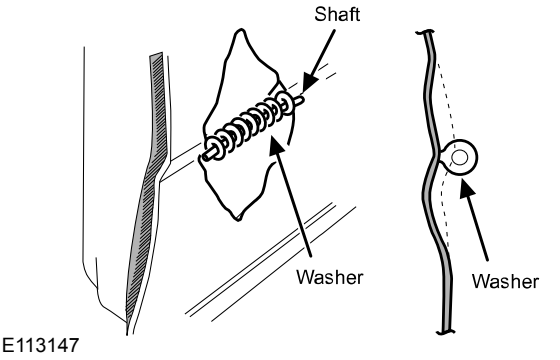
WARNING: To prevent eye injury, wear goggles whenever sanding.

E113146

3. Repair work. Because the rigidity of the door panel is retained by the pressed line, a large strain takes place if the pressed line is deformed. By repairing the pressed line correctly, the strain can be reduced. Repair the pressed line first and then reform the plain surface. In a case that the strain cannot be taken off only by repairing the pressed line because the damage is too serious, the loss of the rigidity of the panel is not only due to the deformation of the pressed line but also to the elongation caused by the plastic deformation on the plain surface. If the elongation on the plain surface is identified, take the strain by shrinking the panel.

4. Weld washers in a row and let the shaft go through them. If the shaft cannot go through, re-weld the washers so that they are in a straight line.

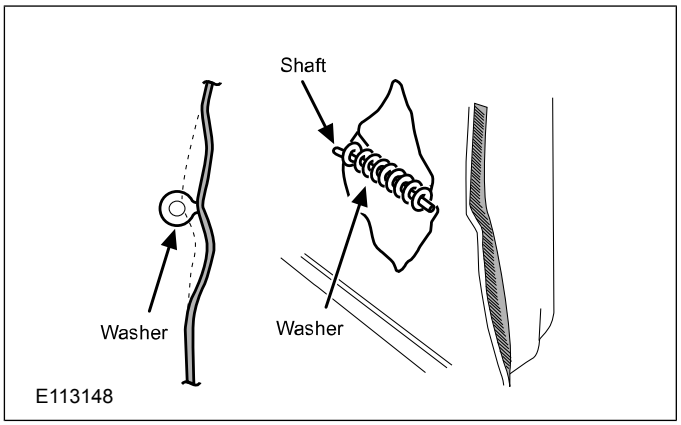
Repairing pressed line:



E113147

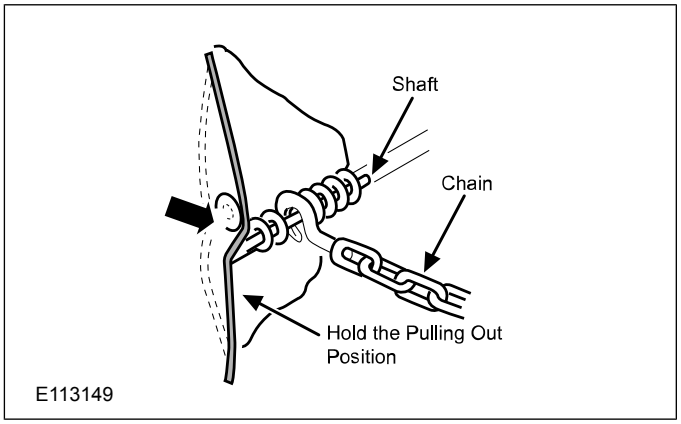
Surface smoothing repair:

DESCRIPTION AND OPERATION

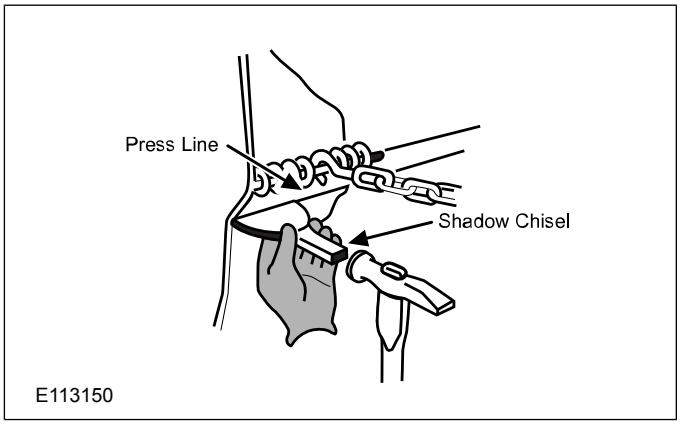


5. Hang the chain around the center of the shaft and pull it out and hold.

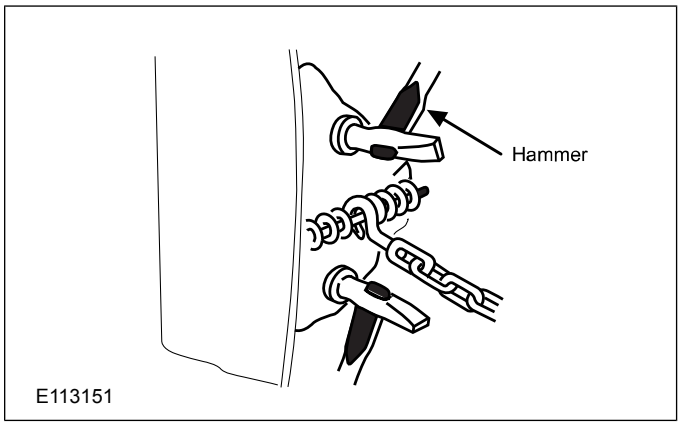
NOTE: Be careful not to pull too much.



6. Pull out the projected area on the pressed line through the washer welding method and reform the recessed area with a shadow chisel and hammer.



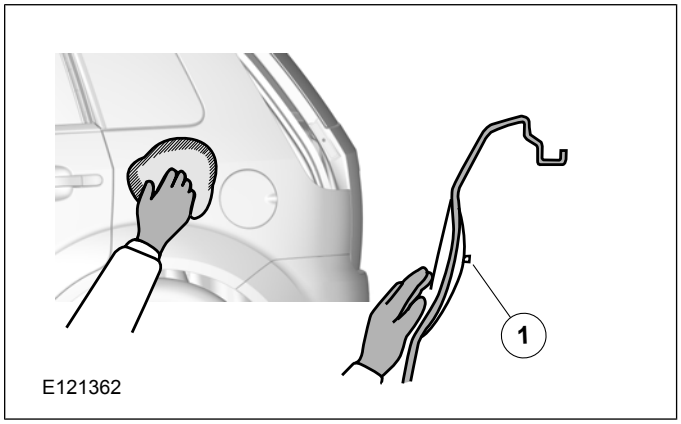
7. Reform around the welded washers by hitting lightly with a hammer.



Shrinking of steel sheet

If the strain cannot be taken off after panel repairing, the elongation around the damaged area extend beyond the original surface. Whenever an excess elongation takes place due to the strain, a shrinking process should be done around the area to return to the original surface.

NOTE: There are two kinds of shrinking of a steel sheet. One is by heating or cooling the area, and another is by hitting the area with a shrinking hammer and dolly.



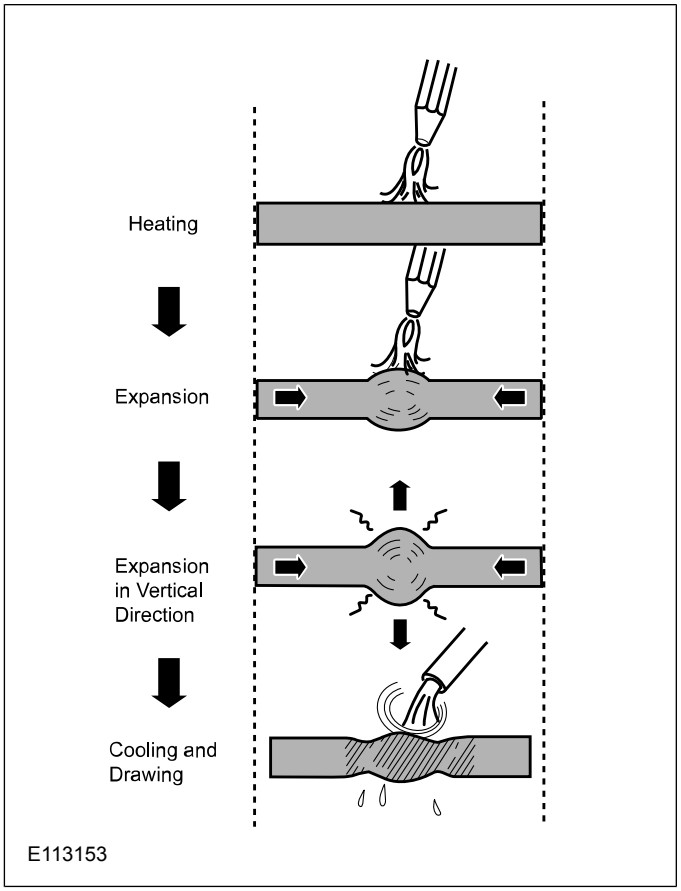
Item	Description
1	Elongation around the damaged area

Shrinking by heating and cooling

1. If a spot on the steel sheet is heated, that heated area swells.
2. If kept heated, the elongation reaches a certain point, further expansion becomes difficult because of the surrounding cold and hard area. Rather, the surrounding area constrains and compresses the expansion.
3. The compression force disappears after swelling the sheet in the up-and down direction where it is heated.

DESCRIPTION AND OPERATION

4. At the moment, if the area is quickly cooled with water, it shrinks pulling the surrounding areas thus making it flat.



E113153

Drawing by Electric Resistance

This method makes it possible to draw (cause shrinking) the strained area on the panel from outside where it is not accessible or it involves additional work if disassembled.

This method of causing shrinkage on the panel fits the shallow and wide work.

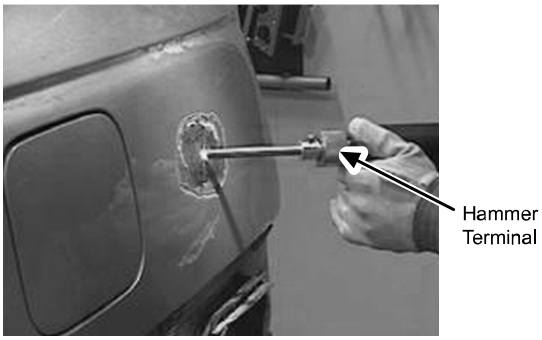
This method uses a washer welder with the attachments of the hammer terminal and carbon electrode installed to it.

E113154

Remove the paint layer on the area to be drawn with a sander.

WARNING: To prevent eye injury, wear goggles whenever sanding.

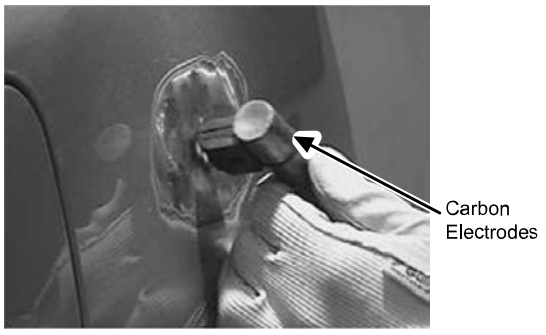
To use the hammer terminal to cause shrinkage on the panel, push the panel roughly with the hammer terminal from the center of expansion outward.



E113155

When a carbon electrode is used, heat the strained area moving from outside spirally toward the center and cool the area with a wet sponge or cloth to make it shrink.

DESCRIPTION AND OPERATION



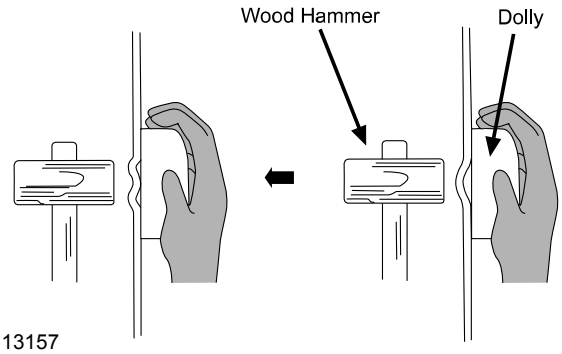
E113156

Shrinking (Drawing)

1. Remove the paint layers on the front and rear surfaces from the area where shrinkage is to take place.

2. Using a hammer terminal or carbon electrode, heat the center of the expansion.

3. Hit the swelled area flat with a wood hammer from the front side with an appropriate dolly contacted the rear side.



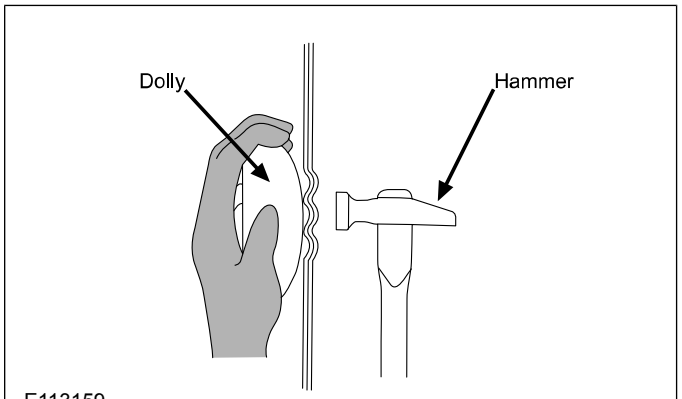
E113157

4. To cause shrinkage on the panel where hit flat by the hammer, cool it with an air blow.


E121472

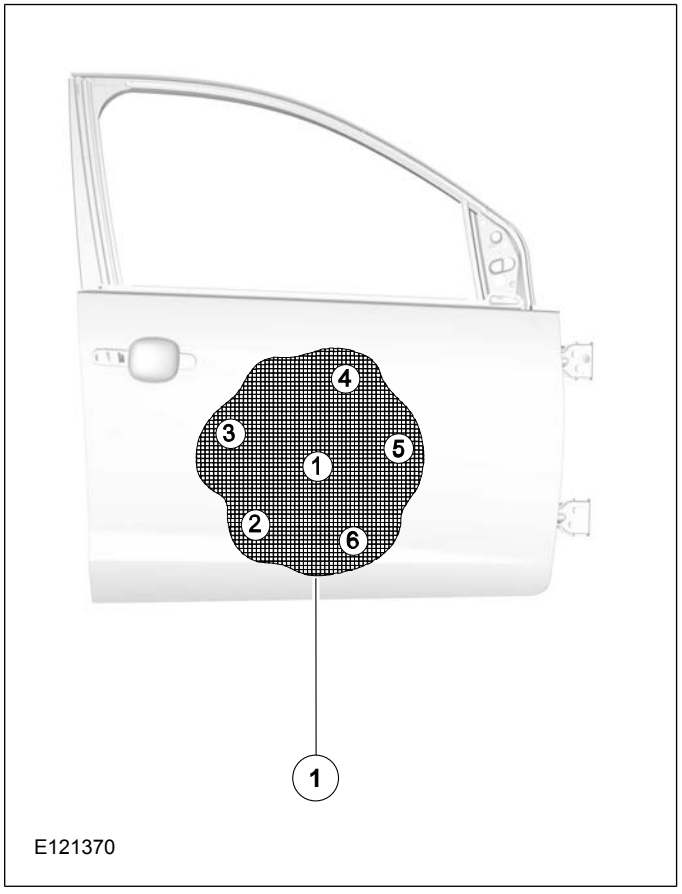
5. Remove tiny wrinkles caused by the shrinkage by hitting them lightly with a hammer and dolly.

NOTE: Be careful not to hit strongly because it may expand the sheet once shrunk.



E113159

6. When the area of expansion is extensive, repeat the same process over and over because it is impossible to repair the expansion at one time. Starting from the center of the expansion, shift the process gradually outward until all the expanded area is shrunk to the same level.



E121370

Item	Description
1	Expansion Area

Shrinking by shrinking hammer and dolly

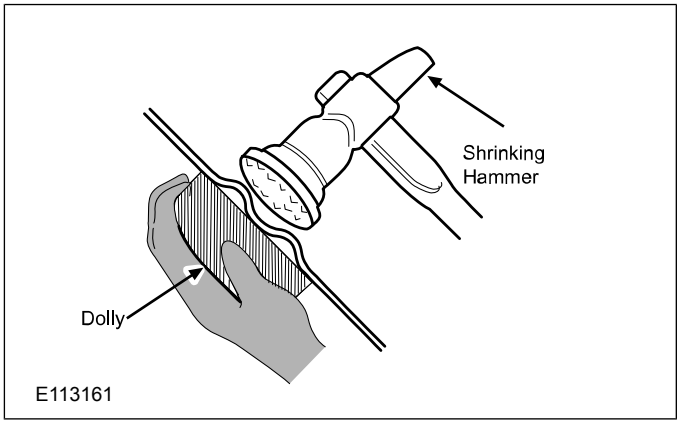
Using a hammer that has pyramidal projections over the hitting surface or a dolly, hit the damaged

DESCRIPTION AND OPERATION

area. If the panel is hit by the hammer, tiny expansions take place, but as a whole, the panel shrinks and get repaired.

This method is used to repair rather a small spot of the damaged area that dose not need to gets repaired by a torch.

NOTE: Do not use the shrinking hammer and shrinking dolly at the same time. If a shrinking hammer or a shrinking dolly is used, the counter tool must be a non-shrinking one.



Inspection and Repair by Filing

Inspection

In order to see the state of evenness on the damaged area on a panel, put scratches across the repaired area to gauge the evenness of the repair.

File the repaired area to remove the high spots (scratches removed), and show the low spots (scratches remaining the repaired area). This filling will show where the surface is uneven or waved that are not easily detected by eye or torch. If necessary, rework the repaired area with a hammer and a dolly or washer welding.

Repeat the inspections by filing all over the damaged areas until these areas are all covered by filed scratches.

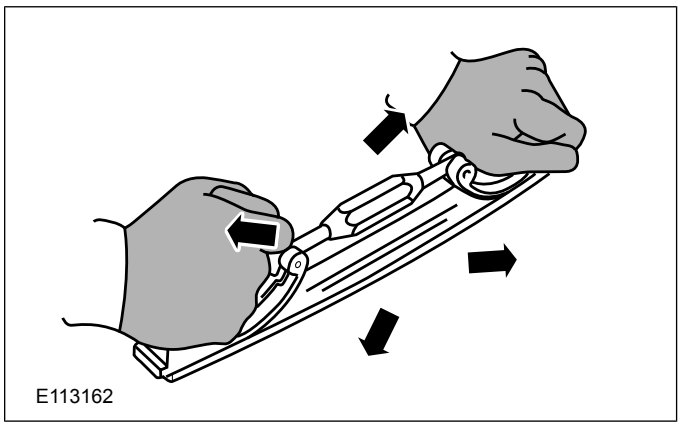
Depending upon the extent of curves, select to use the most appropriate files.

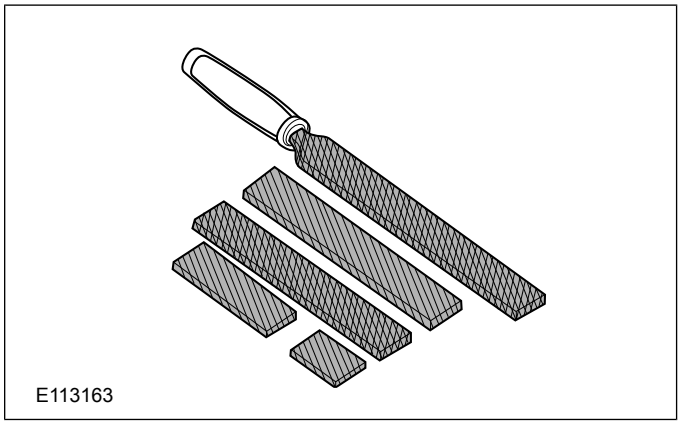
NOTE: An adjustable file is convenient for this purpose because it can be used for varieties of curve filings.

Usage of Files

To use a file, do not push the file frontward because such motion will leave too deep scratches on the panel. Always place the file levelly on the panel and move it diagonally.

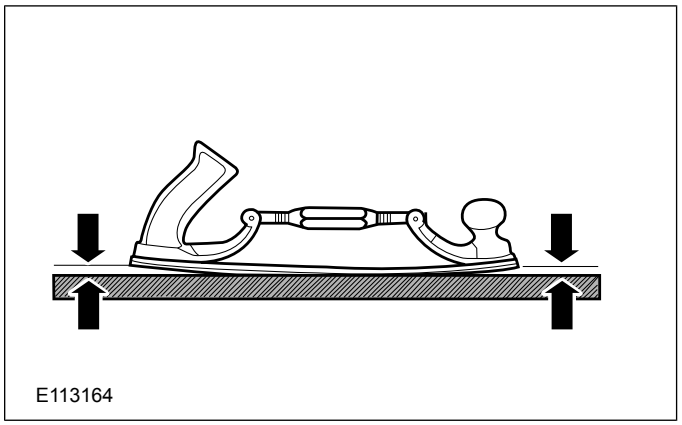
NOTE: It also damages the panel surface with too deep a scratch to use the file will its edge on the panel or to move it in a wavy way.





Adjustable file:

To adjust an adjustable file to meet the surface most appropriately, adjust it, when the file is placed on the panel, so that it has slight clearances between both the front and rear ends and the panel surface respectively as shown.

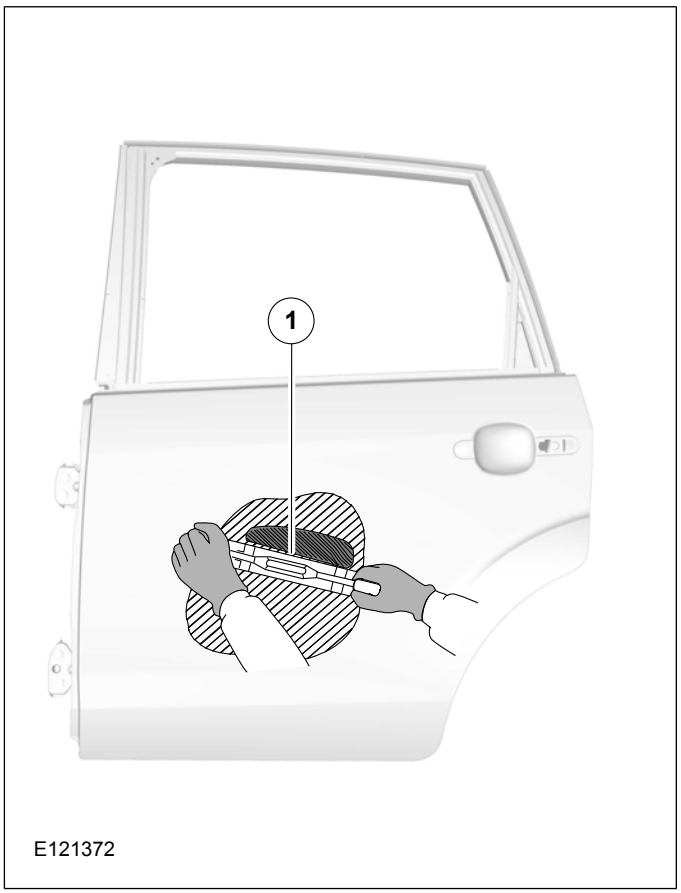


Repair Procedures

1. Where scratch marks are left at the first filing is higher than the normal surface level and where no marks are left is lower.

DESCRIPTION AND OPERATION

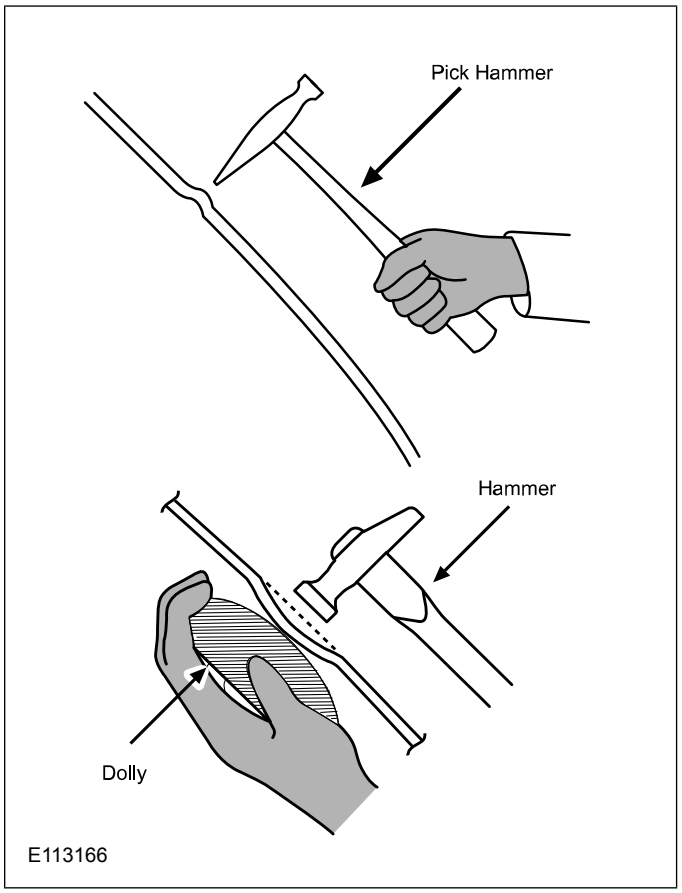
NOTE: Be careful not to file too much because it makes the panel too thin to such an extent that a hole may be open.



E121372

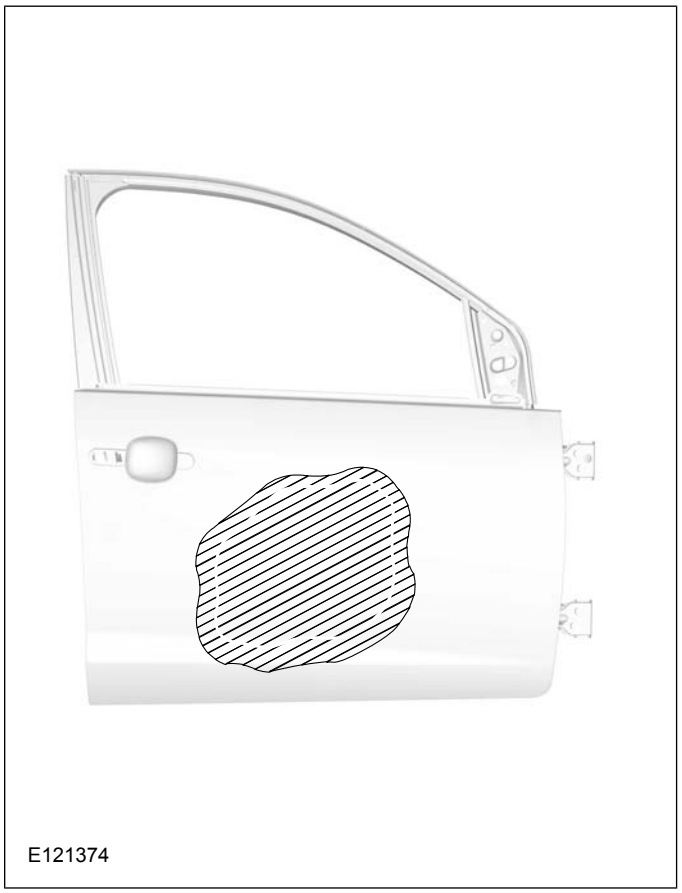
Item	Description
1	File

2. Where it is low, hit it out with a hammer and a dolly. Where it is high, hit it back lightly with a pick hammer.



E113166

3. Repeat steps 1. and 2. until all the repair surface is covered with file scratch marks.



E121374

DESCRIPTION AND OPERATION

4. Make the final inspection after reforming while touching the surface lightly with gloved hands.

Anti-rust treatment

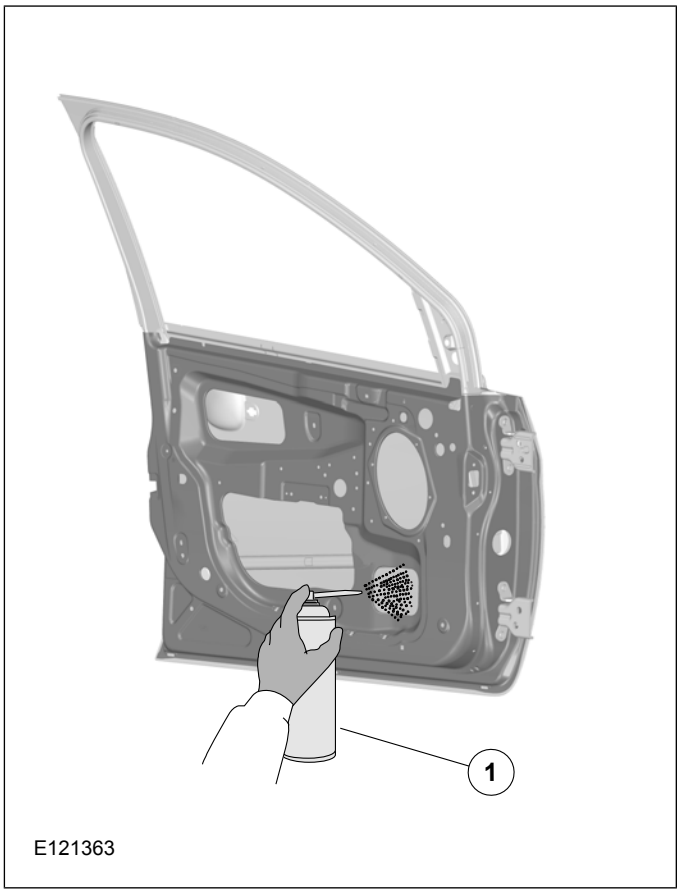
WARNINGS:

Anti-rust agents contain substances that are harmful if you breathe or swallow them, or get them on your skin. Wear coveralls, gloves, eye protection, and an approved respirator while using such agents.

Ventilate when spraying an anti- rust agent since it contains a small amount of organic solvent. Keep sparks, flames, and cigarettes away.

Make the anti-rust treatment to the inside surface of the panel because the paint layer is damaged due to the heat caused as the result of the washer welding or shrinking process.

Apply anti-rust agent to the inside of the area reformed through the internal or external parts installation holes or through work openings.



E121363

Item	Description
1	Anti-Rust Agent

Panel Repair by Hammer and Dolly

The reform on curved surfaces with the use of hammers and dollies can be done by hand without employing any facility, but as it requires high expertise, the result of the work depends on the workmanship of the technicians. With hammers and dollies, it is extremely difficult to finish the repair work to the same level of its undamaged pressed part. So, it may be necessary to replace with a new part according to the level of the damage.

The repair of a crushed vehicle requires a variety of handwork that is not difficult individually. If the damaged areas can be easily accessed by hand, the work using hammers and dollies is recommended because it can be done easily without needing much work time.

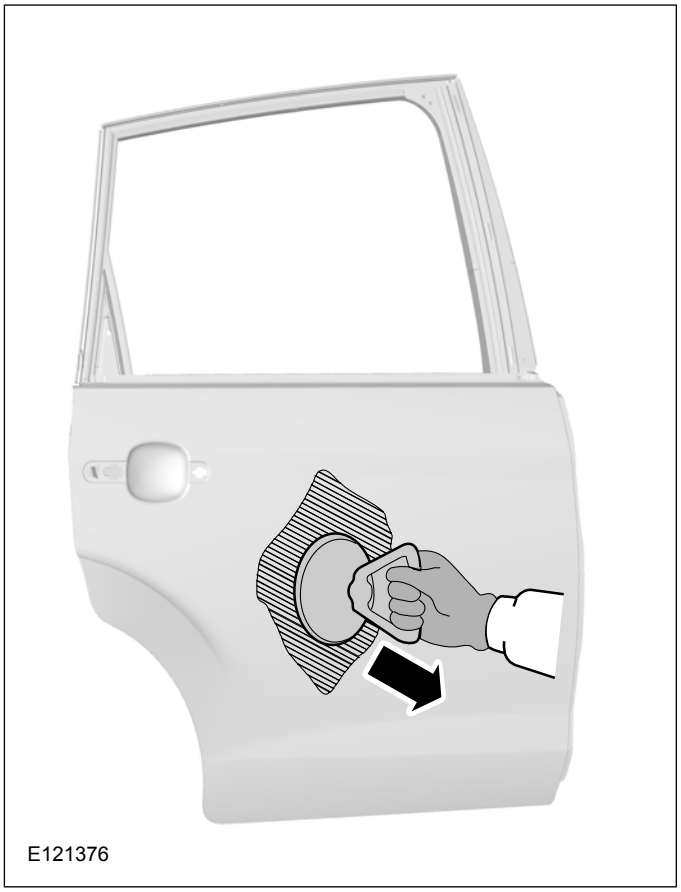
Repair Procedures

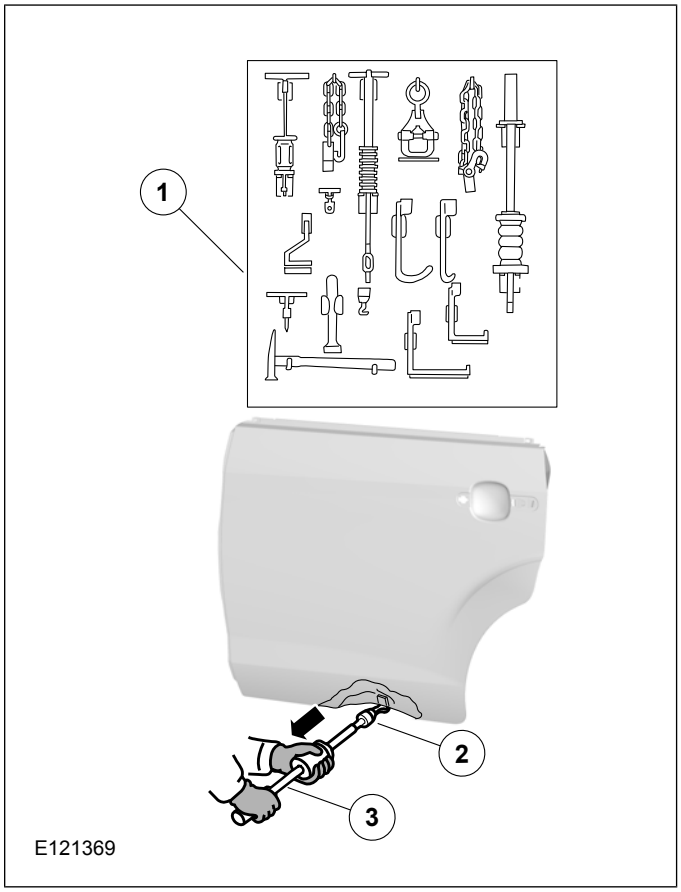
1. Confirm the range of damage. Before starting the repair work, make sure to confirm the deformed range of the damaged area.

For example, in a case that the impact is directed to the center of the door (mole area), the impact dispersion causes plastic deformations at the areas of the door above and below the mole. In combination with the deformation of the press line running under the mole, this deformation makes these upper and lower projected damages (elastic deformations) impossible to return to the original configurations.

Pull out the recessed area using a dent cup and then hit out the pressed line form the rear using a shadow chisel so that the pressed line elastically comes back to the original line.

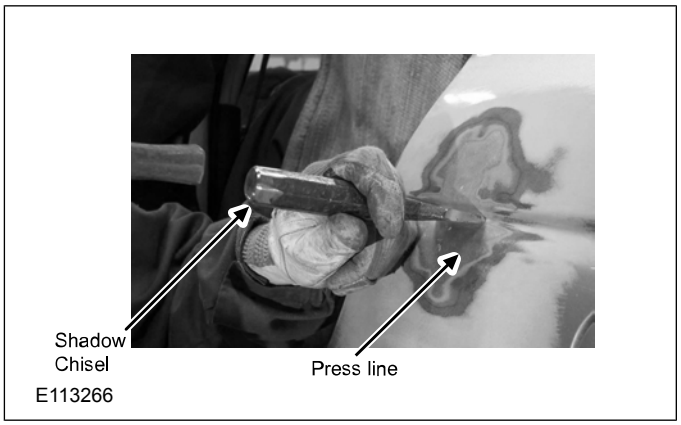
DESCRIPTION AND OPERATION


E121376



E121369

Item	Description
1	Body Puller Set
2	Attachment
3	Sliding Hammer



E113266

2. Remove foreign materials adhered to the rear of the panel. Remove all the foreign materials such as under-coat, sealer, and clay adhered to the rear surface, heating with a gas burner so that the dolly or spoon can closely attached to the rear surface.

3. Rough panel reforming. Using the body puller with a variety of attachments connected, if necessary, such rigid parts as rear wheelhouse and etc. can be pulled out.

WARNING: To prevent injury to your hands, wear gloves whenever hammering work.

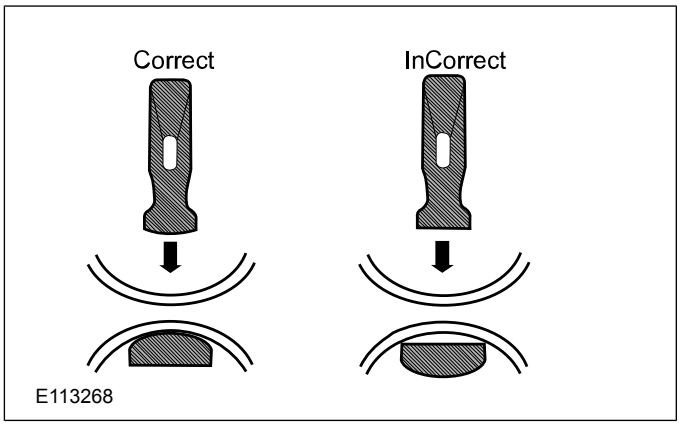
4. Selection of hammers, dollies and spoons.

Select the most appropriate hammers, dollies, and spoons to the curves on the repaired panel.

If the curves of the damaged part of the panel do not fit to any of those of the dollies or spoons available, select dollies or spoons of which curves are smaller than those of the panel damaged area.

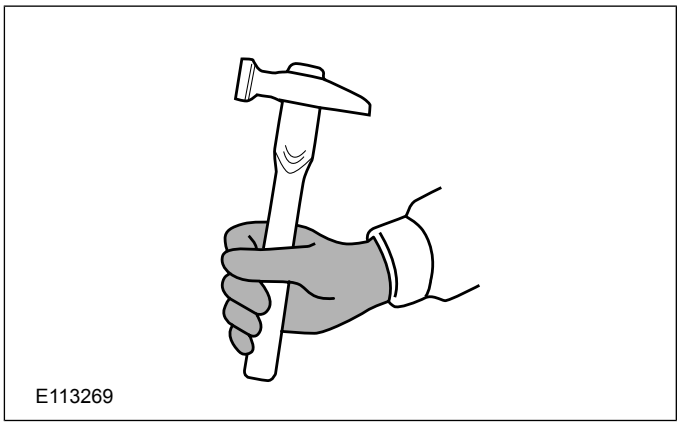
NOTE: Make the repaired surface smooth without any scratches where the hammer, dolly, or spoon contacts the surface.

DESCRIPTION AND OPERATION

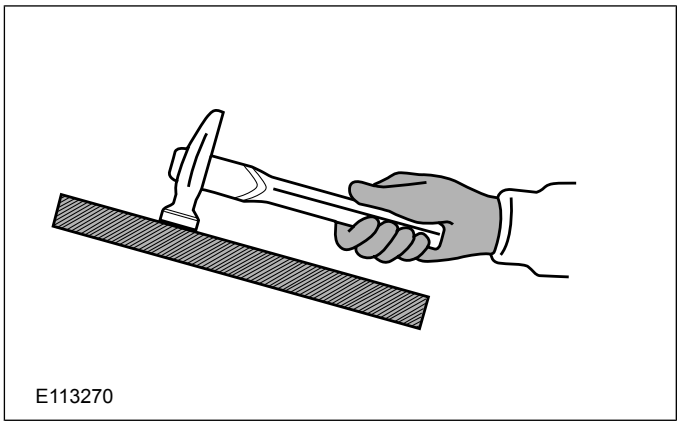


5. Hand repairing of unevenness using a hammer
Key points in hammering work:

Hold the hammer at around the end of the grip lightly and swing it using your wrist.

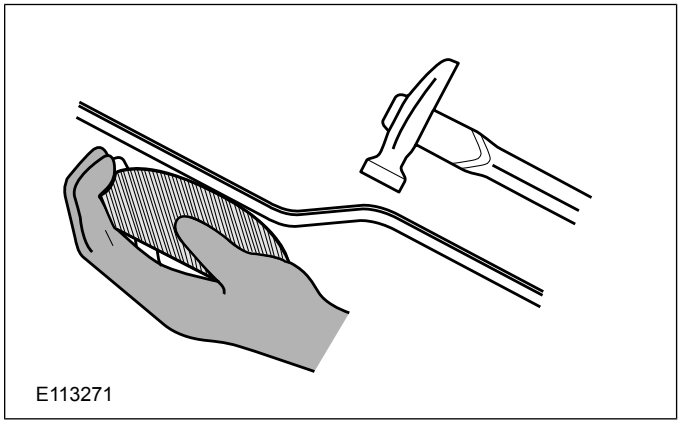


When striking with a hammer, the hammer face must always make contact with the panel surface evenly. NOTE: If the edge of the face contacts the surface, a crescent recess will be left on the panel that is very difficult to take off. Do not use too much force. Strike it as if bouncing it. If the panel is struck with too much force, it will be elongated later and need shrinking work.



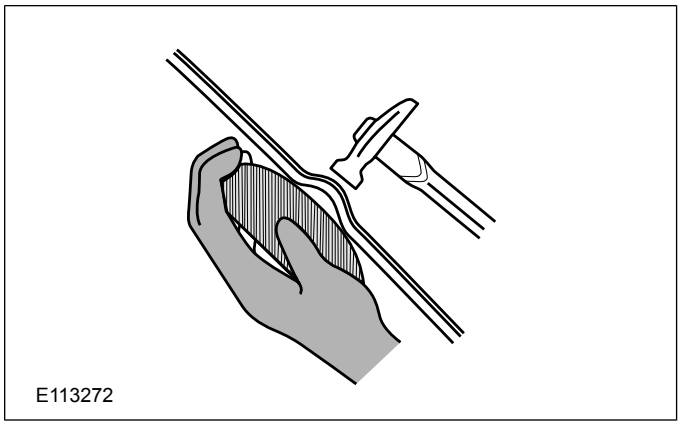
Hammering off dolly

Hammering off dolly is used for a comparatively large unevenness. The recess is stricken out with a dolly. Place the dolly right beneath the lowered area and strike the raised areas around. Then the raised areas will be lowered due to the hammer impact and, on the other hand, the lowered area will be raised due to the reaction of the hammer impact. It is very important to maintain a good balance between the hammer impact and the force to keep the dolly in position.



Hammering on dolly

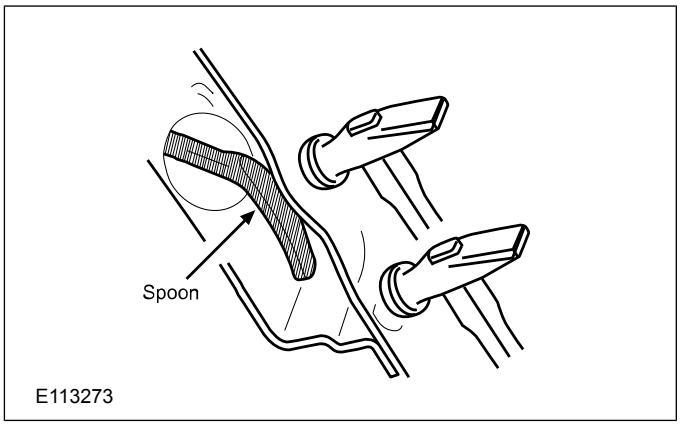
Hammer on dolly is used to get rid of tiny unevenness still remaining on the repair surface. Place the dolly straight under the raised area and strike the area from above with a hammer. While the hammer impact is flattening the raised area, the dolly slightly bounces back due to the hammer impact. To make it flat, repeat this work along the repaired surface on the panel while moving the hammer and dolly.



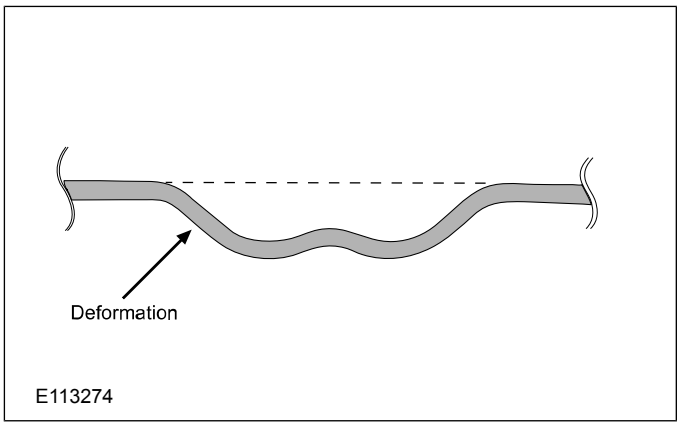
Spoon

For example, start to push inside of the panel with the spoon, and strike with a hammer from the outside of the panel.

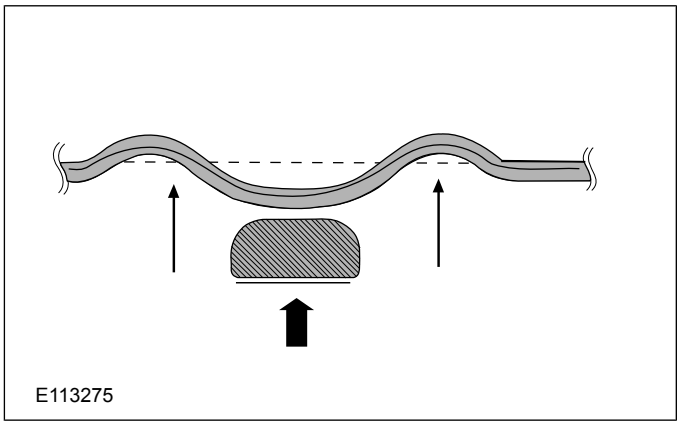
DESCRIPTION AND OPERATION



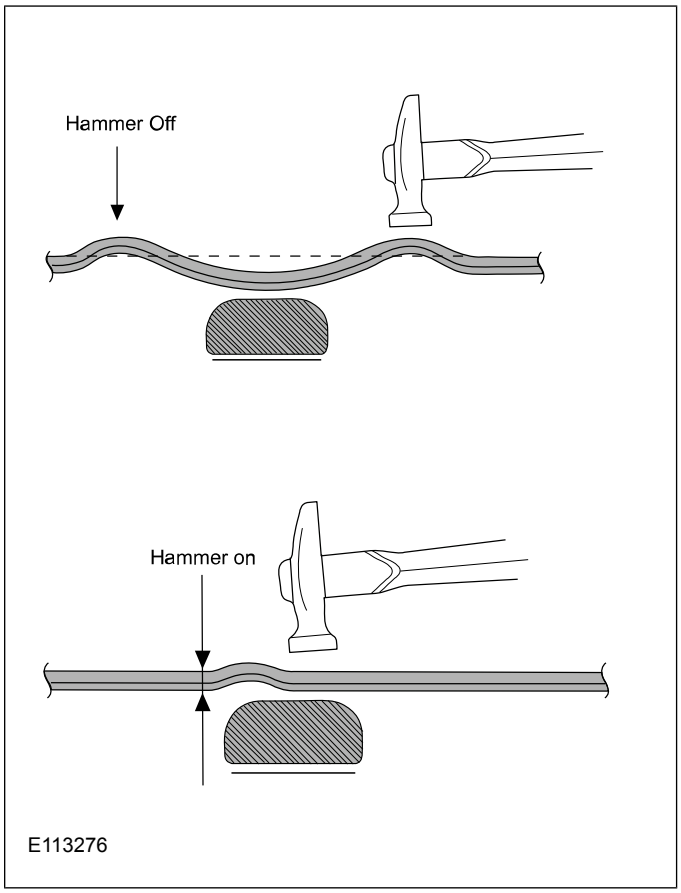
Deep deformation



Hammering out from the underside with a dolly.

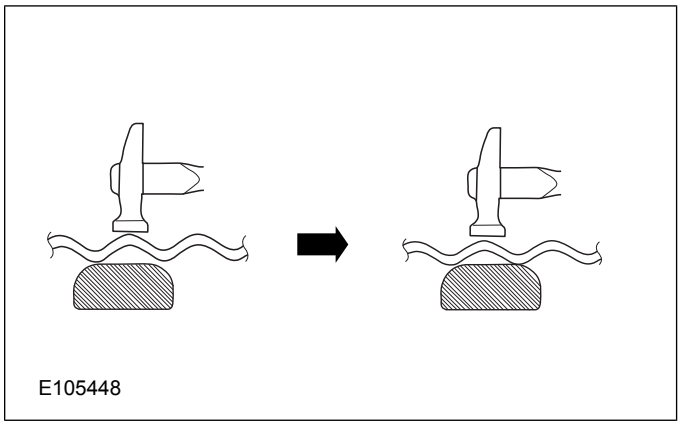


To make it flat, repeat the hammer off dolly and hammer on dolly alternately.



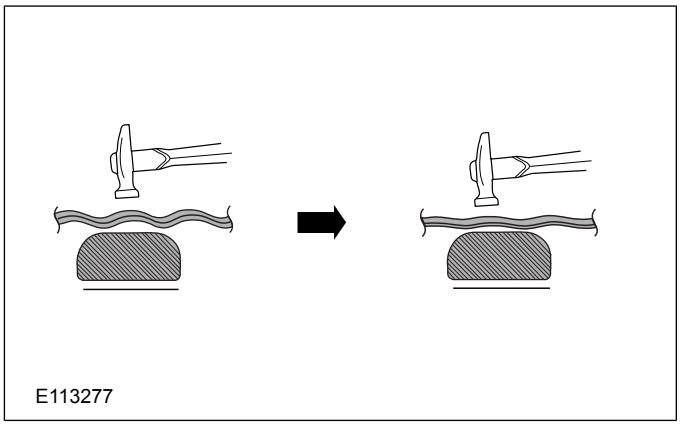
Continuously small deformation

Press up the dolly on the rear of the recessed area and strike the raise area from above with a hammer. Repeat this work until all the damaged area becomes one with just tiny unevenness.



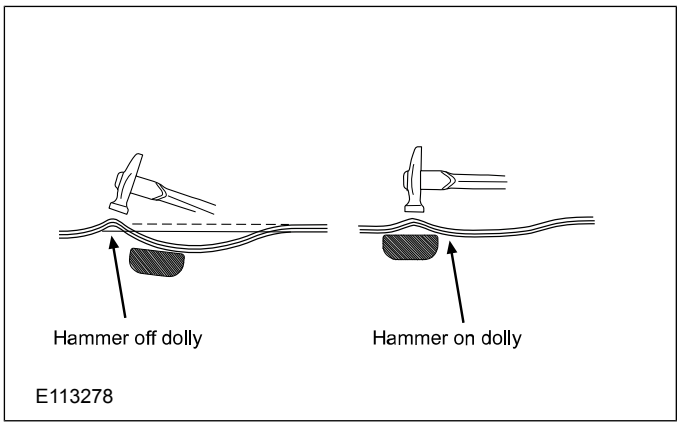
While moving the hammer and the dolly at the same time along the panel surface, repeat the work.

DESCRIPTION AND OPERATION

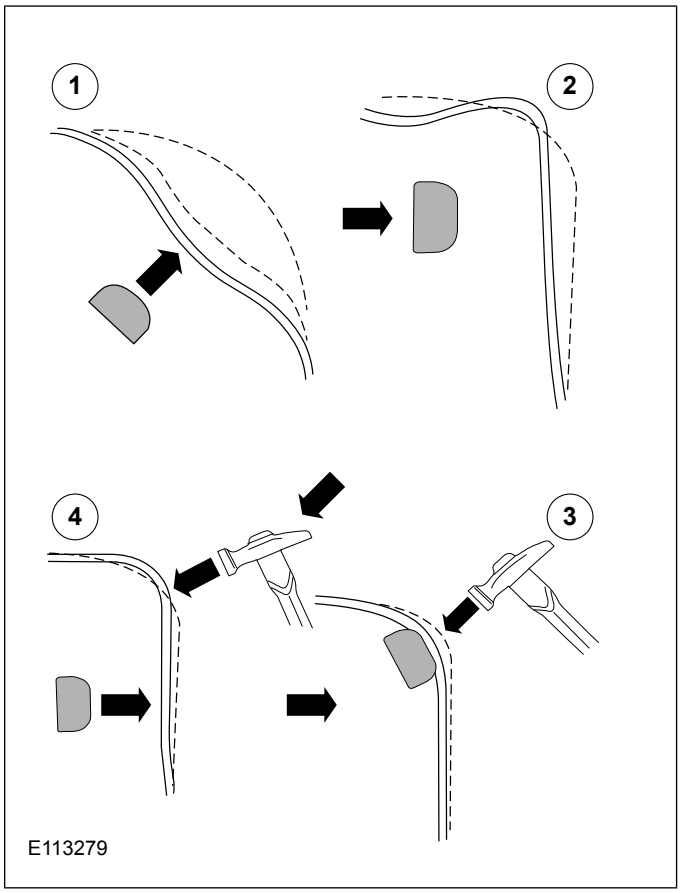


E113277

Plastic deformation



E113278



E113279

Big curved panel deformation

Strike the large unevenness flat to bring the surface to the original shape.

Strike with a hammer and dolly to reform a big-curved recess caused on the panel from the inside using a hammer and dolly alternately.

DESCRIPTION AND OPERATION

Paintless Dent Removal

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range listed in the Training brochure published by the Ford Service Organization.

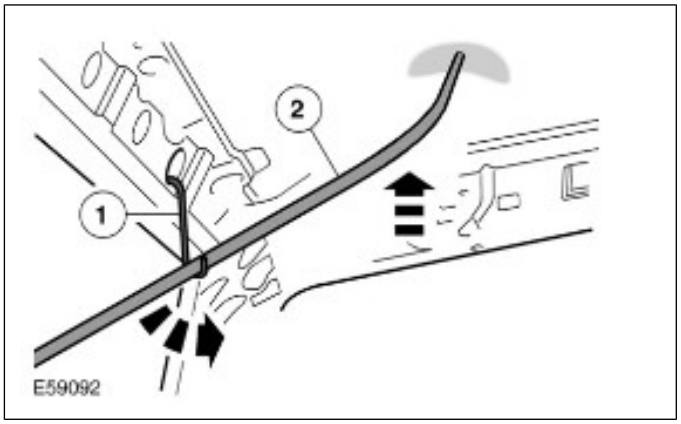
General

Application is restricted to body surfaces which are accessible from both sides. This repair technique is seldom feasible on double-skinned body components or closed body profiles. The same applies to edge areas, swage lines and seams on body components, which are very dimensionally stable.

The following characteristics must be present for a dent to be removed:

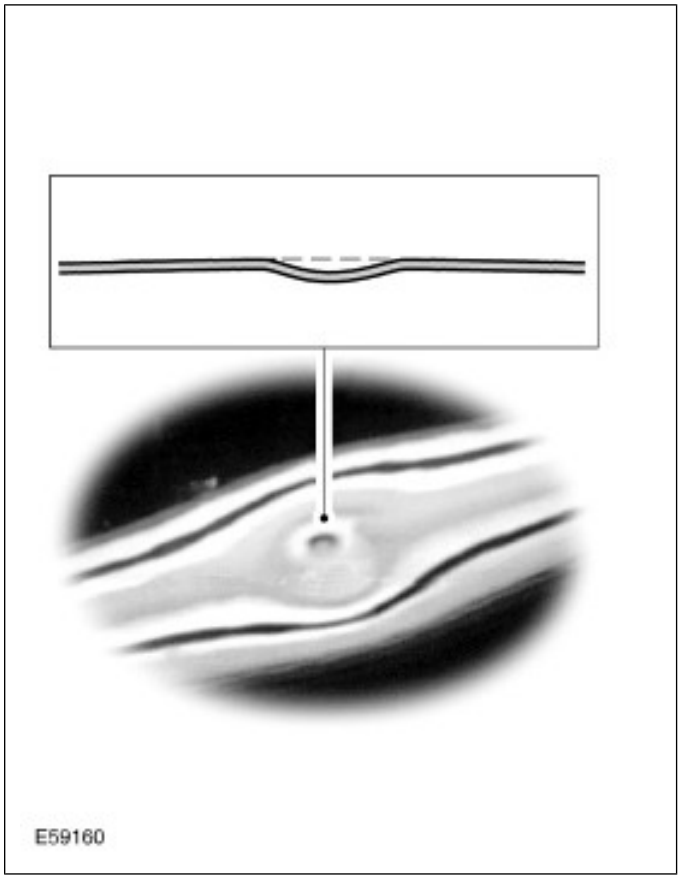
- The diameter must be no more than 50 mm.
- No material stretching in the centre of the dent.
- Repair area must be accessible

Furthermore, sufficient experience in the use of special tools and knowledge of materials are also requirements for a successful repair.



Item	Description
1	Deflection by a hook arrangement
2	Pressure tool

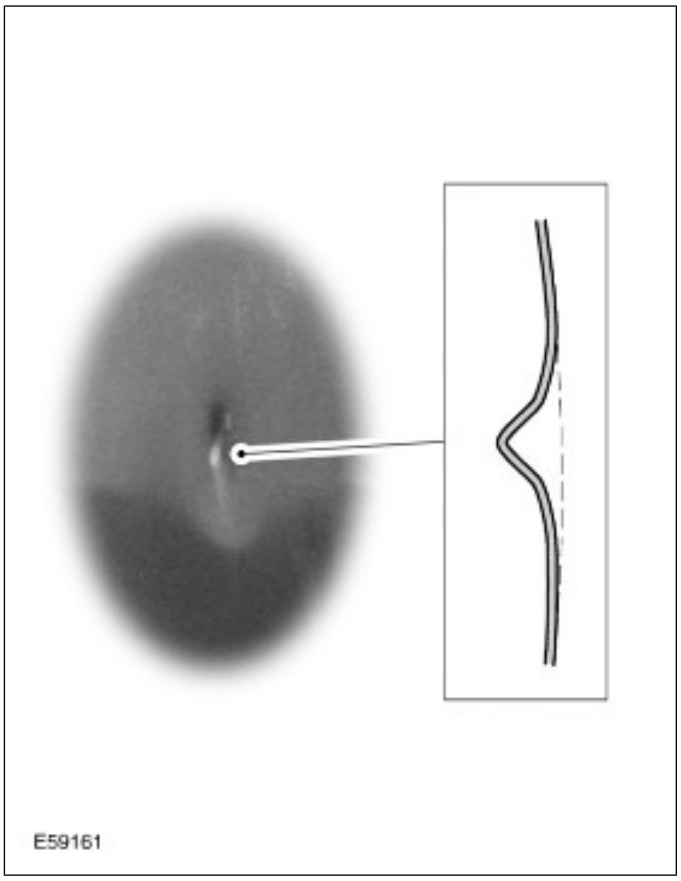
Mild dent



Satisfactory repair results are only possible on mild dents with little depth and small deformation radii. Therefore this repair method is particularly suitable for hail, parking and transportation damage.

Dent with material stretching

DESCRIPTION AND OPERATION



If strong and direct force during the damage process causes the material to stretch in the middle of a dent, then the result is a small and sharp edged dent. Such damage cannot be rectified without visible deformation.

Advantages of a planishing technique:

- Economical in time and materials
- The original paint is retained
- Environmentally friendly (no sanding or painting work)

While carrying out the repair, the following itemized repair route and process flow must be complied with:

1. Damage diagnosis
2. Repair preparations
3. Perform repair
4. Paint finishing, corrosion protection and quality control

In order to ensure corrosion protection, all inner areas of the repair must be treated afterwards. Where it is possible, the paint is repaired. In every case the inner area of the repair must be treated with cavity wax.

DESCRIPTION AND OPERATION

Joining Techniques

Types of joint

Vehicle is assembled by joining various parts and members. The type of joins are categorizes as follow.

Mechanical Joint

Members are joined by bolts, nuts, rivets, etc. In order to join members, it is necessary to create a joining structure.

Chemical Joint

Members are glued together. It is usually unnecessary to drill members for joining.

Metallurgic Joint

Surfaces to be joined are melted to join them to each other. Welding is classified as such. Types of welding include pressure welding, fusion welding, and soldering.

Pressure welding: This method first heats the metal parts to high temperatures to soften them, then applies a pinching (clamping) force. Resistance welding, a pressure welding method, is commonly used in manufacturing and repairing of automobiles.

Fusion welding: This method heats the materials to high temperatures until they melt, and bonds them without applying pressure. Depending on the method of heating, fusion welding can be arc welding or gas welding.

Braze welding: This method bonds two pieces of metal without melting them by using a filler material with a lower melting point than the materials being joined.

Welding of Automobile Body

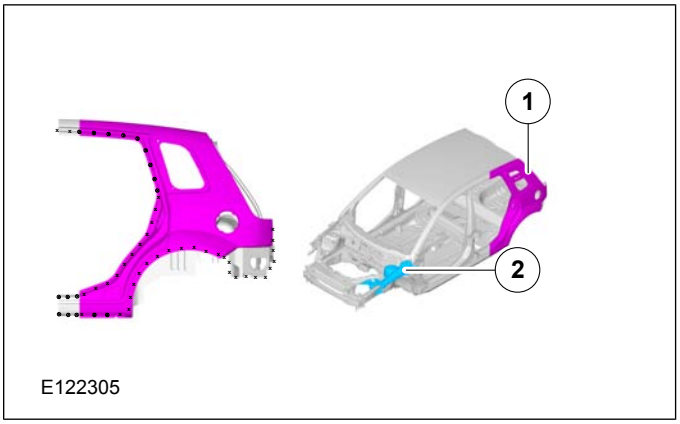
As an automobile body requires various levels of strength and durability depending on the position, the most suitable welding method is applied considering the location, purpose, part shape, thickness, etc. Keeping in mind such structural characteristics, appropriate welding methods have to be applied to maintain the strength and durability of the original vehicle body when repairing a damage. Welding for body repair

- Apply the same welding methods as those used in the factory manufacturing (majority is by spot welding).
- Apply the carbon oxide gas shield arc welding (plug weld, fillet weld) to areas where spot welding cannot be used.

NOTE: Gas welding and blaze welding should not be applied for bonding of structural members.

Mass Production Body Welding Diagram (rear side outer panel and front wheel house/damper housing).

The symbols in the mass production body welding diagram carry following meaning. 1: Spot weld; 2: MIG weld; 3: 2-plate welding; 4: 3-plate welding; 5: 4-plate welding; 6 : The number of welding



E122305

Item	Description
1	Rear Side Outer Panel
2	Front Wheelhouse/Damper Housing

Welding Equipment

Welder

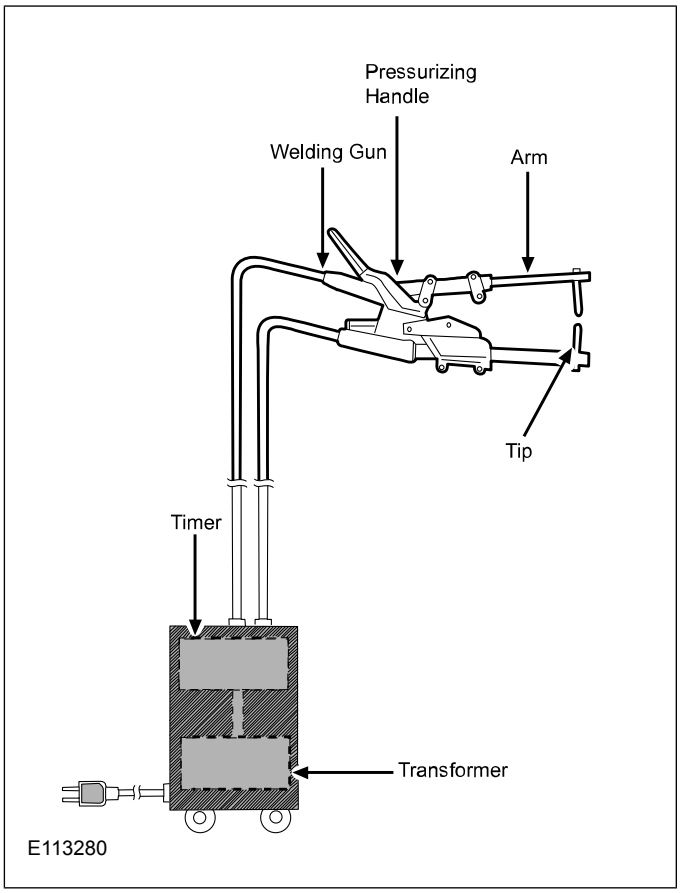
The spot welder consists of the welding gun, transformer, and the timer.

The type that integrates the transformer in the welding gun and another type having a separate transformer are commonly used.

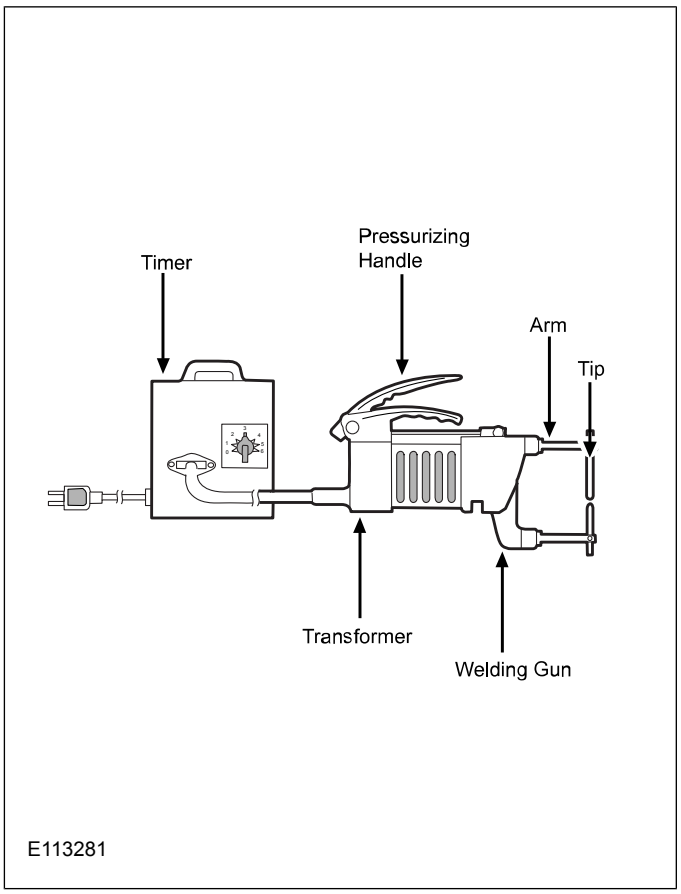
Most of the spot welders used for body repairs allow adjustment of the pinching pressure and the current application duration although most do not permit adjustment of the welding current.

Transformer separate type:

DESCRIPTION AND OPERATION



Transformer integrated type:

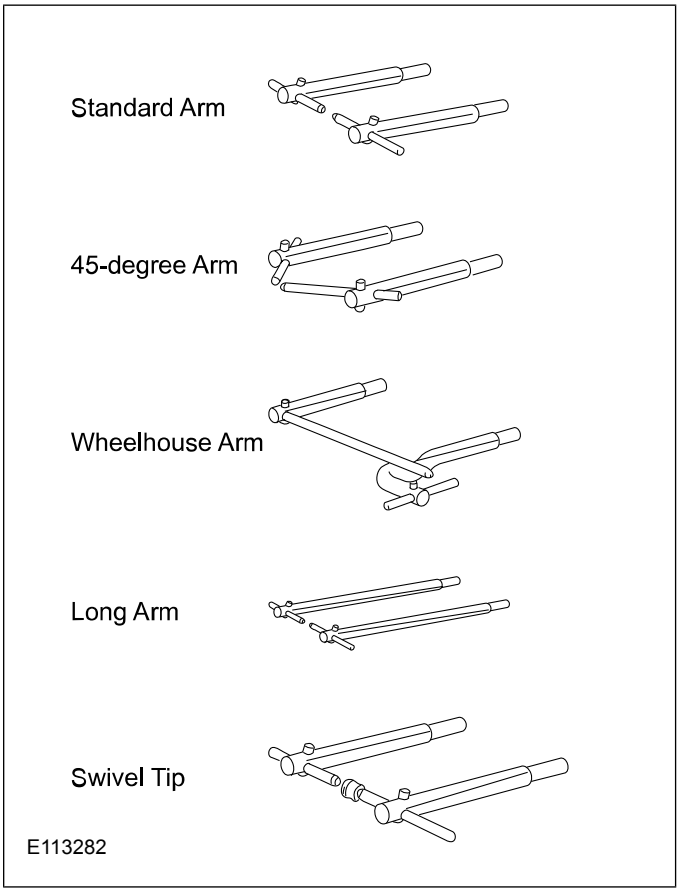


Welding Tip, Arm

The tips provide pressure to the welding area, apply current, and allow the work pieces to cool while holding them tightly. To resist deformation and conduct heat efficiently, the tips are made of copper alloy (chromium copper).

The arms feed current to the tips to suit various requirements. They are available in many different shapes and lengths.

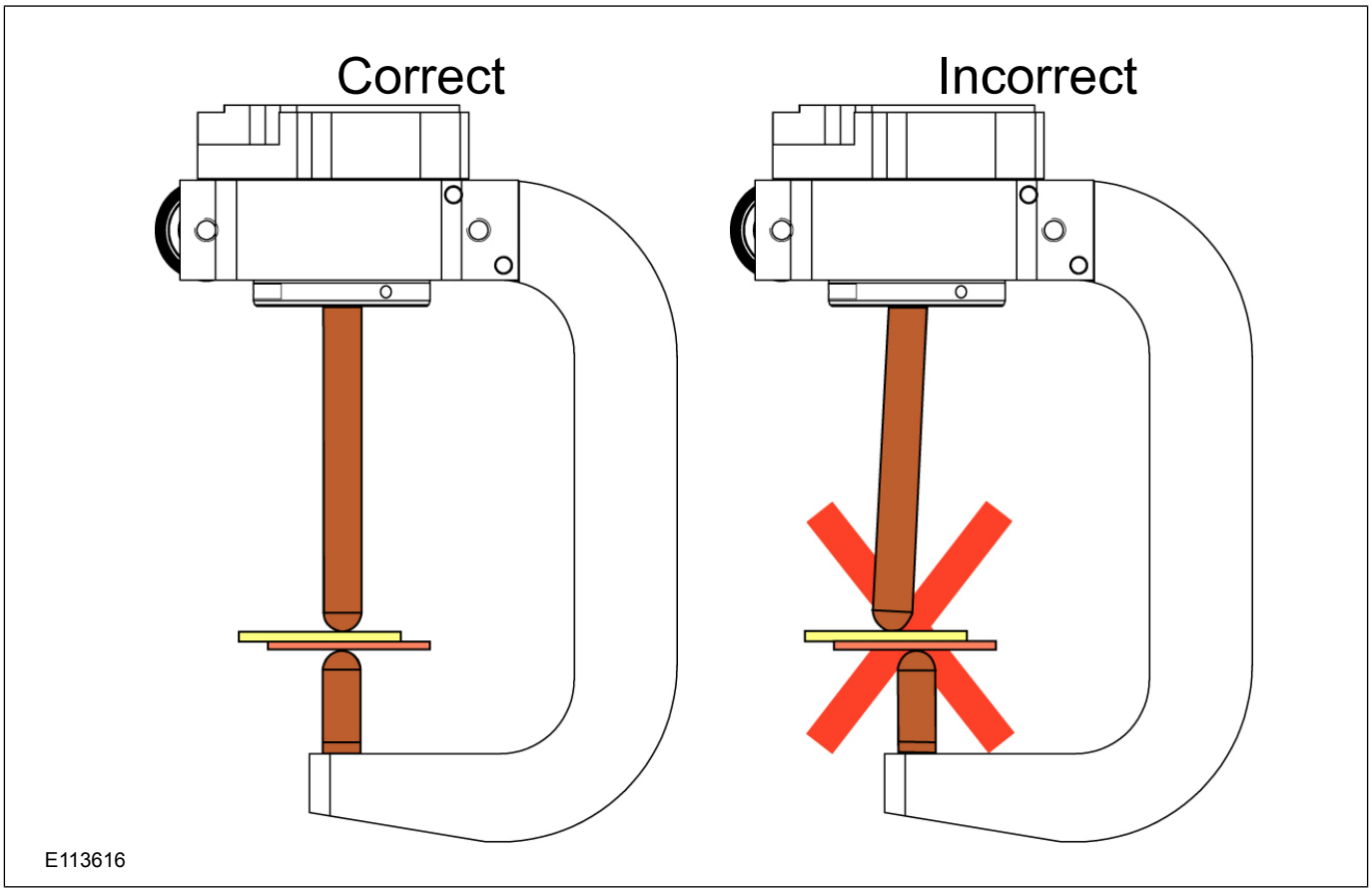
The pressurizing handle moves the tips up and down to hold work pieces tightly.



Tip adjustment C-tong

The correct and incorrect position of the tip is shown.

DESCRIPTION AND OPERATION



Transformer

Spot welding requires a large current which is provided by a transformer that changes the primary voltage of 200 VAC to a much lower secondary voltage DC while providing welding current of 5000 to 9000 A.

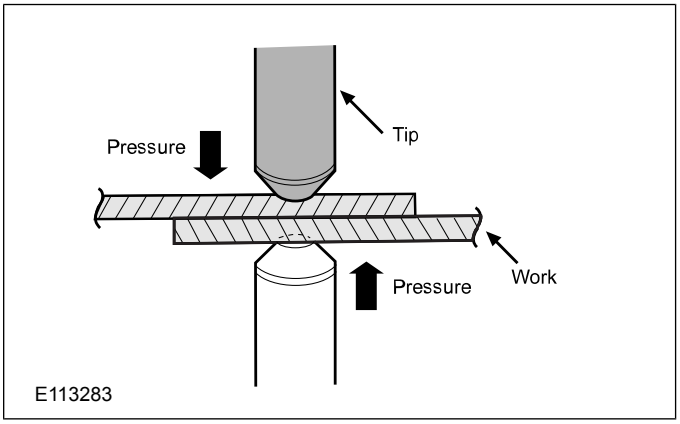
Timer

The timer controls the duration of applied current and is in the primary circuit of the transformer. It provides current to the primary circuit for a prescribed period of time, when signaled from the switch that is located in the pressurizing handle.

Welding Principles

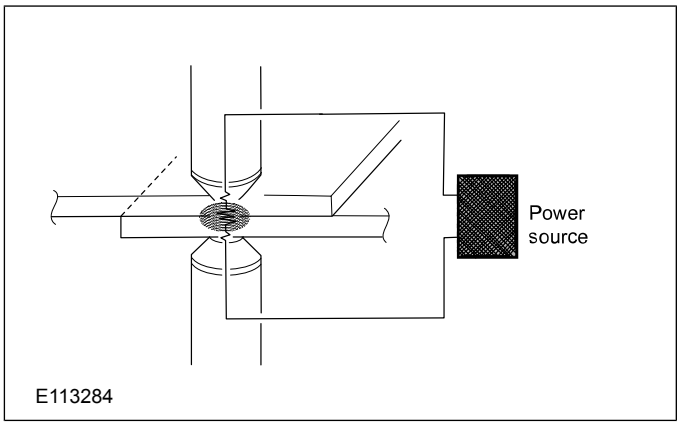
Spot welding consists of such procedures as holding two metallic plates between electrodes, applying an electric current to the electrodes to melt the bonding area by the heat occurring from the electric resistance, and applying pressure for bonding.

1. Pinching (tight holding). To allow the current concentration in the welding area, the work pieces are held tight between tips (electrodes).

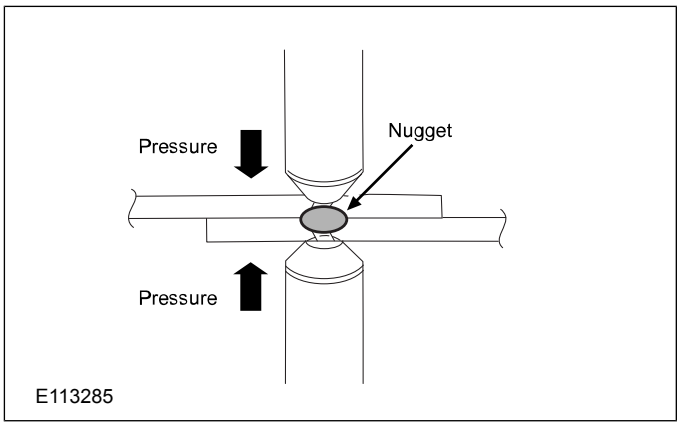


2. Current application (melting). As a large current is applied to the work pieces via the tips, joule heat occurs at the mating surfaces of the work pieces where the electric resistance is the largest, and the temperatures in that area increases progressively. As the current application is continued, the mating surfaces melt and bond together by the pressure.

DESCRIPTION AND OPERATION



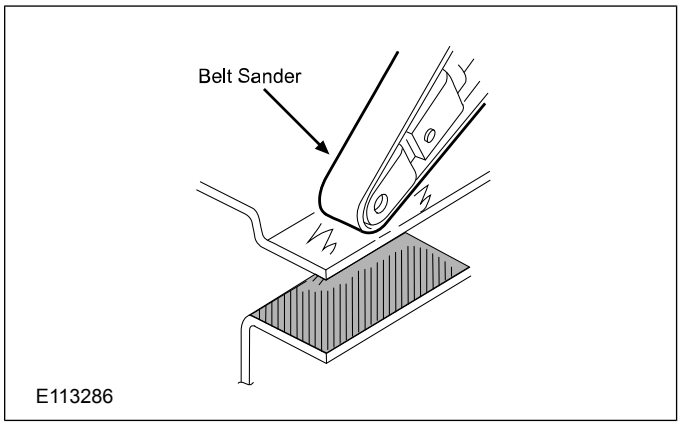
3. Holding (pressuring and cooling). As the current application is discontinued, the melting area is gradually cooled and a nugget (spherical area of solidification after melting) is formed. Due to the pressure application, the material structures of the nugget become fine, which improves the physical characteristics.



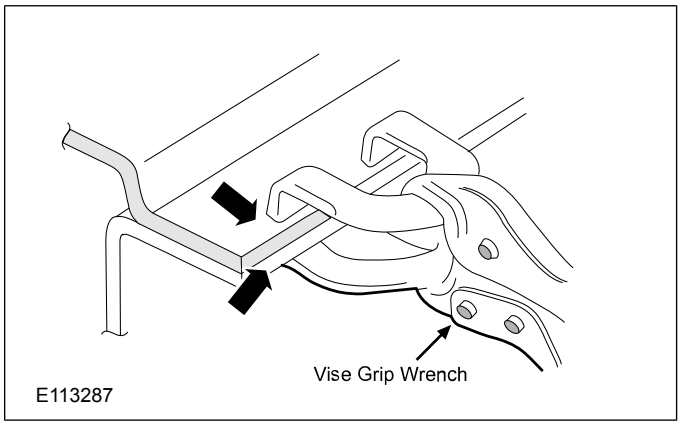
Notes on Welding

1. Sanding of work piece. When paint film, rust, or other foreign matter is between the tip and work piece, current will not occur sufficiently, causing poor welding. Remove the paint film, rust or other foreign matter on the surface of the work piece with a belt sander.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever sanding.

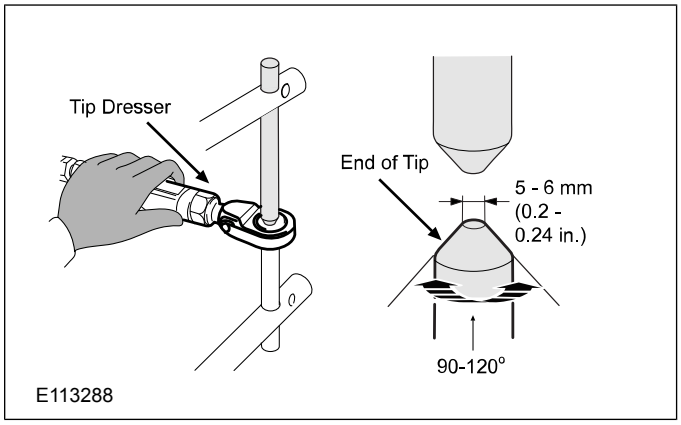


2. Make the contact surfaces tight with the use of a vise grip wrench.



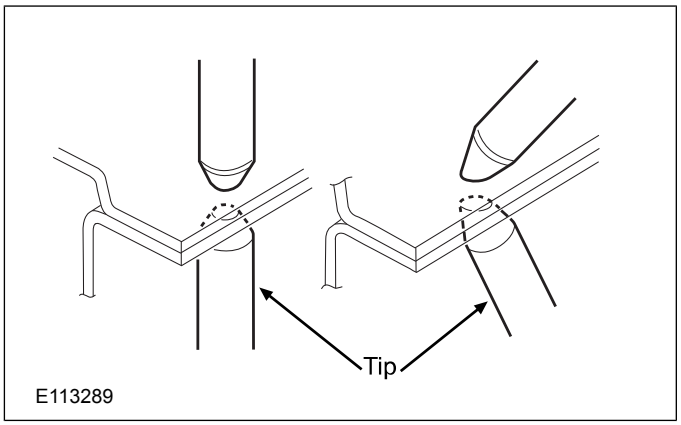
3. Condition of tip.

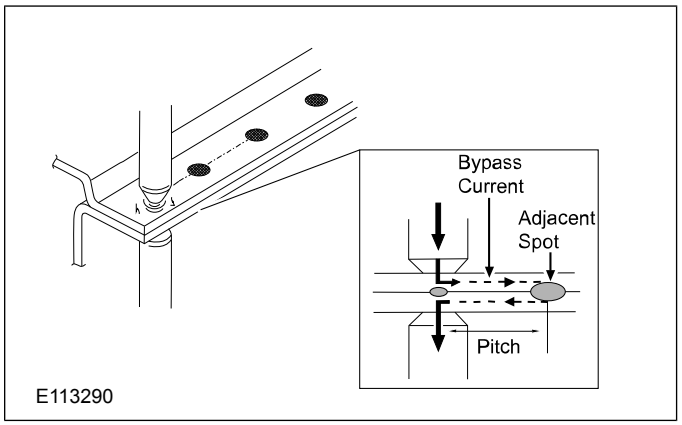
- When the diameter of the end of tip becomes large, the current concentration lowers, causing the nugget to become small. When the tip diameter is too small, the nugget will not become large.
- When welding, the shape and the surface conditions have to be checked regularly.
- When the end of tip is worn, correct the shape (90 to 120°) as illustrated using a tip dresser.



4. Arm setting. The installed condition of arms affects the holding pressure and current. The arms have to be properly aligned when installing.

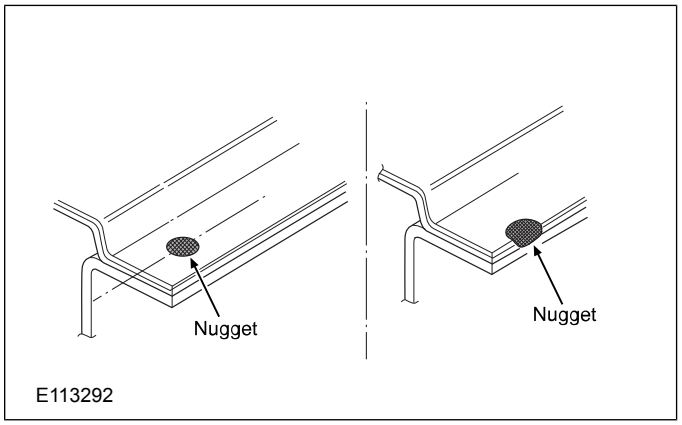
DESCRIPTION AND OPERATION





5. Spot welding position.

- While reducing the spot welding pitch increases the strength, when spots are excessively close together, welding current occurs through the already-welded spot (bypass current), causing lack of current in the area to weld and reducing the strength. When the pitch is small, the bypass current increases.
- When the spot is too close to the end, the end becomes a part of the melted nugget, reducing the plate thickness and the strength. Spot is center of the weld flange.

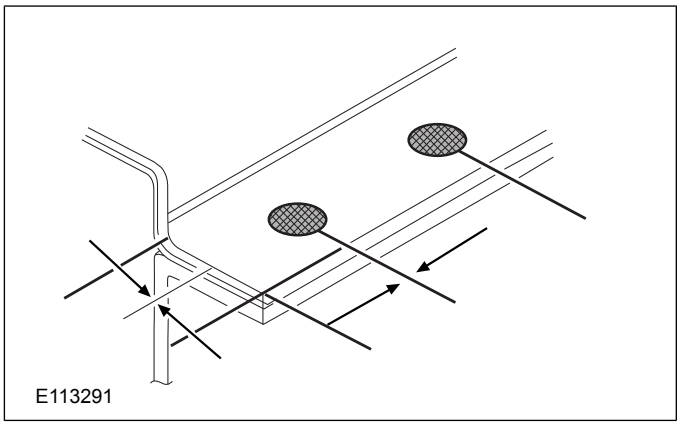


Reference of welding position

The spot welding pitch (space between spots) and the end distance (distance from the end of the panel) affect the strength of the whole vehicle body. Appropriate welding pitch and distance from the end of the plate have to be applied depending on the thickness of the panel.

Thickness mm (in)	Pitch mm (in)	End Distance mm (in)
0.6 (0.02)	11 (0.43) or more	5 (0.20) or more
0.8 (0.03)	14 (0.55) or more	5 (0.20) or more
1.0 (0.04)	18 (0.71) or more	6 (0.24) or more
1.2 (0.05)	22 (0.87) or more	7 (0.28) or more
1.6 (0.06)	29 (1.14) or more	8 (0.31) or more

DESCRIPTION AND OPERATION



6. When performing spot welding, make sure that you conform to the following condition: use the correct current, conductivity time, welding pressure, holding time, and shutdown time recommended for the spot welder. Follow the spot welder manufacturer's instructions.

Welding Parameters (Given as reference only)

GMT (mm)	Welding Force (kN)	Welding Time (ms)	Welding Current (kA)	Cap Diameter (mm)	Contact Diameter (mm)
0.63	1.85	140	8.5	16	6
0.75	1.95	160	9.0	16	6
0.80	2.10	160	9.5	16	6
0.85	2.30	180	10.0	16	6
0.90	2.45	200	10.5	16	6
1.00	2.65	220	11.0	16	6
1.13	2.90	220	11.5	16	6
1.25	3.10	240	12.0	16	6
1.38	3.40	260	12.5	16	6
1.50	3.65	280	13.0	16	6
1.75	4.10	320	13.5	16	6
2.00	4.50	360	14.0	20	8
2.25	4.90	440	15.0	20	8
2.50	5.20	520	16.0	20	8
2.75	5.55	560	16.5	20	8
3.00	5.90	640	17.0	20	8

Inspection of Welded Area

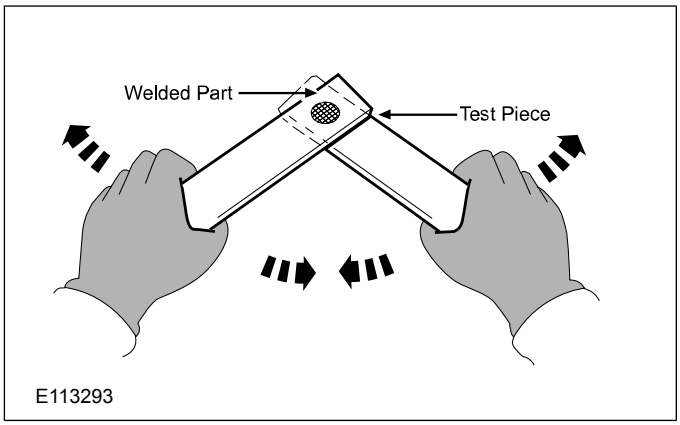
Destructive Inspection (Using Test Piece)

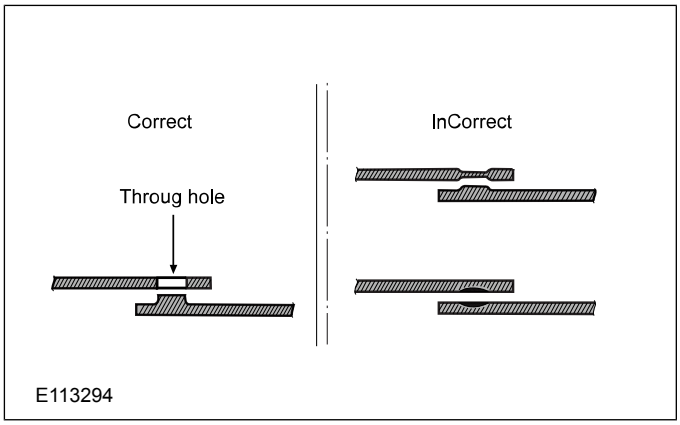
1. Prepare test pieces made of the same material and thickness as the welded work piece and weld together as illustrated.

2. Apply force in the directions shown by the arrows to separate the spot weld, and check the conditions of the broken pieces. If a through hole appears in a panel, the welding shall be judged correct.

WARNING: To prevent injury to your hands, wear gloves whenever checking work.

DESCRIPTION AND OPERATION

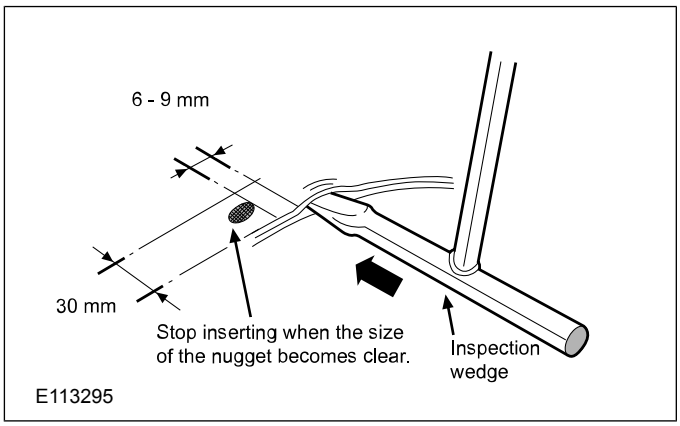




Non-destructive Inspection

1. After welding, insert the inspection wedge into the side of the nugget (welded area) at the below-illustrated position.

WARNING: To prevent injury to your hands, wear gloves whenever checking work.



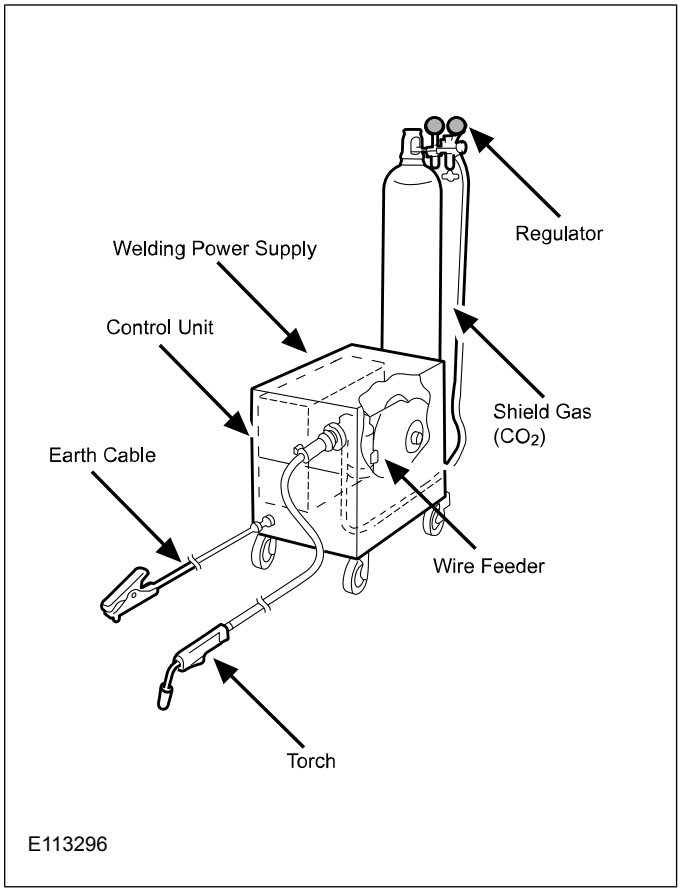
2. The welding shall be judged correct if the diameter of the nugget is larger than ø 3 mm (0.12 in.).

3. After the inspection, correct the deformation caused by the inspection wedge.

Carbon-dioxide Gas shield Arc welding

Welding Equipment

The carbon-dioxide gas-shield arc welding equipment consists of the torch, wire feeder, shield gas supply, control unit and the welding power supply. The wire feeder and the welding power supply are integrated in some types.

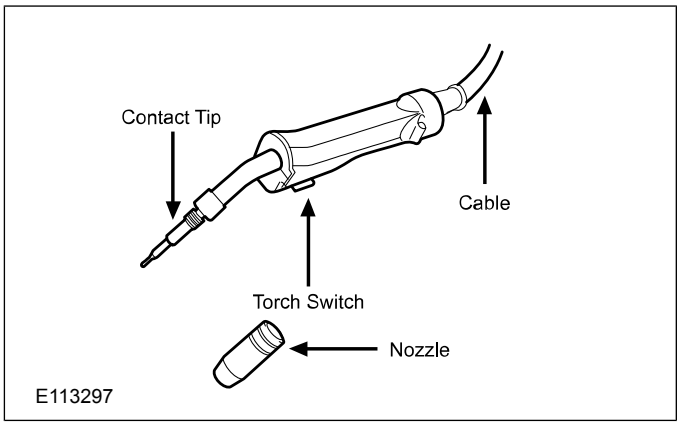


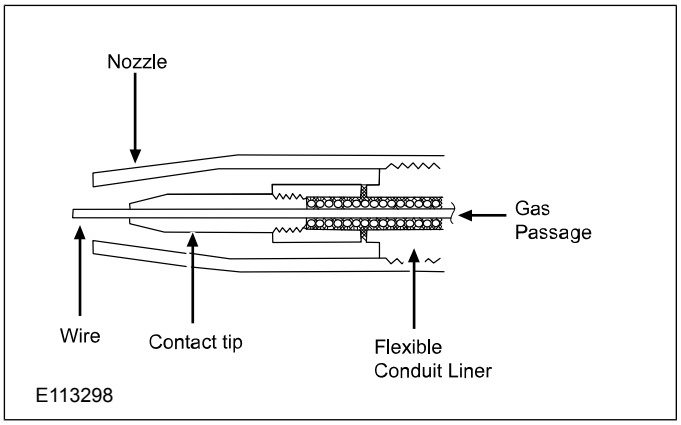
Torch

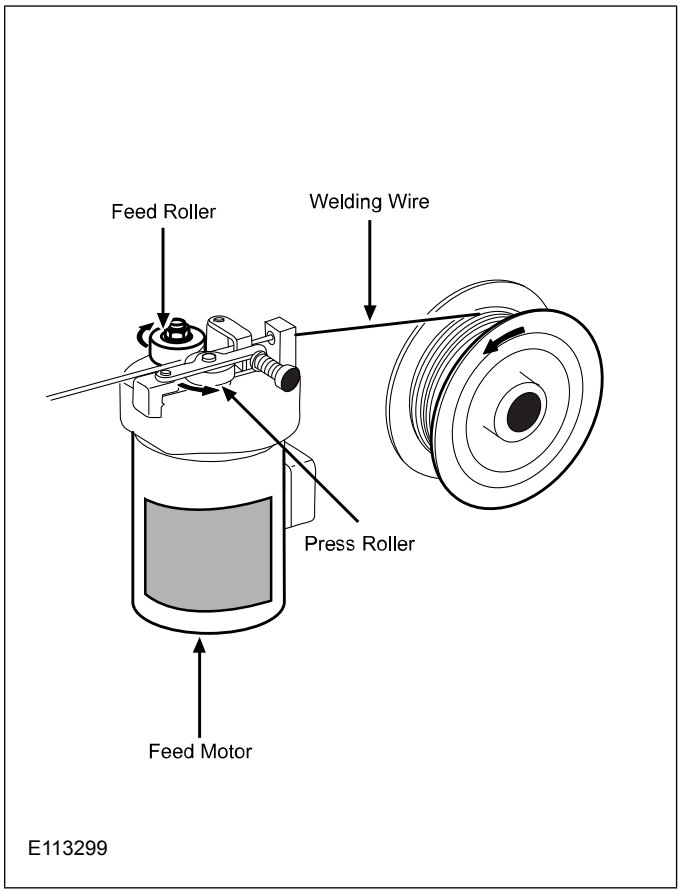
As well as providing a stream of shield gas to the welding area, the torch allows the current to flow through the wire to generate arcs.

The nozzle, which guides the shield gas to the welding area, and the contact tip, which transmits welding current to the welding wire, are attached on the end of the torch. The cable that transmits welding current to the contact tip, the flexible conduit liner and the shield gas passage are provided inside of the torch. The torch switch for starting and finishing of welding is incorporated in grip.

DESCRIPTION AND OPERATION







Wire and Wire Feeder

The wire feeder is the device that sends the wire, which serves as a welding rod, to the torch. It consists of the feed motor, reduction gear, feed roller, and press roller.

The spinning of the motor is transmitted to the feed roller via the reduction gear, and sends the wire, which is pinched between the press roller and the feed roller, to the torch. The wire is provided at a prescribed speed depending on the welding current and the voltage.

The wire is a long, single string of steel having a diameter of 0.6 to 0.9 mm (0.02 to 0.04 in.). The material is almost similar to the work piece, which is usually a mild steel panel.

As the carbon dioxide gas exhibits the oxidizing nature at high temperatures, the wire contains a small volume of deoxidizing compounds. The wire is coated with thin copper plating to prevent corrosion and to improve conductivity with the contact tip.

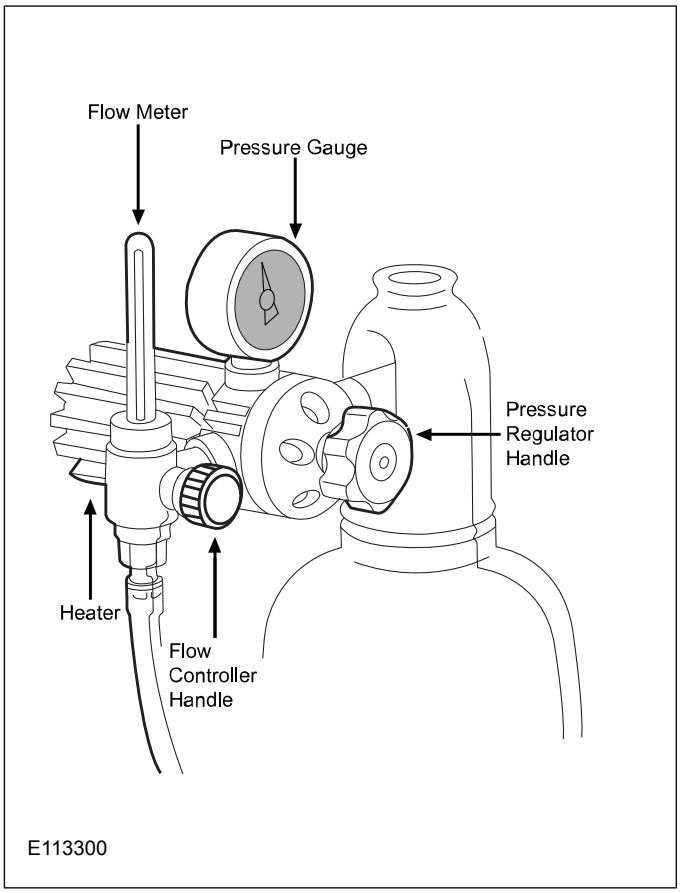
Shield Gas Supply

The shield gas supply is a device that directs the shield gas from the gas cylinder to the torch. It consists of the regulator, which reduces the high gas pressure in the gas cylinder to the prescribed pressure and allows adjustment of flow rate, and the solenoid valve that opens and closes the gas passage. The carbon dioxide gas is charged in the cylinder in the state of liquid.

The electric heater is incorporated in the regulator to prevent icing of the regulator due to evaporation of the liquid that draws heat.

The purity of carbon dioxide gas is specified in JIS. For welding, Class 3, which contains less moisture, is usually used.

DESCRIPTION AND OPERATION



Control Unit

Receiving signals from the torch switch, the control unit regulates wire feed and turns on/off the welding power supply and the shield gas supply.

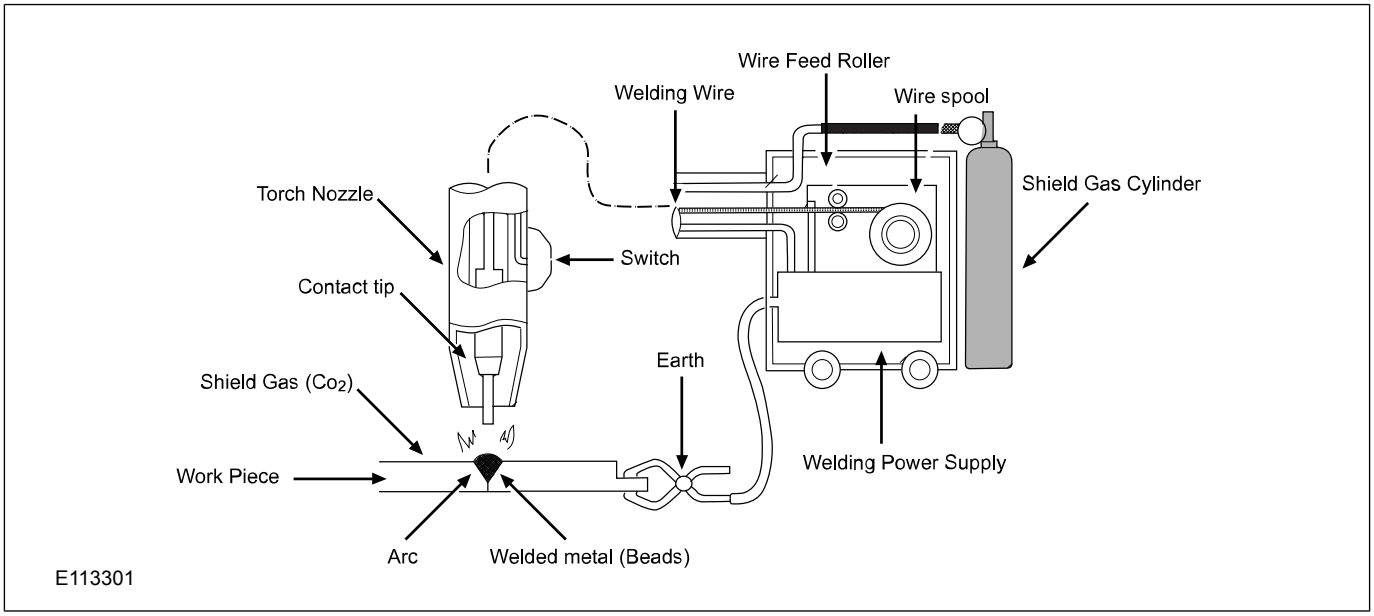
The most important roles are the starting and stopping of wire feed, and the wire feed speed control depending on the current and voltage to maintain the arc length as constant as possible. A large number of semi-conductors are used in the electric circuits in the power unit.

Power Unit

The power unit provides the electric energy to generate arcs. It converts the AC (200 volts) from the power supply to several ten volts of DC that is required for welding by means of the transformer and the rectifier.

Principles

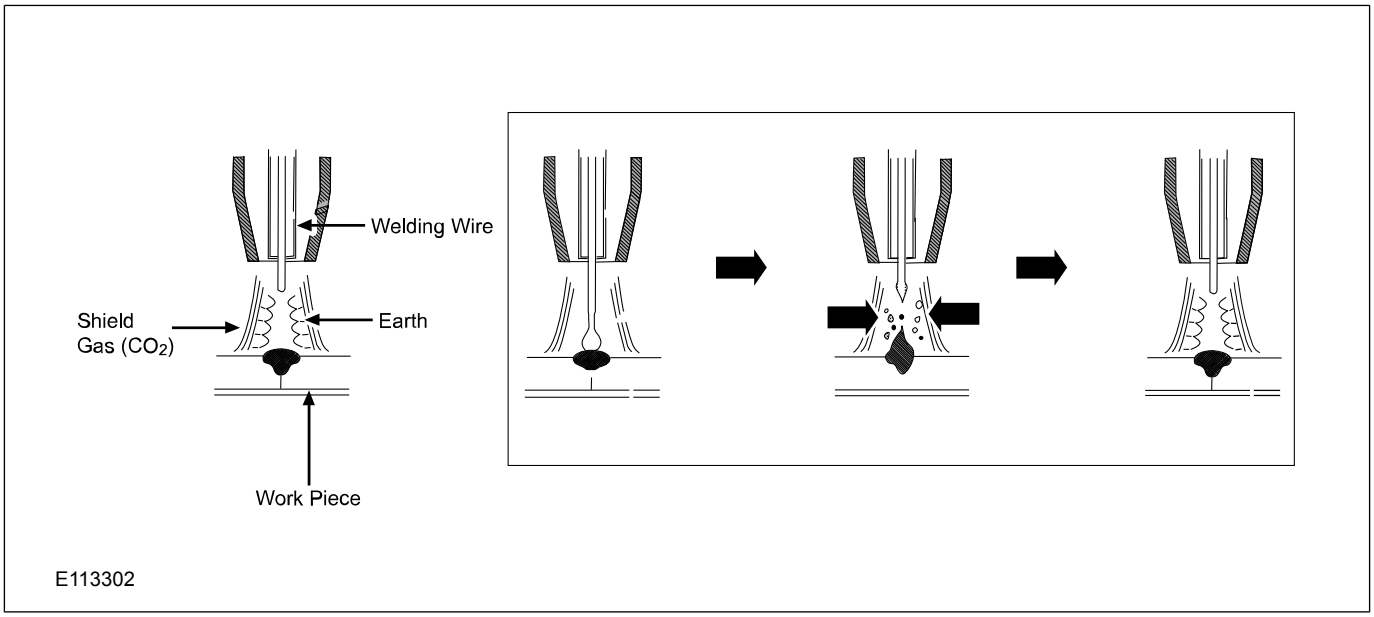
The carbon-dioxide gas-shield arc welding is a welding method that lets an arc (electric discharging) occur between the wire (welding rod), which is automatically fed at a constant sped, and the work piece, using the heat from the arc. The wire and the work piece are melted and welded together. During welding, carbon dioxide gas (CO2) is supplied from the gas cylinder to keep the welding area from the air for prevention of oxidation and nitrifying. In carbon-dioxide gas-shield welding, the unique, melt-drop-transfer welding called the “short arc method” is applied. When welding thin panels, problems such as distortion and blowing of material tend to occur. To prevent such problems, it is necessary to restrict the incoming heat amount. In the short-arc method, by using a wire of a very small diameter and allowing arc to occur at a small current and low voltage, the incoming heat to the work piece is restricted, which keeps the depth of fusion small for optimum welding of thin panels.



DESCRIPTION AND OPERATION

Transfer of melt drop in short-arc welding:

The end of the wire melts due to the heat from the arc, touches the work piece, making a short circuit. As a short circuit occurs, a large current occurs and separates the shorted part by the pinching force, causing the arc to occur again.



Notes on Welding

welding Current

The welding current affects the depth of fusion and the melting speed of the wire. It also affects the stability of arc and occurrence of spatters. As the current increases, the depth of fusion goes deeper while the height (the rising of melted metal on work surface) and width of beads becomes larger.

Wire diameter and welding current:

Wire Diameter mm (in)	Current Range (Amp)
0.6 (0.02)	40 ~ 90
0.8 (0.033)	50 ~ 120
0.9 (0.035)	60 ~ 150

Work thickness and current:

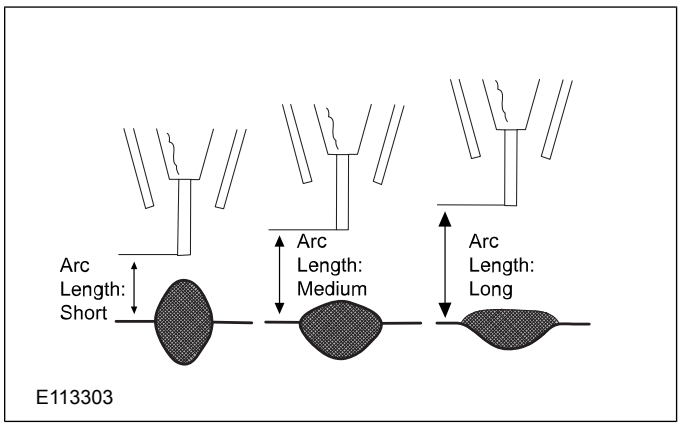
Thickness mm (in)	Wire Diameter mm (in)	Current Range (Amp)
0.8 (0.033)	0.9 (0.035)	60 ~ 70
1.0 (0.04)	0.9 (0.035)	60 ~ 70
1.2 (0.05)	0.9 (0.035)	70 ~ 75
1.6 (0.06)	0.9 (0.035)	80 ~ 85

Arc Voltage

To ensure correct welding, an appropriate arc length is required. The arc length depends on the arc voltage.

As voltage increases, the arc length increases, causing the beads to become shallow and wide. Conversely, when the voltage decreases, the beads become deep and high. If the voltage is excessively high, arcing is reduced, making welding difficult. If voltage is excessively low, the wire touches the work, causing the arc to stop.

When arc voltage is correct, a steady “Gee” sound can be heard.



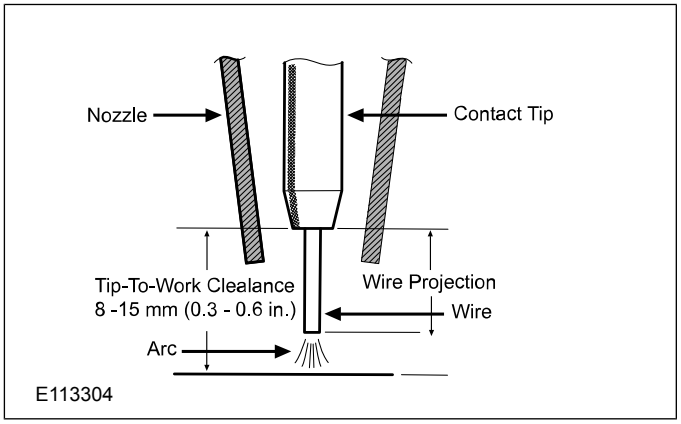
Tip-to-work Clearance

If the clearance is excessive, the wire melts quickly because the length of the protruding wire is too

DESCRIPTION AND OPERATION

long, and due to preheating of the sticking wire the current decreases, reducing the depth of fusion.

When the clearance is excessively large or small, the shield effects are reduced, negatively affecting the work efficiency. The standard clearance is 8 to 15 mm (0.3 to 0.6 in.).

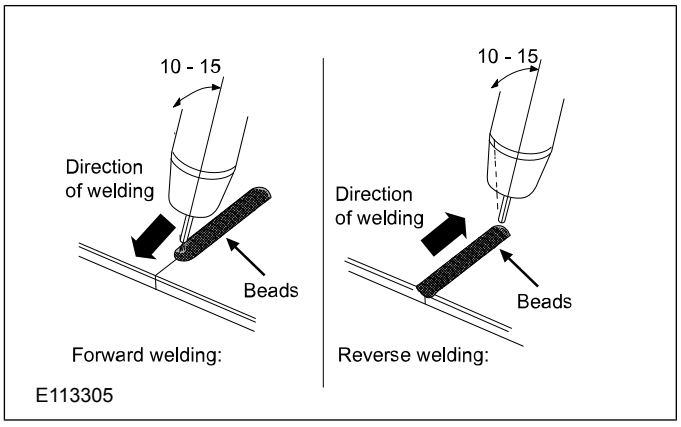


Torch Angle and Direction of Welding

The welding techniques are called forward welding and reverse welding, describing the direction the torch is being moved while welding.

In forward welding, the depth of fusion is small and the beads become flat. In the reverse welding, the depth of fusion becomes large and the beads rise.

The torch angle, 10 to 15° is the same for forward welding or reverse welding.



Shield Gas Volume

A larger quantity of shield gas dose not always ensure good shield effects. If excessive, the flow of gas will be disturbed, reducing the shield effects.

The gas supply has to be regulated depending on the nozzle-to-work clearance, welding current, welding speed and presence of wind at work area. The standard flow rate is 10 to 15 liters per minute.

Welding Speed

As welding speed increases, the depth of fusion becomes small and the bead becomes narrow and rising. Further increase of welding speed will cause an undercut that weakens the weld and fusion can be insufficient. Generally speaking, welding speed must be increased for thinner panels.

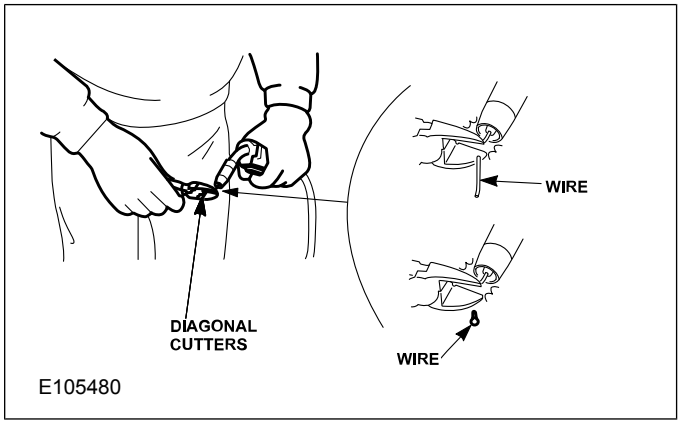
Panel Thickness mm (in)	Welding speed (cm/min)
0.8 (0.03)	105 ~ 115
1.0 (0.04)	100
1.2 (0.05)	90 ~ 100
1.6 (0.06)	80 ~ 85

Starting of Arc

1. Thoroughly remove paint or other contaminants from the area on the metal that is being welded.

2. Check the length of the projecting wire and its tip. When the protruding wire is too long or the tip of the wire is round, the arc will not start smoothly. Adjust the wire length and cut the tip with a diagonal cutters.

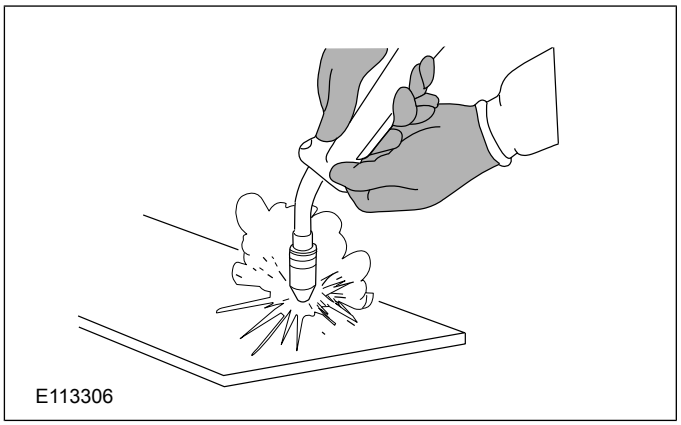
WARNING: When cutting wire, keep the torch facing down and away from your face to avoid being struck by the clipped end.



To start the arc. As you pull the trigger (torch switch), shield gas and wire will be fed out. Touch the work with the tip of the wire to start arc. By keeping the tip-to-work clearance somewhat small, the arc will start easier.

WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

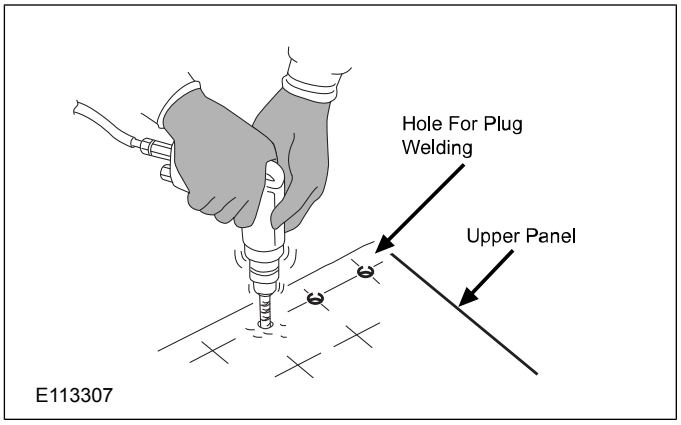
DESCRIPTION AND OPERATION


E113306

Plug Welding

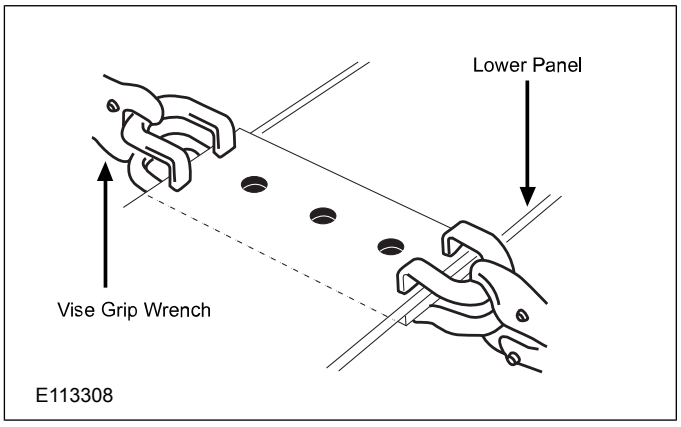
Procedures

1. Plug hole drilling. Drill a hole for plug welding in the upper work panel. To retain welding strength, the proper hole diameter must be chosen as dictated by metal thickness.



E113307

2. Clamping of work pieces. Using locking jaw pliers, hold the upper panel tightly on the lower panel. Any deformation should be corrected by forming with a ball peen hammer before welding to ensure a tight fit.

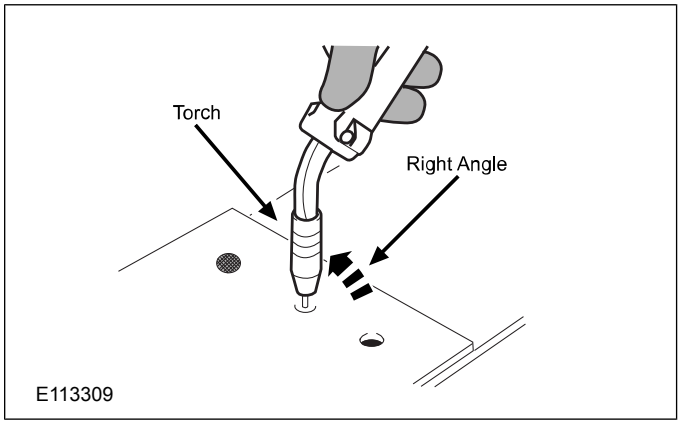


E113308

3. Welding of plug hole.

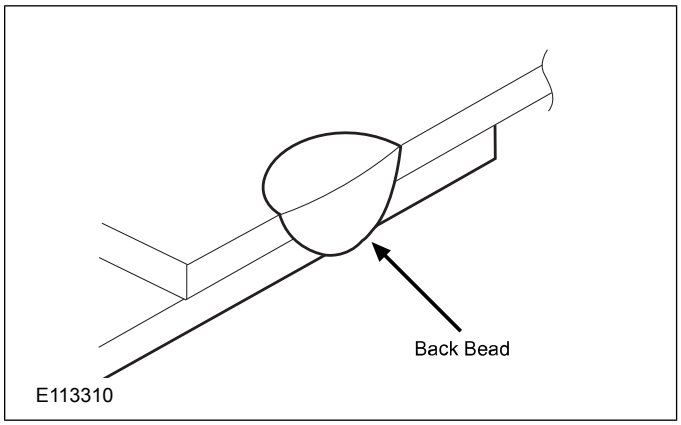
WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

- Hold the torch firmly at a right angle to the plug welding hole.
- Move the torch along the hole to weld.
- Check fusion and ensure adequate penetration of the bottom panel.
- When plug diameter is about 5mm (0.2in.), aim the torch at the center of the hole and weld without moving the torch.



E113309

4. Inspection of welded area. If the back beads (round marks) appear on the bottom panel, sufficient fusion has been achieved.



E113310

Butt Welding

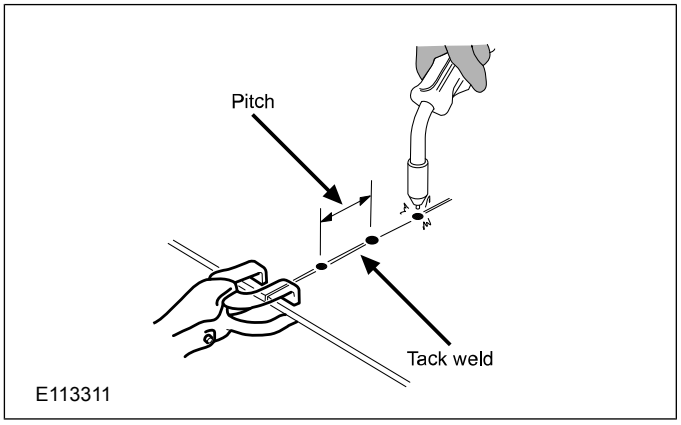
Procedures

1. Tack welding.

WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

DESCRIPTION AND OPERATION

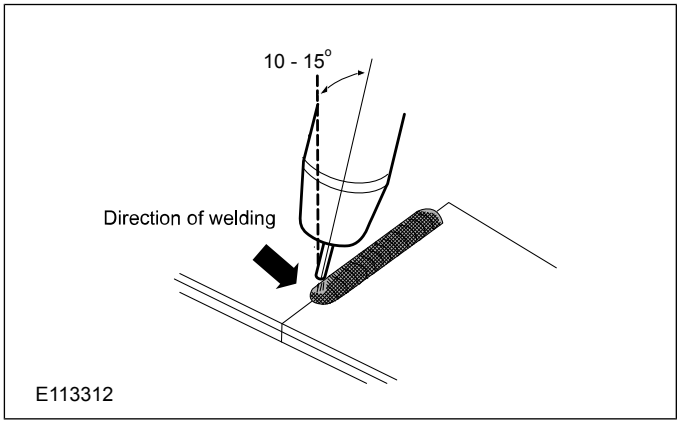
- Align ends of the work tightly against each other.
- To prevent distortion and ensure precision, make several tack welds.
- The thinner the panel, the smaller the pitch of the tack weld.



2. Main welding.

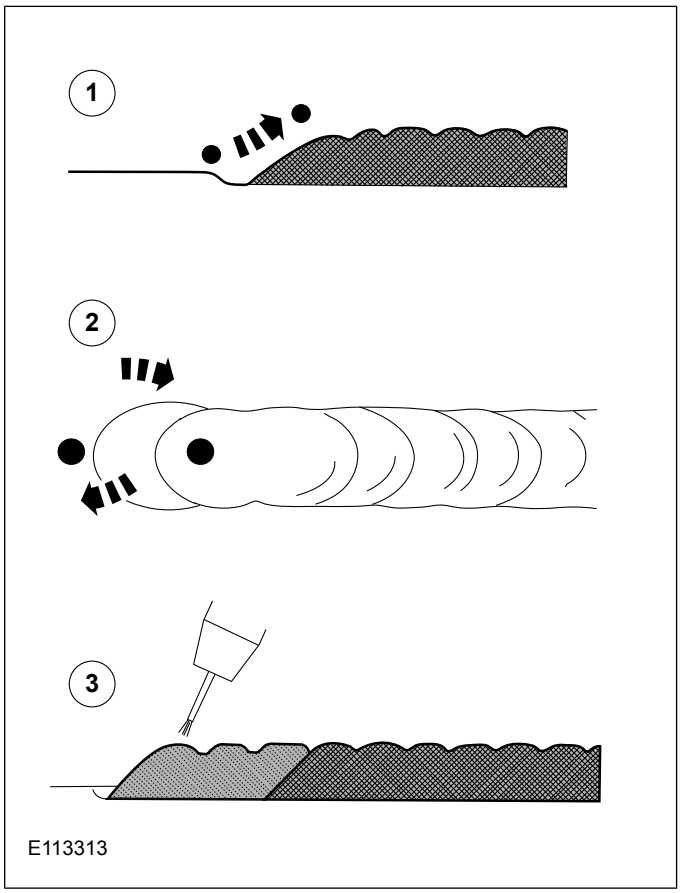
WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

- Tilt the torch 10 to 15° and use the forward welding method to weld along the mating line.
- To prevent an unsteady hand while welding, place yourself in a comfortable and supported position to help maintain the correct tip-to-work clearance and torch angle.
- Move the torch at a steady speed while confirming the conditions of fusion.
- When welding thin panels, such as an outer panel, move ahead with the forward welding, and weld in spaced segments to prevent a blow hole.



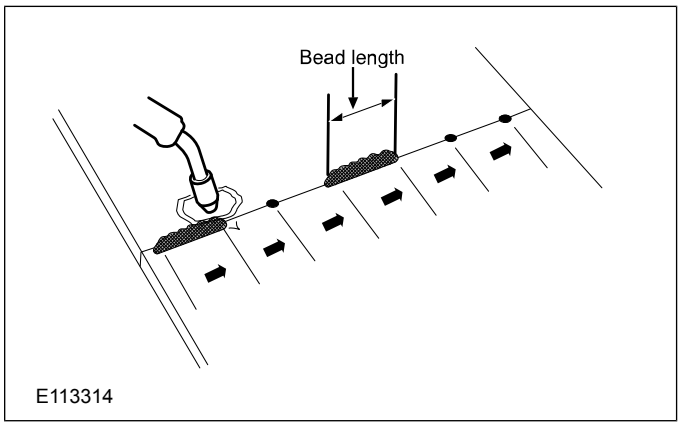
3. Restarting of beads.

- If the butt weld is long, the beads have to be completed in several segments.
- Start arc slightly near the end of the previous bead (1), and immediately move the torch onto the end of existing beads (2), and weld while maintaining steady bead width and height (3).



4. Preventing distortion in weld material.

- To reduce distortion, allow heat in the work to be dispersed as much as possible.
- Usually, weld from the center of the area or from the center toward the outside of the joint. Thinner panels will distort more than thicker panels.
- For thin panels, keep the beads short.



DESCRIPTION AND OPERATION

5. Inspection of weld area.

Metal Inert Gas (MIG) welding

General Information

Due to the high heat conductivity of alloy, the heat generated from the electric current and contact resistance dissipates quickly. This makes spot welding unsuitable for repair of aluminum panels. To spot-weld aluminum alloy, an extremely strong current of well over ten thousand amperes is required. For that reason, “MIG” welding must be used to weld an aluminum alloy automobile body.

Comparison of spot welding for aluminum alloy and steel plate:

Material	Thickness mm (in)	Current (Amp)
Aluminium Alloy	1.2 (0.05)	About 26,000
Steel Panel	1.2 (0.05)	About 9,300

MIG welding (Metal Inert Gas Arc Welding):

This welding method is of a consumable electrode type in that the welding wire serves as the electrode. The inert gas and the wire are automatically fed through the torch. The arc occurring between the electrode wire and the work piece heats the work pieces and wire, which melt and fuse together.

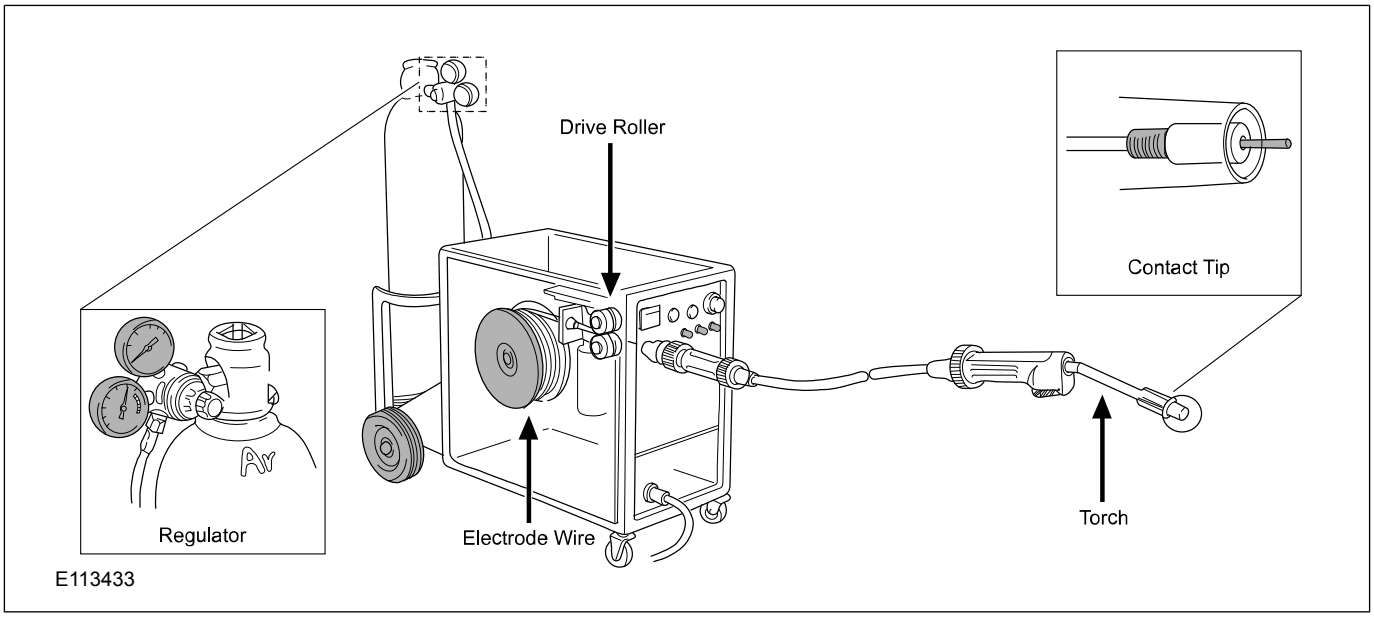
In ordinary gas-shield arc welding, carbon dioxide or a mixture of carbon dioxide and argon is used as the inert gas. While a true inert gas is inactive, carbon dioxide is not completely inactive. For that reason, carbon-dioxide gas-shield welding is more accurately called Metal Active Gas Arc Welding (MAG welding).

Welding Equipment

The welder must provide a maximum current of approximately 200 A and allow changes of welding techniques. It should allow welding of both aluminum alloy and steel by replacing attachments, gas bottles and resetting controls as recommended by the welder manufacturer.

Welding panels as thin as 1.6 to 3.0 mm (0.07 to 0,12 in.) is possible if the operator is a skilled welder. Some newly introduced equipment allows welding of panels of less than 1 mm (0.04 in.) thickness.

NOTE: For details on correct welding current and voltage, refer to equipment manufacturer’s recommendations.



Electrode Wire (Fuse Material)

Select appropriate electrode wire which results in the desired qualities of the finished weld (strength, toughness, corrosion resistance, etc.).

The electrode wire for Honda’s aluminum alloy vehicle body should be of “A5356WY” material, with a diameter of 0.8 to 1.2 mm (0.03 to 0.05 in.) depending on the thickness of the work.

Shield Gas

100 % argon gas shall be used.

DESCRIPTION AND OPERATION

Reference data of welding parameters:

Thick-ness	Wire Dia	Current	Voltage	Gas flow
1.6	0.8	50 ~ 70	10 ~ 11	15 ~ 18
2.0	0.9 ~ 1.0	60 ~ 110	12 ~ 15	15 ~ 18
2.5	0.9 ~ 1.2	80 ~ 120	13 ~ 16	17 ~ 20
3.0	0.9 ~ 1.2	100 ~ 140	15 ~ 18	17 ~ 20
5.0	0.9 ~ 1.2	120 ~ 170	17 ~ 20	10 ~ 20

Notes of MIG Welding

The welding parameters have to be set correctly and adjusted precisely during welding because the allowable thickness range is rather limited compared to the welding of steel panels.

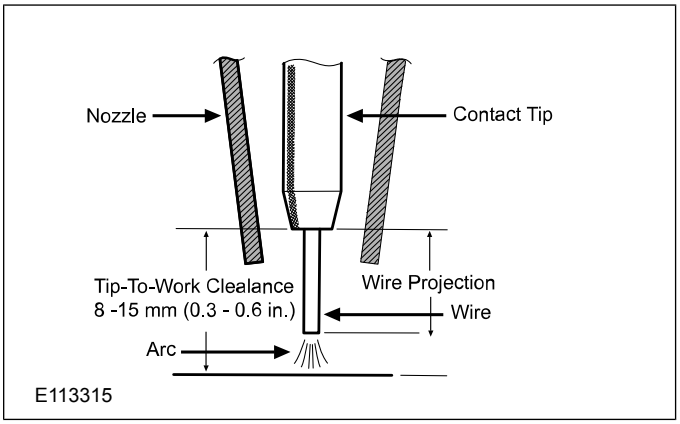
Compared to welding of steel panels, about 50% more shield gas is required.

When inserting the welding wire into the feed mechanism, remove any burrs from the tip of the wire with emery paper and push the wire through the torch by hand. Care should be taken to avoid damaging the teflon inner liner of the cable.

The tension on the wire drive roller must be adjusted lower than when welding with steel wire. Hold the wire lightly at the contact tip and adjust the tension to allow slippage of the wire at the drive roller when the torch switch is turned on. If the drive roller tension is excessive, the wire can become jammed. If tension is insufficient, the wire speed will become inconsistent.

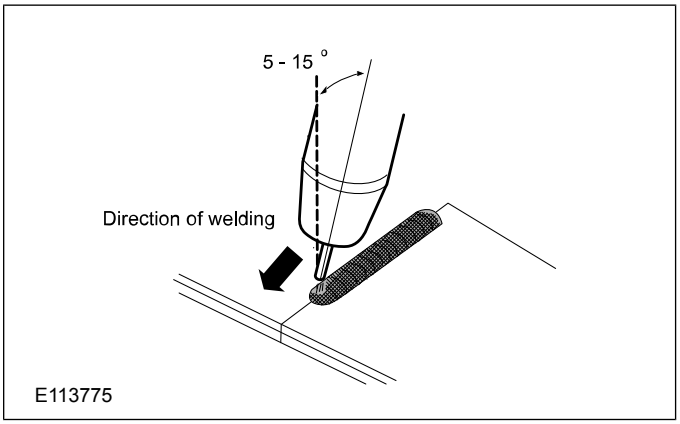
The wire feed speed is typically higher than when welding steel panels.

The tip-to work clearance should be the same as when welding steel panels. The torch angle, however, must be at a right angle to the work surface.



Forward welding:

Use forward welding technique. Keep the torch more upright (5 to 15°) against the direction of travel than when welding steel panels.



The arc sounds from aluminum welding should be soft, continuous humming like those from welding of steel panels. The welding speed is considerably faster than welding steel panels and since the aluminum wire contains magnesium, a small amount of soot occurs along MIG welding beads.

WARNINGS:

To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

Small pieces of aluminum alloy are spattered by MIG welding can be projected over considerable distances. It is therefore important to provide protection not only for the welder operators themselves but also anyone in the surrounding areas.

Spatter tends to stick on the torch nozzle, the end of the contact tip and can obstruct the proper flow of shield gas causing welding defects. Remove the torch nozzle and clean thoroughly then apply a sticking inhibitor agent.

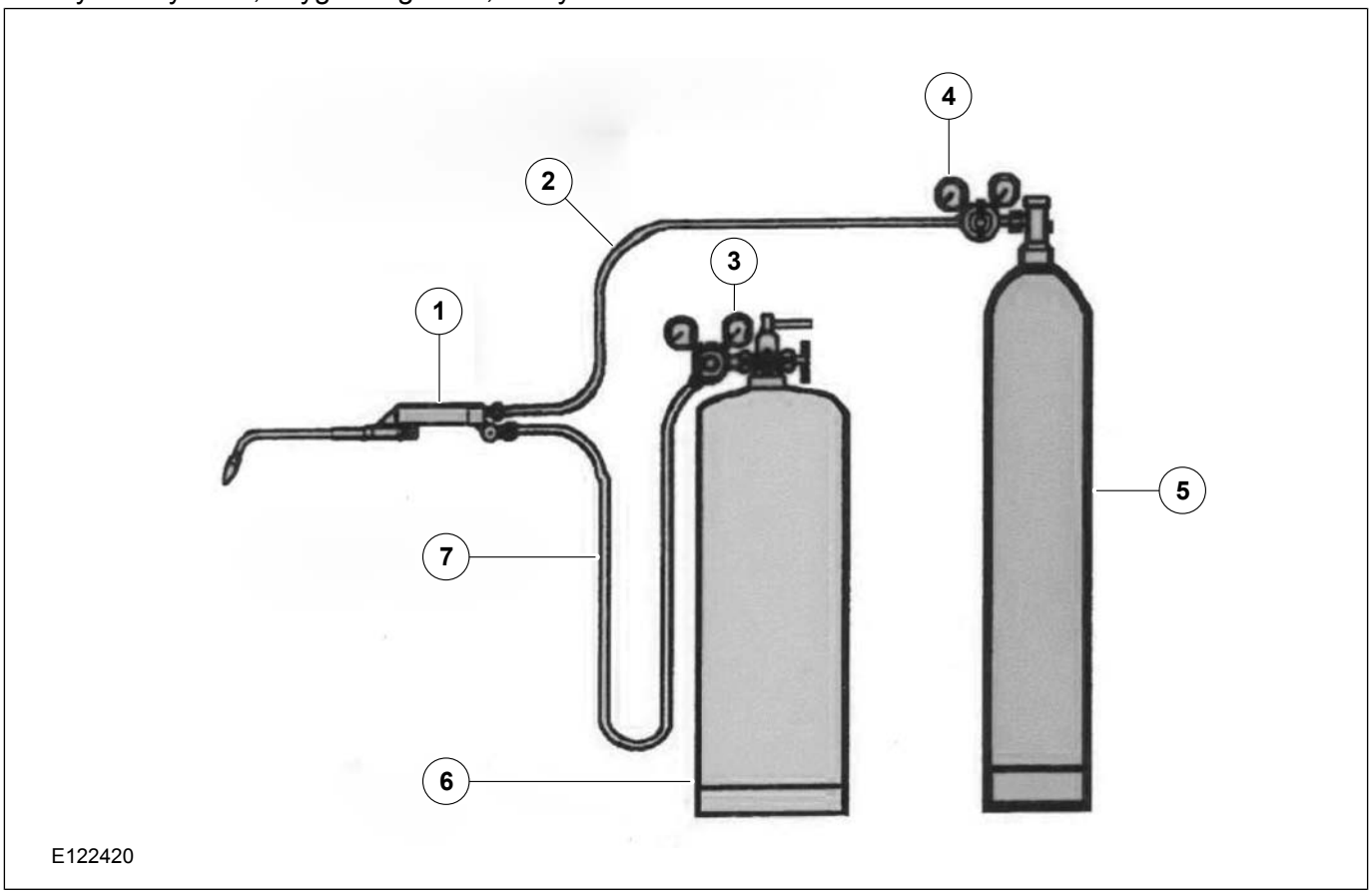
DESCRIPTION AND OPERATION

The torch nozzle and the contact tip wear more rapidly than when welding steel panels.

Oxyacetylene Gas Welding

Welding Equipment

A gas welding outfit consists of the oxygen cylinder, acetylene cylinder, oxygen regulator, acetylene regulator and torch with its hoses. For safety, anti-flashback (check) valves should be fitted between the hose ends and torch. Should a backfire occur in the torch, such check valves prevent an internal fire from going through the hose to the regulators and bottles where it could cause an explosion.



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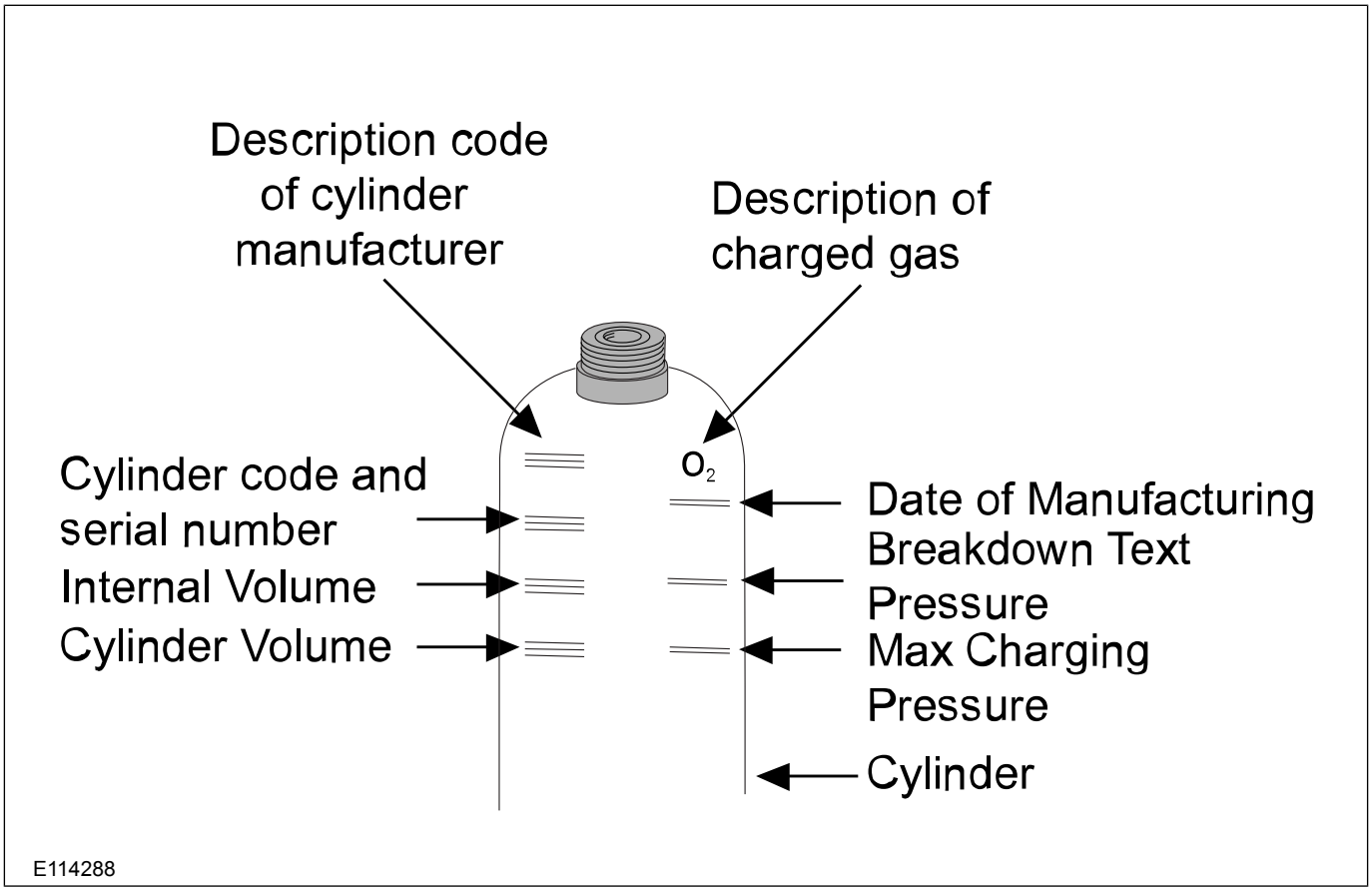
Item	Description
1	Torch
2	Oxygen Hose
3	Acetylene Gas Regulator
4	Oxygen Regulator
5	Oxygen Cylinder
6	Dissolved Acetylene Cylinder
7	Acetylene Gas Hose

Oxygen and Oxygen Cylinder

Oxygen (O2) is a colorless, odorless gas that is 1.1 times heavier than air. Oxygen is chemically active and combines with most matter except inert gases, gold, platinum, etc. and produces oxides. This rapid oxidation produces light and heat, which is called combustion. Although oxygen itself does not burn, it assists burning of other material and often called the “supporter of combustion”. While there are several ways of producing oxygen, industrial welding oxygen is produced by fractionating the liquefied air made by compressing air at low temperatures.

The oxygen cylinder is a thick steel reservoir tested to a pressure as high as 19600 kPa (200 kgf/cm2). A safety device “works at 19600 kPa (200 kgf/cm2)” in the valve neck of the cylinder and helps prevent rupture if the internal pressure becomes excessive. The oxygen is compressed to 14700 kPa (150 kgf/cm2) 95°F (35°C) and charged into the cylinder. An oxygen cylinder is painted black to indicate that the content is oxygen along with stamped O2 mark on the shoulder of the cylinder. (Note: The color

codes of the gas cylinder may be different depending on the regulation of the country. Check standards in your country.)



Acetylene and Solution Acetylene

Acetylene gas (C2H2) is not a single element. It is a hydrocarbon, composed of carbon and hydrogen, generally produced by mixing carbide with water. Pure acetylene gas is colorless, has a slight aroma, and is lighter than air (specific gravity: 0.91). Due to the high carbon content, acetylene gas burns with a red flame and produces soot. When oxygen is supplied, however, the flame become blue and the temperature rises as high as 5432°F (3000°C). Devoid of air or oxygen, acetylene is stable under normal temperatures/pressures but easily decomposes and can explode when slightly heated, compressed or subjected to an impact. Generally, the risk of explosion becomes likely from about 150 kPa (1.5 kgf/cm2) and explosion is inevitable above 200 kPa (2 kgf/cm2)*. If acetylene comes in contact with copper, silver, etc., the highly explosive compounds such as acetylene-copper or acetylene-silver will be produced.

Acetylene dissolves easily in acetone (CH2COCH3), DMF (HCON [CH3] 2), N,N-dimethylformamide, etc. As the solution acetylene is not explosive, acetylene is charged into a steel cylinder in which porous material such as calcium carbonate, charcoal, asbestos, etc. is filled, and stores acetylene dissolved in acetone or DMF. The charge pressure is regulated to under 1520 kPa (15.5 kgf/cm2) at 59°F (15°C). The cylinder is painted brown with a mark (C2H2) inscribed on the shoulder.

A decomposing explosion can take place without external oxygen because heat occurs when decomposing and the heat causes volumetric expansion. Under certain conditions, the risk of explosion starts from 150 kPa (1.5 kgf/ cm2).

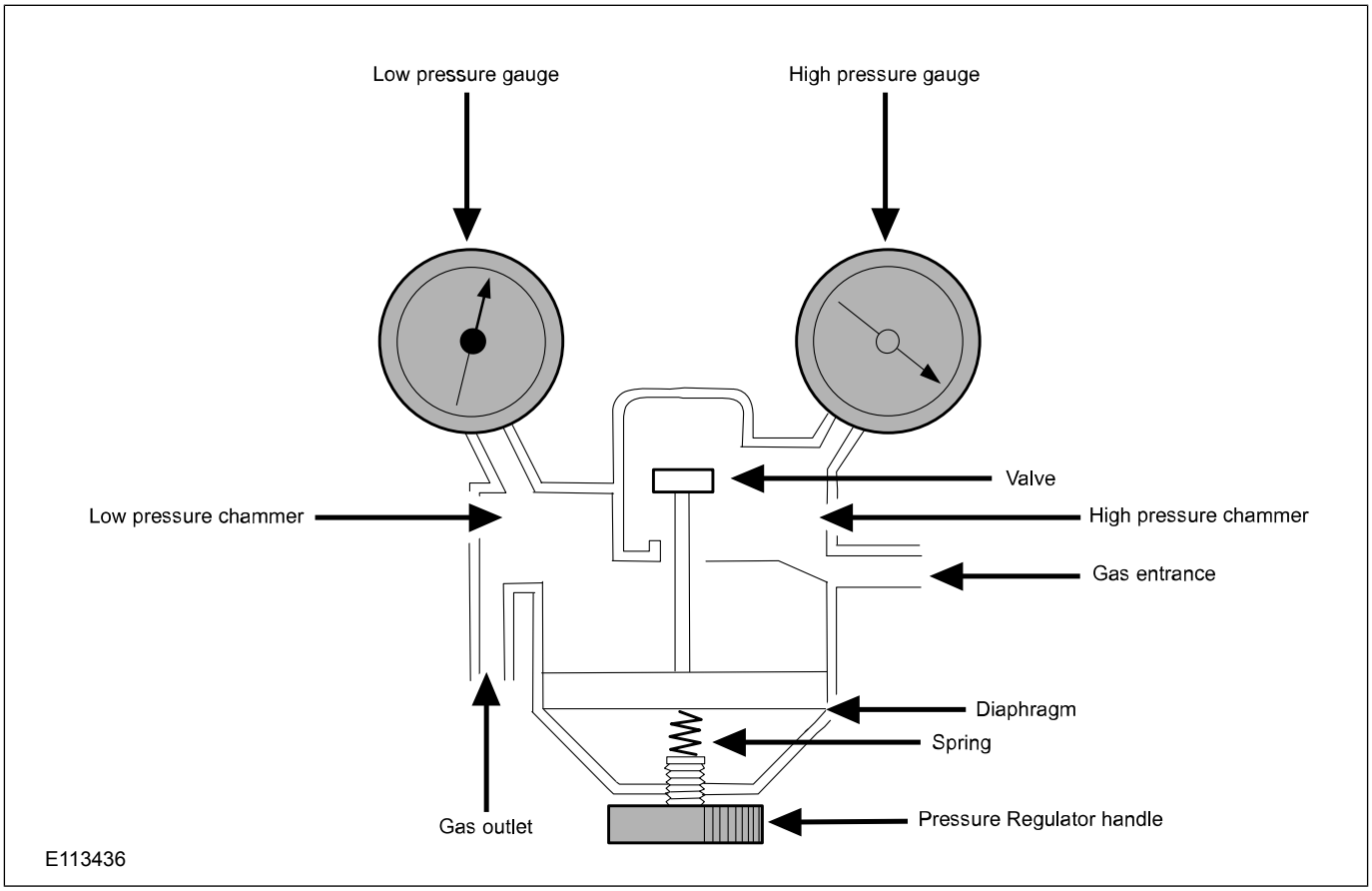
Regulator

The oxygen or acetylene charged in a cylinder is pressurized higher than the pressure required for welding. As gas is consumed, cylinder pressure drops but the regulator keeps “at torch” pressure at the appropriate level to ensure consistent welding.

The regulator consists of the high pressure gauge, low pressure gauge, regulator handle, spring, diaphragm, and valve. The high pressure gauge indicates the cylinder pressure while the low pressure gauge indicates the regulated pressure. The spring, diaphragm and valve keep the

DESCRIPTION AND OPERATION

regulated pressure constant. The pressure is adjusted to the desired level using the regulator handle.



Torch

The torch mixes oxygen and acetylene at an appropriate ratio to produce the correct flame for the application. It is also called the blowpipe. Torches are roughly classified as welding torch, cutting torch, and further classified as low pressure torch, medium pressure torch, etc.

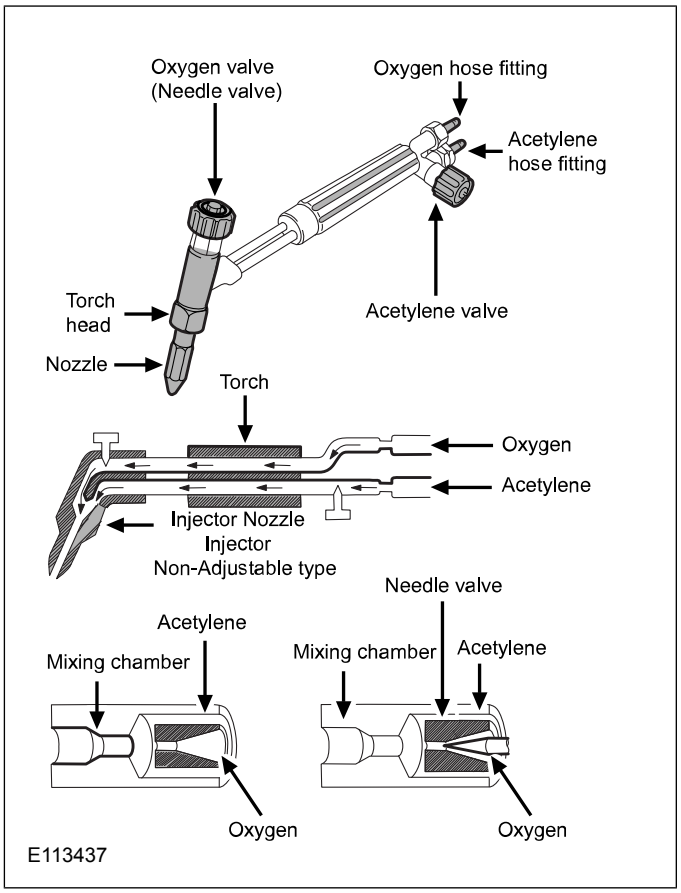
Welding Torch

Torches generally used for welding are the low pressure type which can operate at low acetylene pressure. In the torch, the stream of oxygen draws acetylene from the center of the injector nozzle to produce the mixture.

A torch with a pressure-regulated, needle valve at the injector nozzle is called a “variable pressure” torch or French torch. Torches without a regulating device at the injector nozzle are a “non-adjustable” torch or German torch.

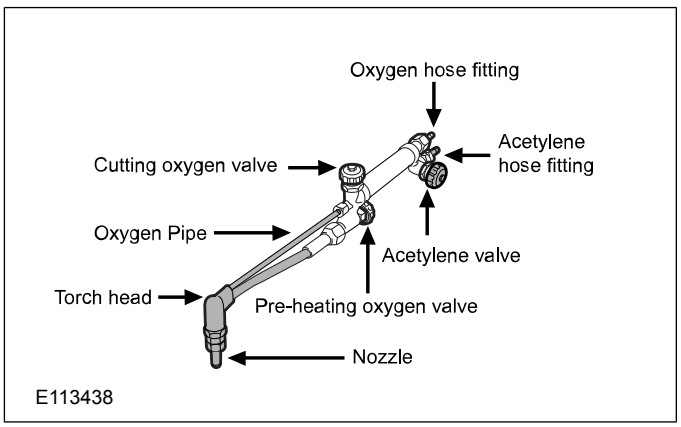
The flame size is increased or decreased by changing the nozzle. The size of the nozzle is identified by acetyleneper- hour (French torch) number or thickness of steel plate weldable (in millimeters) with that nozzle (German torch).

DESCRIPTION AND OPERATION



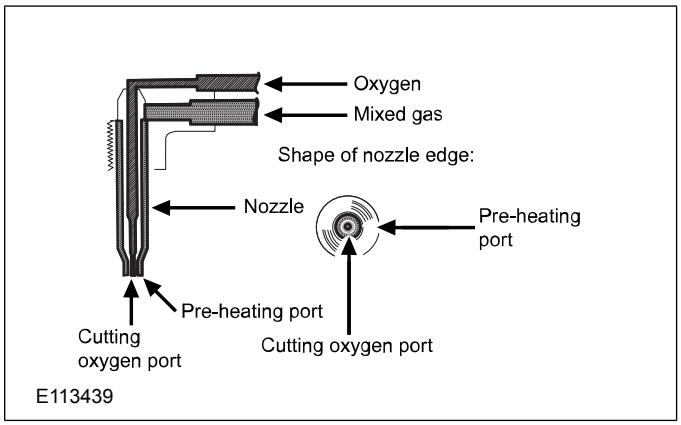
Cutting Torch

The cutting torch has an additional oxygen pipe and a valve to direct high-pressure oxygen to nozzle.



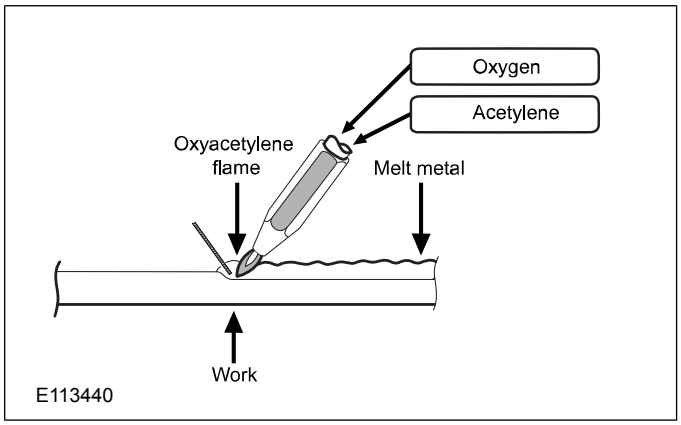
The nozzle's center point is for oxygen supply while the surrounding port is for preheating the steel prior to cutting.

Cross section of nozzle:



Principles

Gas welding mixes acetylene gas with oxygen to create a high temperature about 5432°F (3000°C) flame that melts the edges of the area to be welded then joins them with welding rod. Due to the difficulty of containing its heat in a small area, gas welding heats a wide area and reduces the strength of steel panels and for that reason, gas welding is not used during mass-production or to repair body damage. However, since gas welding allows easy adjustment of flame and heat application, it is used to heat a body panel for correcting position, to cut off a part of the panel, and for brazing.



Type of Flame

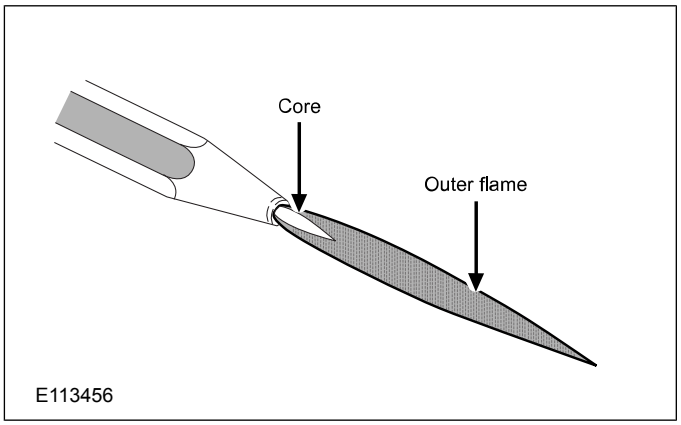
When acetylene and oxygen are mixed and burning, the flame changes depending on the amount of oxygen supplied. Depending on the mixing rate, the flames are classifies into the following three types.

Neutral Flame

The neutral flame is also called the standard flame. It is attained when acetylene and oxygen are mixed 1 to 1 (volume rate) and ignited. This flame consists

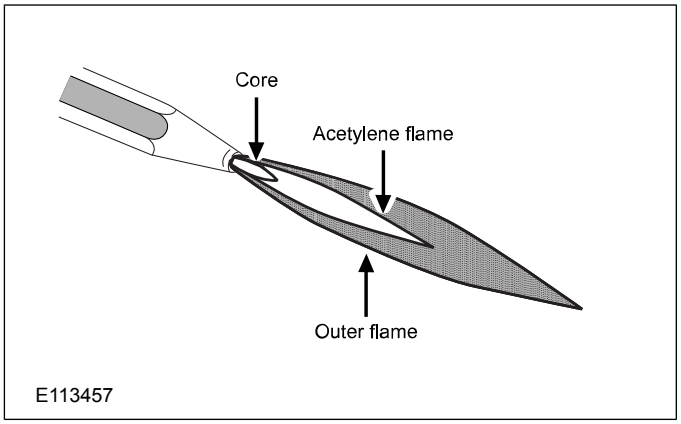
DESCRIPTION AND OPERATION

of the core (also called white cone), which is the bright whitish part in the center, and the surrounding transparent blue flame called the outer flame (also called secondary flame). The neutral flame is used for welding of most metals such as mild steel.



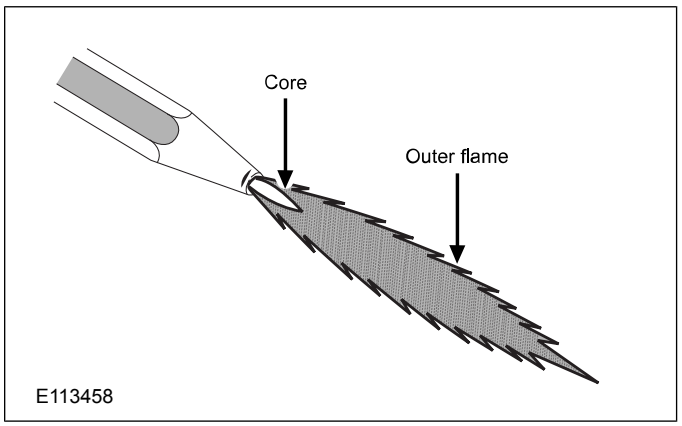
Carbide Flame

The carbide flame is also called the acetylene-rich flame or the reducing flame, and contains slightly more acetylene than oxygen. Unlike the neutral flame, the carbide flame consists of three pats: core, outer flame, and middle acetylene cone surrounding the core. The length of the acetylene cone varies depending on the richness of acetylene in the mixture. When the length of the acetylene cone is two times of the core, it is called the “double acetylene flame”, when three times more, it is called the “triple acetylene flame”. The mixing rate of oxygen and acetylene is about 1 to 1.4 (volume rate) in the case of the double acetylene flame. The carbide flame is used for welding aluminum, nickel, nickel alloy, etc.



Oxidizing Flame

When there is more oxygen than acetylene, an oxidizing flame is formed. While the oxidizing flame appears similar to the neutral flame, the core is short and purplish compared to the neutral flame, and the outer flame is short and flashing. The oxidizing flame is used for oxidizing melted metal, welding of brass, bronze, etc., but not used for welding mild steel.



Flame Adjustment for Welding

WARNING: To prevent eye injury and burns when welding, wear an approved welding helmet, gloves, and safety shoes.

1. Attach a nozzle suitable for the work (standard: Nozzle number 100R/h per 1 mm (0.04 in.) of work panel thickness) to the torch.

2. Adjust the oxygen and acetylene pressure.

- Oxygen pressure: 100 to 500 kPa (1 to 5 kgf/cm2)
- Acetylene pressure: 10 to 30 kPa (0.1 to 0.3 kgf/cm2)

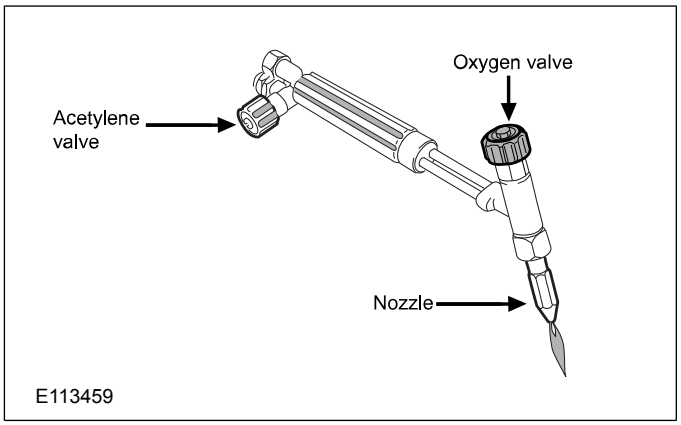
3. First open the acetylene valve on the torch about 1/2 turn, then open the oxygen valve slightly and ignite at nozzle.

4. The acetylene will burn red and as you open the oxygen valve the flame will gradually turn blue and become a carbide flame.

5. As you keep increasing oxygen, the acetylene cone will become small, and becomes a neutral flame.

6. To make an oxidizing flame, open the oxygen valve further or reduce acetylene.

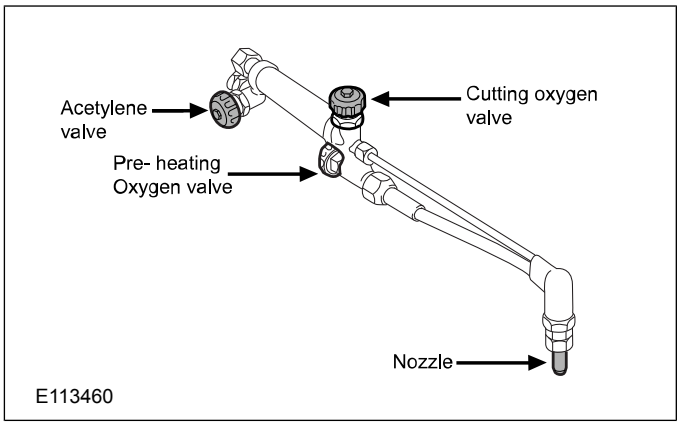
DESCRIPTION AND OPERATION



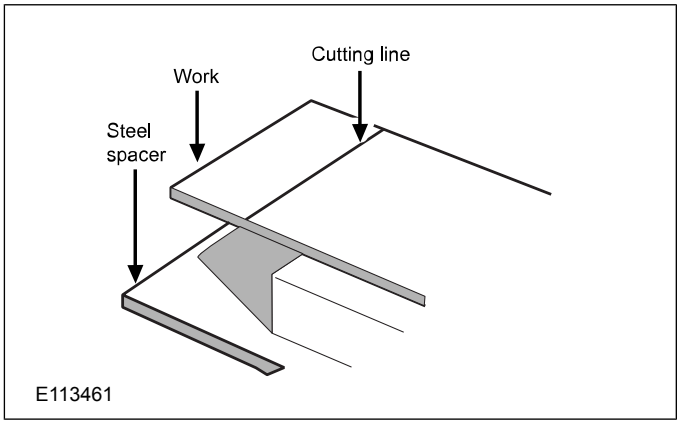
Flame Adjustment for Cutting

WARNING: To prevent eye injury and burns when heating, wear an approved welding helmet, gloves, and safety shoes.

Steel is cut by first preheating the metal to combustion temperature, then the metal burns and starts to melt, and at this point the additional stream of high-pressure oxygen is used to cut though the metal.

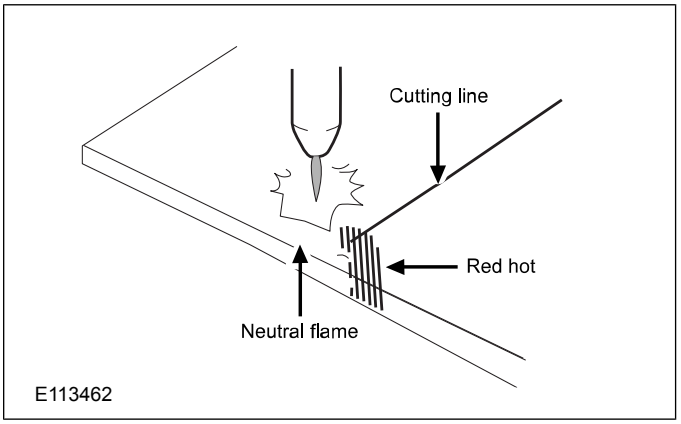


1. Place the work flat but raised slightly on steel spacers (scrap metal) to create an open space under the cutting line. To prevent accidental fires, it is best to place a sheet of scrap steel below the work to be cut.



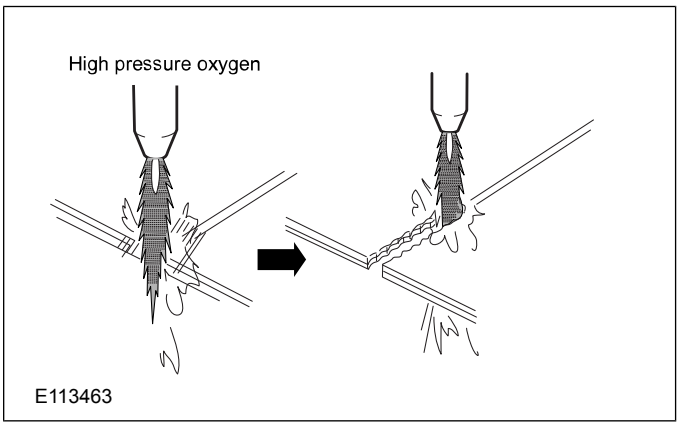
2. Adjust the acetylene valve and the preheating oxygen valve to make a neutral flame.

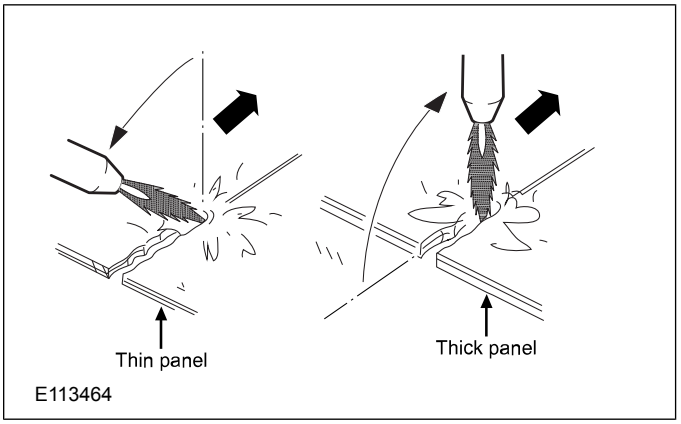
3. Preheat the end of the cutting line with the neutral flame until the work becomes red hot.



4. As the work becomes red hot, quickly open the cutting oxygen valve, discharging high-pressure oxygen to cut along the desired line.

- Maintain a constant clearance between the work and the torch and move the torch while confirming that the work is cut properly.
- When cutting relatively thick panel such as the side frame, keep the torch at a right angle. To cut a thin panel like the outer panel, keep the torch tilted.





DESCRIPTION AND OPERATION

Welding

Before welding work is performed on a vehicle body, all safety measures for the protection of people, modules and electrical components must be observed.

NOTE: Before beginning the work, please refer to the safety instructions and warnings in the chapter Safety Instructions. Please also note the warnings of the respective equipment manufacturer.

In body construction, the main type of welding used is resistance spot welding. In the course of repair work, this must be restored accordingly.

However, there are also fields of application for MIG welds.

MIG welding

Fields of application

- Any joins that are MIG welded in production must also be replaced by MIG welds.
- Puddle welding may be used in certain cases, if there is insufficient access.
- If the overall panel thickness is greater than 3 mm, without correspondingly powerful spot welding equipment, puddle welding should be used.
- At present, MIG brazes must still be replaced by MIG welds. See chapter MIG Brazing.

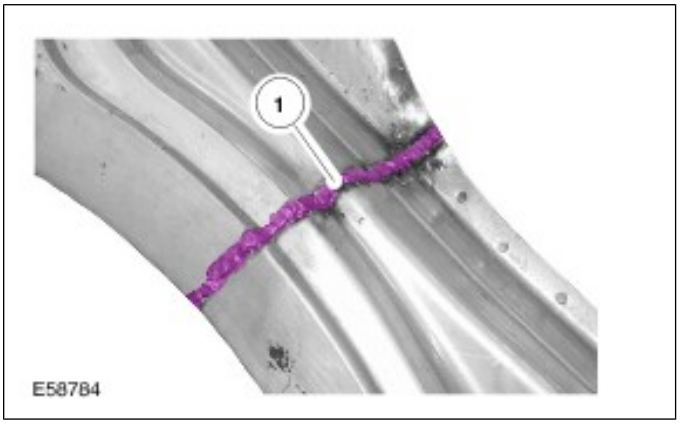
NOTE: The increased application of heat during MIG welding destroys the corrosion protection layers over a much larger area than during resistance spot welding. For this reason, greater care must be taken when applying the corrosion protection afterwards.

Welding repairs can only be carried out properly if the equipment is set up correctly and all welding-related preparations are complied with accurately.

- Please note the instructions of the respective welding equipment manufacturer.
- The hose assembly must be untwisted.
- The core must be free of abraded rod particles.
- The gas and current nozzles must be free of slag and scale residue.
- Pay attention to the quality of the welding rod and the throughput of gas.
- Ensure that the joint surface is perfect.
- Prepare a bare metal joint surface.
- Maintain the correct gaps (root formation).
- Produce a test weld.

Full seam

A welded joint with a full seam is suitable for joining highly profiled body parts. Pillar and sill areas are typical application areas.



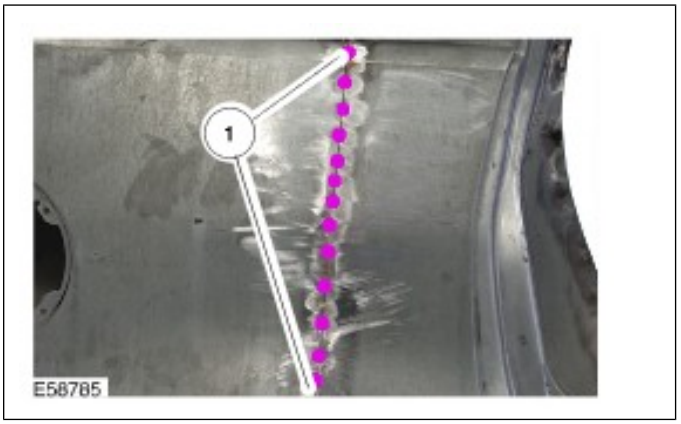
Item	Description
1	Full seam

Before the welding process, you must carry out the following operations:

- Both parts of the panel must be bare on both sides over a width of 5 mm.
- Align the parts precisely with clamps.
- To prevent the panel from warping, tack longer joints before welding them.

Interrupted weld seam - intermittent seam

The intermittent seam is used for offset joint surfaces or for butt joints with a metal insert. This form of seam is mainly used on the external panel area for sectional repairs.



Item	Description
1	Intermittent seam

Please note the following welding parameters:

DESCRIPTION AND OPERATION

- Weld gap.
- Spot weld interval.
- Apply alternate tack welding across the entire length of the seam. This keeps warping to a minimum.

Puddle weld.

Puddle welding is used as a substitute if no spot welding equipment that is sufficiently powerful for the thickness of the panel is available. This welding method is also used if the welding position cannot be accessed with a spot welding gun.

NOTE: A test weld should always be carried out to ensure that the welded joint is not just a surface connection.

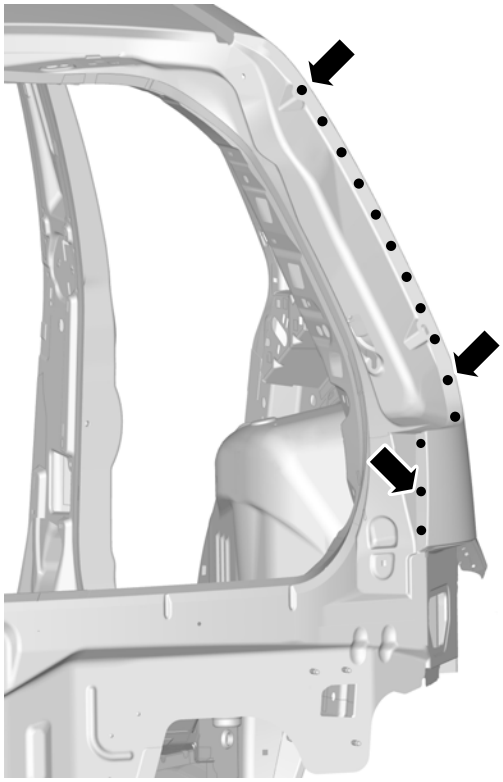
Please note the following welding parameters:

- The panels to be joined must lie perfectly flat to one another.
- The panel flanges must be bare at the welding position. Treat other areas with corrosion protection.
- Prepare the holes depending on the thickness and number of the panels. The hole size should be 6-10 mm, or match the original weld spot.
- Start the welding procedure on the panel at the bottom so that the hole is filled completely.

Resistance spot welding.

The basic principle for repair welds is to restore the original welded joint as far as possible.

NOTE: Before starting the work, please refer to the chapter on safety instructions.



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The repair welds must have the same number of weld spots as the welds used in production with the correct diameters.

This requires that:

- The panels to be welded overlap.
- The weld spot is accessible on both sides for the electrodes.
- The shape and alignment of the weld electrodes is correct.
- The resistance welding equipment is powerful enough to reproduce the spot weld diameter used in production.

NOTE: The welding equipment settings and the adjustment of the individual parameters are to be made in accordance with the device manufacturer's specifications.

Well-prepared welding flanges are a prerequisite for a problem-free welded joint. This means:

- The welding flanges must lie perfectly flat to one another.
- The welding flanges must be clean and free of oil or grease on both sides.
- Welding primer (zinc-coated and conductive) must be applied as corrosion prevention.

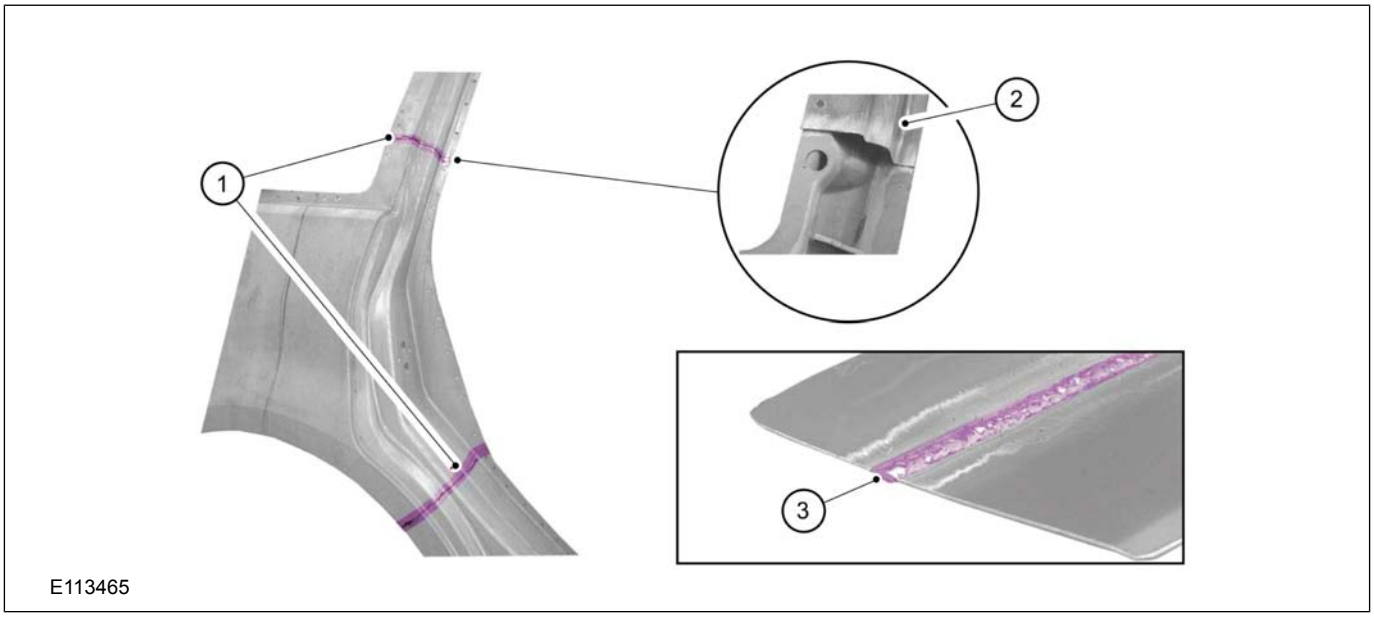
DESCRIPTION AND OPERATION

Only in limited cases can welding errors in resistance spot weld joints be detected from the outside . Therefore, a test weld should be carried out before each repair weld. The peel test carried out after the welding gives information on the quality of the welding. The spot weld must not flake off.

Joining techniques

Butt joints

The butt joint is a joining technique frequently used in body repairs. The butt joint is typically used for repairs in the pillar and rocker panel area.



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Item	Description
1	Join areas
2	Profile
3	Full seam

Areas that are suitable for the use of the butt joint:

- short seam lengths.
- highly profiled structures.
- mostly thin panel thicknesses.

The edges of the panels to be joined are placed against each other and are joined with a full seam in whilst maintaining a required welding gap (welding gap same as panel thickness).

NOTE: The butt joint requires a high degree of accuracy and care when trimming and cutting. For correct execution of the welding, an exact, even welding gap must be maintained.

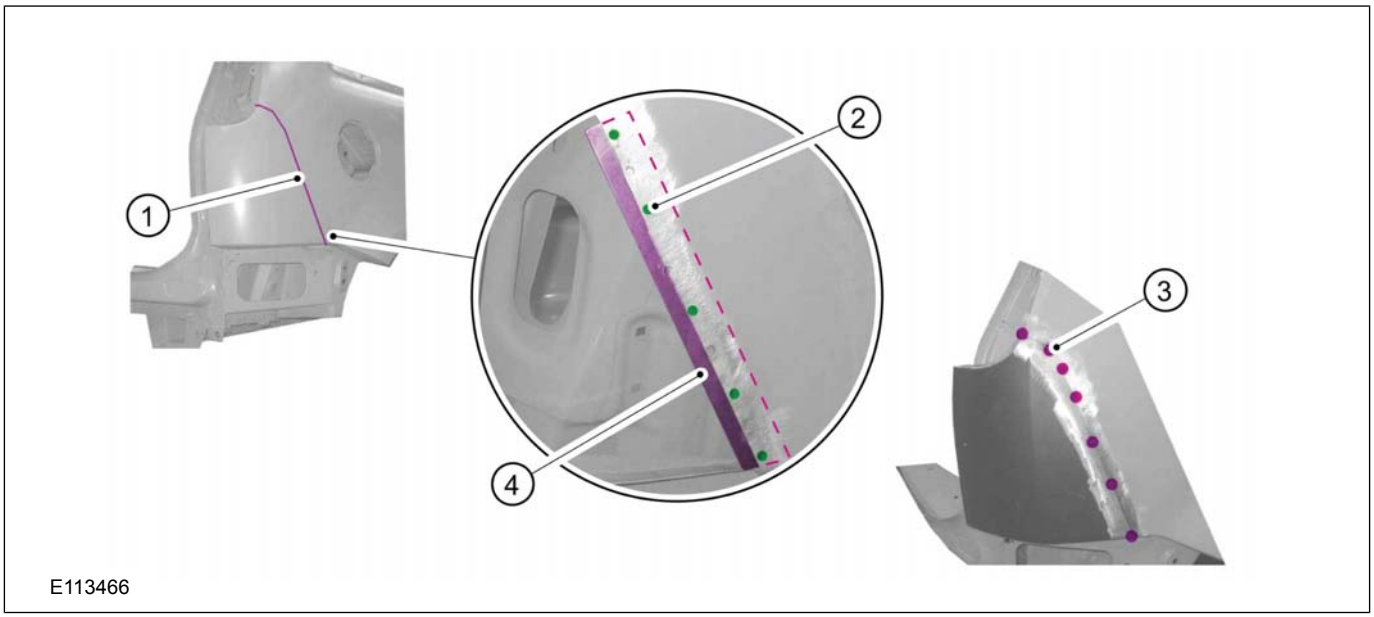
Preparation of the joint areas includes:

- Sanding the connection areas bare on both sides.
- Removal of the zinc layer in the welding area.
- Carrying out welding tests on an equivalent sample panel before the actual welding, if necessary.
- Tack welding in the join area: From the edges to the centre, then check the shape.
- Joining new and old parts with a full seam weld.

Butt joint with panel strip

As with the butt joint without a panel strip, the panels to be joined are pushed together, but are joined with an intermittent seam. A panel strip placed beneath the area to be joined stabilizes the welding area.

DESCRIPTION AND OPERATION



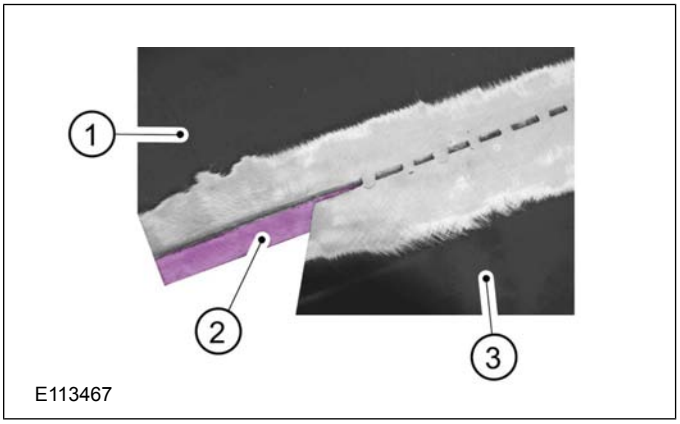
Item	Description
1	Join area
2	Tack welding
3	Spot welding
4	Panel strip

Preparation of the joint areas includes:

- Preparation of a panel strip approx. 30 mm wide.
- Grinding the joint areas and the panel strip to bare metal on both sides.
- Removal of the zinc layer in the welding area.
- Carrying out welding tests on an equivalent sample panel before the actual welding, if necessary.
- Tacking the panel strip to the old part with several resistance spot welds.
- Joining the new and old panel with an intermittent seam.
- Lead loading the weld seam.

Joggled joint

The joggled joint variant is restricted to body areas with a good surface condition without beads/swage lines or profiles. A sectional replacement with a joggled joint is welded with an intermittent seam. This procedure is used, for example, at the transition from the side panel to the rocker panel (3-door vehicles).



Item	Description
1	Body part
2	Joggled area
3	New panel

The amount of reworking required is kept to a minimum, by avoiding the use of a full seam. Other advantages are:

- Heat-induced warping caused by the welding procedure is low, as intermittent seam welding only applies a little heat.
- When cutting the new part, slight measuring tolerances are permitted, as these are covered by the joggled area.

Preparation of the joint areas includes:

- Sanding the connection areas bare on both sides.
- Removal of the zinc layer in the welding area.
- Preparation of a joggled strip.

DESCRIPTION AND OPERATION

- Carrying out welding tests on an equivalent sample panel before the actual welding, if necessary.
- Joining the new and old panel with intermittent seam welding.
- Lead loading the weld seam.

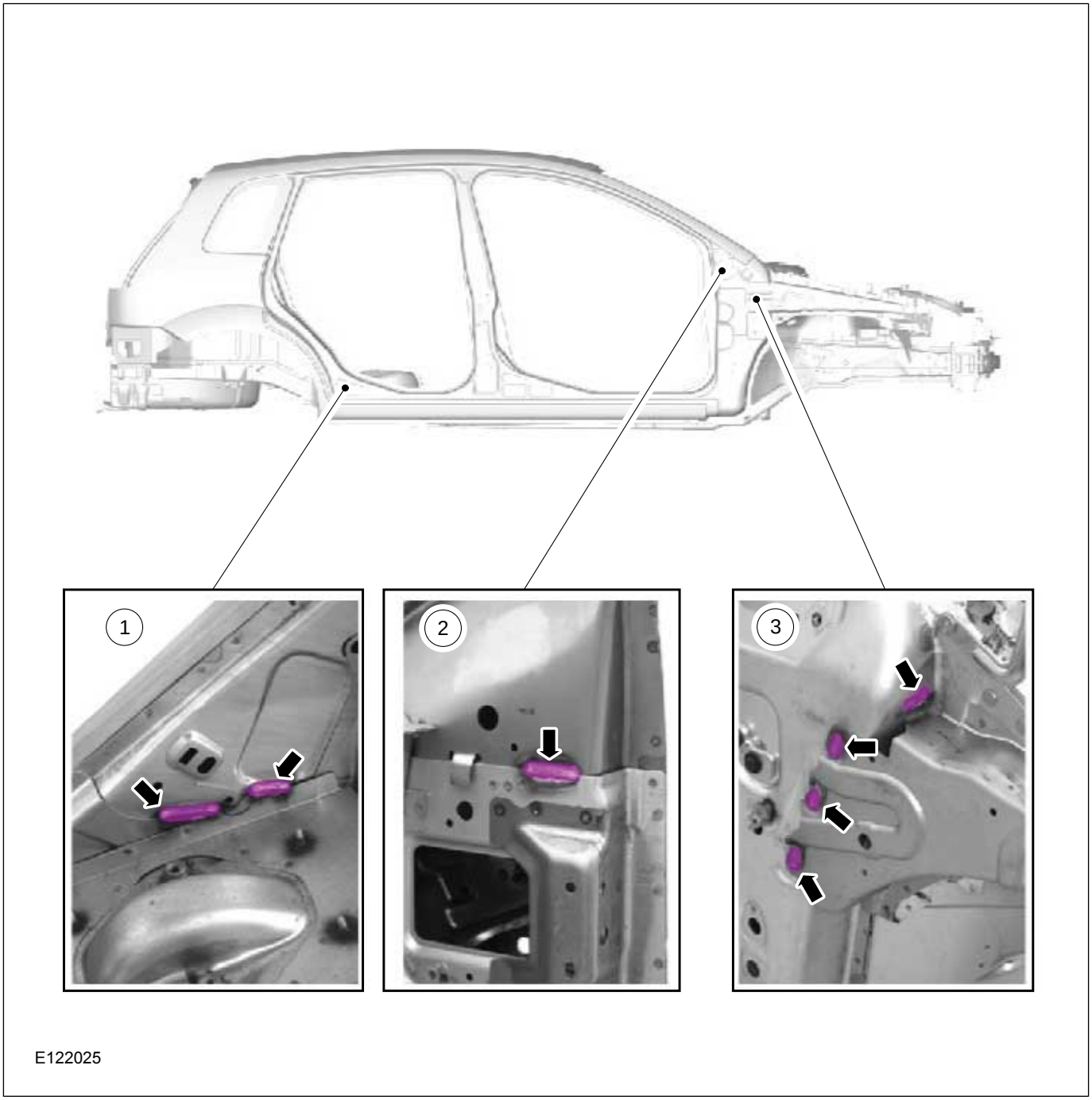
MIG brazes

Metal Inert Gas (MIG) brazing is increasingly used in production for certain body areas.

In areas in which resistance spot welding is not possible due to limited space or higher strength requirements, MIG welding was previously used.

Increasingly, these MIG welded seams are being replaced by MIG brazes.

NOTE: At the time of printing, MIG brazing has still not been approved for repair in the workshop. Please find out the current status.



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DESCRIPTION AND OPERATION

Item	Description
1	Outer wheelhouse / rocker panel reinforcement (inner)
2	A-pillar reinforcement / A-pillar inner panel (inner)
3	Bulkhead reinforcement / A-pillar (outer)

MIG brazed connections are partly used in production for the following areas: Inner fender reinforcement to A-pillar, A-pillar reinforcement to A-pillar inner panel and outer wheelhouse to rocker panel reinforcement.

The temperature range used during MIG brazing is significantly lower. This keeps the damage to the anti-corrosion zinc layer on zinc-coated panels to a minimum.

This results in the following advantages of the MIG brazed seam:

- No corrosion of the brazed seam.
- Low erosion of the zinc coating in the joining area.
- Minimal destruction of the coating on the reverse side of the panel.
- Low level of heating and thus little warping.
- Easy finishing of the brazed seam.
- Good for bridging gaps.

NOTE: MIG welds must not be carried out on or near existing MIG brazed seams as even the smallest amount of brazing solder can result in a reduction in the strength of the weld seam.

Alternative repair methods are specified in the model-specific body literature.

MIG brazing requires a new generation of welding equipment and training in the technique. For this reason, MIG brazed joints must be replaced by MIG welds at another place if a repair is performed.

When carrying out these repairs, the requirements in the corresponding repair instructions must be taken into consideration.

Rivets

With riveting, two or more panels are joined together using a joining element (rivet). In body construction, pop rivets and punched rivets are used.

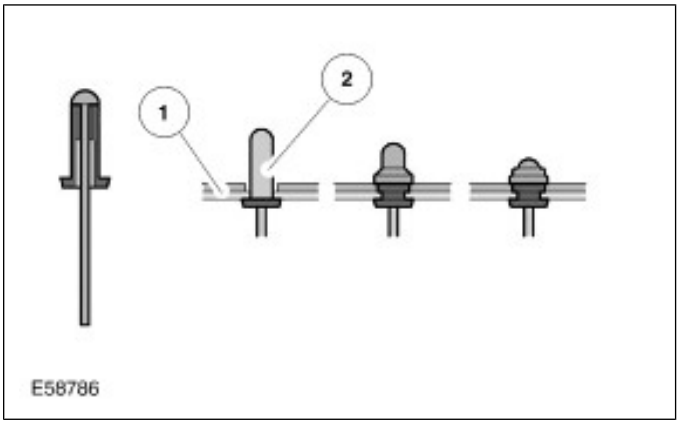
Advantages of riveted connections:

- Metallic and non-metallic materials can be joined together.
- Different thicknesses of materials can be used.
- The material does not have to be heated, and therefore does not warp.
- Low level of preparation required.

NOTE: For detailed instructions on the procedure, please refer to the equipment manufacturer's operating manual.

Disadvantage:

- During dismantling procedures, swarf/rivet remains can fall into inaccessible cavities, which can lead to rattling and rusting.



Item	Description
1	Panels
2	Pop rivet

Pop rivets are used if only one side of the panel is accessible. In this process, overlapping panels are drilled and connected with a pop rivet.

Pop rivets can be inserted pneumatically, hydraulically or manually with rivet guns.

Brazed connections

Brazing is a procedure for connecting metallic materials using a further melted metal.

The melting point of the brazing material is lower than that of the basic material. The basic material is covered with the brazing material and not melted.

As the material is heated to a lesser extent than during welding, brazing is particularly suitable for parts that are sensitive to warping, oxidization and heating. Brazing means it is possible to join together all common metals.

Brazed connections can be detached again through heating.

DESCRIPTION AND OPERATION

Brazed parts have a limited strength, low thermal resistance and a certain risk of corrosion due to the difference between the basic materials used and the brazing material (difference in potential).

NOTE: All connections that are brazed in production must also be brazed if a repair is performed.

Watertight, permanent connections must be produced at the transitions between A or C pillars and the roof. Continuous welded seams in visible areas require time-consuming finishing. For this reason, such connections are not welded, but brazed.

Brazed connections are:

- Very stable and yet elastic.
- Watertight.
- Easy in surface processing.

NOTE: Brazed connections require careful preparation. It is extremely important that the joint surfaces are exactly aligned and that a bare metal joint surface is prepared.

This means:

- Thorough cleaning of the surfaces to be brazed.
- Close contact of the panels at the brazing position.
- The connection/repair position is heated to the melting temperature of the brazing material (approx. 900° C).
- The brazing material is applied to the connection area and heated on the panel to the melting temperature.
- The liquid brazing material is drawn between the panels through capillary action.
- The materials join together at the edges of the panels (alloy formation).

Lead loading

Lead loading with tin is the best repair method for smoothing joins on sectional replacements or for rectifying small uneven areas on the panel surface. Tin has the following advantages:

- Excellent bonding on bare metal surfaces.
- Good moulding properties.
- Good properties for the production of shapes and contours.
- Permanent shape.
- Heat expansion is the same as steel.

WARNING: Brazes are metal alloys (usually lead and tin). Poisonous gases and dust can be produced during processing. Use an extraction unit and, if required, a protective mask.

NOTE: Since 07/2003, lead compounds have been ruled out for production. In the workshop too, lead-free tin solders must be used.

For correct repair, the panel is beaten out almost to the original shape and then the rest is smoothed out through lead loading. First, the panel to be lead loaded must be properly prepared.

To create a basis for the actual lead loading process, a lead loading paste is first applied to the panel. The paste is then heated and wiped away with a cloth. Now the tin can be applied and moulded with a brazing block.

After the repair site has cooled slowly, it is worked with the body plane until the surface is smooth and has no visible joints.

Bonding

Bonded connections are used more and more in modern body designs. Here, a distinction is made between bonds for stabilization purposes and bonds for adhesive strength. Bonds for stabilization purposes are found on clinched flanges and on cross beams in doors or on the roof.

WARNING: Risk of poisoning! Adhesive can be harmful to health. Ventilate rooms well and use breathing protection. Where possible, work with an extraction unit.

NOTE: Adhesives are chemical products and are subject to the safety regulations of the manufacturer.

The repair adhesive is an elastic 1K adhesive on a polyurethane basis. Bonds that rely on adhesive strength are used instead of conventional metal connections. Here, the hardening 1K epoxy resin is used.

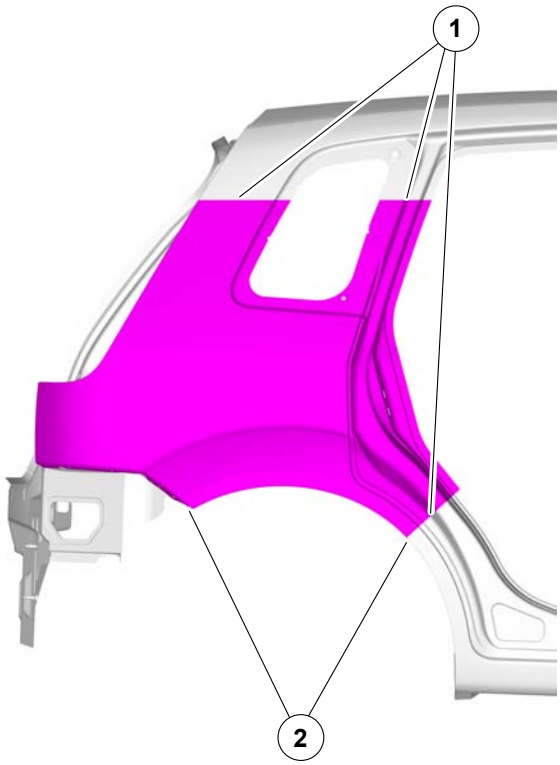
Bonded connections have the advantage over conventional connection procedures that no heating is required. This means it is not necessary to remove heat-sensitive parts, such as the fuel tank, electronic modules or plastic parts.

In addition, bonded connections have further advantages:

- They are air and watertight.
- High corrosion protection

DESCRIPTION AND OPERATION

- Different materials can be connected.
- Bonding can be combined with resistance spot welding.



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Item	Description
1	Butt joints
2	Bonded connection

NOTE: The quality of the bonded connection is largely dependent on the care taken during preparatory work.

Different adhesives are used in body repairs. Please refer to the repair instructions for the specific adhesive to be used. Please also take into consideration the instructions of the adhesive manufacturer.

Body bonding requires the following steps:

- The processing temperature of the parts to be processed must comply with the adhesive manufacturer's specifications.
- The connection surfaces must be even and perfectly flat to one another.
- Sand the connection surfaces bare. Use only completely dirt and grease-free tools to do this.
- Clean the connection surfaces with the special cleaner provided by the adhesive manufacturer.

  Do not use thinner, petroleum ether or other cleaning agents.
- Leave the connection surfaces to dry.
- **NOTE:** Use protective gloves when applying the adhesive.

  Apply the adhesive to one or both surfaces to be bonded, according to the manufacturer's instructions, using a suitable tool.
- Join the parts as precisely as possible immediately after applying the adhesive so that only minor corrections are necessary.
- Fix the parts in the final position with clamps.
- Depending on the adhesive, the hardening process can be accelerated using a hot air blower.
- Finally, clean the area that has been bonded of leftover adhesive.

Bonding and welding

On some vehicle models, (such as the Ford Ka), bonding is combined with resistance spot welding. This connection technique has the following advantages:

- Tight, anti-corrosion connection seam.
- High strength due to additional resistance weld spots.

Please note the following points during the repair work:

- Only use adhesive suitable for welding (conductive).
- Carry out resistance spot welding on the connection flanges before the adhesive hardening process.
- Carry out test welding with the adhesive applied.
- If MIG welding is carried out during a sectional repair on a connection flange with adhesive material, the adhesive material must be applied at a distance of approx. 10 mm from the weld spot.

Bonding and riveting

As with welding, bonding can also be combined with riveting. This connection technique has additional advantages. These are:

- Metallic and non-metallic materials can be joined together.
- Different thicknesses of materials can be used.

DESCRIPTION AND OPERATION

- The material does not have to be heated, and therefore does not warp.
- The rivet connection stabilizes the connected components during the adhesive hardening phase.

DESCRIPTION AND OPERATION

Plastic Repairs

General

Many different kinds of plastics are used for automotive parts depending upon the purposes of parts. Their characteristics are also very different from one to another. It is, therefore, important to know those material names and their chemical and mechanical characteristics. Roughly divided there are two kinds of plastics, a thermoplastic resin and a thermosetting resin. The proportion of plastics used in vehicle construction continues to rise. Up to now damaged plastic components often had to be replaced. In the meantime plastic repair is becoming more and more accepted because of rising costs.

NOTE: Plastic adhesives are chemical products and are subject to the safety instructions of the manufacturer.

Because of the various compositions of plastics, repair work to plastic parts involves a variety of repair methods.

The following methods are used:

- Thermoplastic straightening.
- Plastic welding.
- Plastic adhesive bonding.
- Plastic lamination techniques.

In repair work, the material properties of plastics are highly significant. There are two main groups:

- Thermoplastics.
- Thermosets.

NOTE: Elastomers make up a third group of plastics. These are not mentioned below because they have no plastics repair applications.

Thermoplastics

If heating temperature is raised, the resins become soft and if it is heated further, they are melted. When the temperature is down, they return to a solid state.

Name of Plastic	Codes
Polyethylene	PE
Polypropylene	PP
Polyvinyl chloride	PVC
Acrylic nitril butadiene styrene copolymer	ABS
Acrylic resin	PMMA
Polyamide (Nylon)	PA
Polycarbonate	PC
Polyphenylene	PPO
Themoplastic synthetic rubber	TPR

Thermosets

Once this type of resins is heated and, as the result, hardened, they are not softened again even if they are heated again.

Name of Plastic	Codes
Polyurethane	PUR
Unsaturated polyester	UP
Glass fibre enhanced plastic	FRP
Phenol resin	PH

Plastics used by Ford

Identifier	Description
PA	Polyamide
PC	Polycarbonate
PP	Polypropylene
PP/EPDM	Polypropylene/ethylene propylene diene copolymer
PC/PBT	Polycarbonate/polybutylene terephthalate
PBT/PC	Polybutylene terephthalate/polycarbonate
PUR	Polyurethane

DESCRIPTION AND OPERATION

Identifier	Description
GRP	Glass reinforced plastic

Properties of Major Plastics

Polyethylene (PE)

Good in cold resistant, electrical characteristic, and chemical- resistant properties. Impenetrable except air. Though inferior in strength, rigidity and thermal resistant properties, as density is increased, rigidity and thermal resistant property is improved.

Polypropylene (PP)

The lightest in weight of all the resins. Used for large size parts like bumpers. Its strength, rigidity, and surface hardness are greater than those of Polyethylene(PE). It has a high thermal resistant temperature. Good in electric characteristics, anti-water and chemical-resistant properties. Strong in bending. Inferior in adhesiveness and weatherproof property.

Polyvinyl Chloride (PVC)

Through addition of plasticizer, it is possible to adjust its property from soft to hard. Good in electrical characteristics, chemical- resistant, and weather resistant properties. Inferior in antishock and anti-bending properties.

ABS Resin

(Acrylic nitril butadiene styrene copolymer). Good in mold forming, anti-shock property, and metal-plating properties. Easy secondary processing. Inferior in weatherproofing, heat resistant, and chemical resistant properties.

Acrylic Resin (PMMA)

Clear and transparent. Used for lens for taillight lens. High transparent rate. Good in strength, weather proofing, and easiness in work process. Inferior in anti-shock, anti-solvent, heat-resistant properties.

Polyamide (Nylon) (PA)

Used for structural and skeletal member parts because of its high strength and tenacity. Good in self-lubricant, anti-wear, anti-solvent properties. Wide range of temperatures for use. High water absorption rate. A change of dimensions and or softening due to water absorption may cause troubles from time to time.

Polycarbonate (PC)

Strong in shock absorption. Good in heat resistant and coldresistant properties, electrical characteristics, self-digesting and weather proofing properties. Low fatigue strength. Stress cracks and solvent cracks may happen.

Unsaturated Polyester

A typical material based on glass-based fiber for FRP. Good mold forming property. Cheaper than epoxy resin. Good in strength, rigidity, and electrical characteristics. Weak in alkali and hydrolytic dissociation easily takes place. Greatly shrinks when hardened. Insufficient heat-resistant property.

Polyurethane

High elasticity. Good in anti-wear, anti-deterioration, anti-oil, and weatherproofing properties. Weak in alkali and hydrolytic dissociation easily takes place. Its hard foam is good for heat insulation and sound-insulation. As a adhesive, it can be hardened at room temperature and is strong.

Plastic identification

Normally the identifier is marked on the plastic components used in vehicle construction.

NOTE: The identification of the type of plastic is necessary for the plastic welding process in order to determine the correct welding rod (welding material) to use.

If none is present, it can be determined using two different procedures/methods:

- Visual Inspection
- Mechanical Check

Visual Inspection

Visual inspections mainly serve to identify PUR and GRP materials. Thermoplastic components are often painted and are therefore difficult to identify.

Identification characteristics:

- When PUR cracks or similar damage occurs, pores of foam can be seen.
- GRP can be recognized by the glass fiber structure on the inside.

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CAUTION: Danger of poisoning! When burned, most plastics release vapors harmful to health. Ventilate the room well and use respiratory protection. Where possible work using an extraction system.

A burning test allows the plastic to be determined more exactly. This involves burning a small piece of the plastic material and observing the behavior of the flame, the smoke characteristics and the dripping behavior.

Characteristics of plastics:

Plastic	Flame behavior	Smoke characteristic	Dripping behavior
ABS	No way to distinguish from other copolymers	Blackish	-
PA	Bluish, transparent flame with yellow edge	No smoke	Drips with blistering
PC, PC/PBT, PBT/PC	Yellow, very sooty flame with black-brown fire areas	Yellow-white plumes of smoke	-
PP, EPDM	Calm flame, similar to a candle	No smoke	Melts
PUR	Agitated flame	Intense sooty plumes	Hardly drips
GRP	Yellow-red, intense sooty flame	Whitish plumes of smoke	-

Another method to determine the plastic group is the sanding test. In this a place is chosen which will not be visible later, and the finger belt sander is used to sand the plastic.

The plastic group can be determined using the pattern of the dust:

- Thermosets produce a white dust.
- Thermoplastics smear and do not produce dust.

Mechanical Check

The plastic group can be determined by a sound test:

- Degree of hardness - the higher-pitched the sound, the harder the plastic.
- Elasticity - the more muffled the sound, the higher the elasticity of the plastic.

Safety instructions

In addition to the general safety instructions, the relevant regulations and accident prevention legislation must be observed.

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

Information sheets, safety notices and guidelines for the processing of adhesives containing isocyanate, polyester resin, adhesives, solvent and thinners provide more details on their use.

The following instructions must always be followed:

- Polyester resin, adhesive, solvents and thinners are inflammable and must not be used near naked fire or flames.
- Sawing and grinding operations must only be carried out in rooms equipped with extraction systems.
- If no rooms with extraction systems are available, only use tools with extraction equipment.
- Protective equipment such as gloves, protective goggles, aprons and breathing masks are essential.

Plastic welding

Splits formed in plastic bumpers are typical possible plastic repairs.

NOTE: Do not carry out plastic welding in the area of fixed foam backing. The foam backing will usually be destroyed and the function of the component is then no longer guaranteed.

If repair using adhesive methods is not possible because of unfavorable conditions at the rear of

DESCRIPTION AND OPERATION

the repair location, plastic welding is a possible repair process.

There are two methods of welding: hot air draw welding and hot air fanning welding.

Plastic welding set

Item	Description
1	Various welding rods
2	Scraper (heart-shaped)
3	Hot air blower (approx. 1500 W)
4	Clamps
5	Welding nozzles

In addition to the components listed, plastic welding requires tools already found in the workshop such as scrapers, sanders, face cutters etc.

As with all other welding processes, only certain material combinations can be joined together using plastic welding.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range listed in the Training brochure published by the Ford Service Organization.

Repair sequence during plastic welding:

NOTE: The manufacturer's data must be taken into account when choosing welding materials and the correct temperature setting of the hot air gun.

- To prepare the location for welding, remove paint residues and sand the weld area.
- Drill out the ends of the split to stop it spreading further. Shape the location to be welded into a V-shaped joint.
- Perform the welding. Hot air draw welding or hot air fanning welding.
- Rework the weld seam. After cooling, sand the raised weld seam.
- Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface and paint it.

Despite good preparation and the correct choice of welding materials, weld faults may occur. The correct choice of temperature is important for the success of the repair.

Possible causes of weld faults:

- Deformation caused by overheating of the repair area or tensions in the material while welding the component. Plastic material too thin.
- Poor weld joint because the weld temperature was too low or the welding speed was too fast. Welding different materials together.
- Weld seam dropped because the split gap was too wide or the welding temperature was too high.

Adhesive bonding of plastics

Adhesive bonding of plastics has some advantages over welding methods:

- Within the group of thermoelastic plastics, all semi-rigid ancillary components (such as bumpers, front grilles, etc.) can be repaired without identification.
- A two-component polyurethane based adhesive is used for all thermoplastic parts.
- Reinforcement strips can be attached behind splits (split length up to max. 100mm) and openings to ensure the original strength properties.

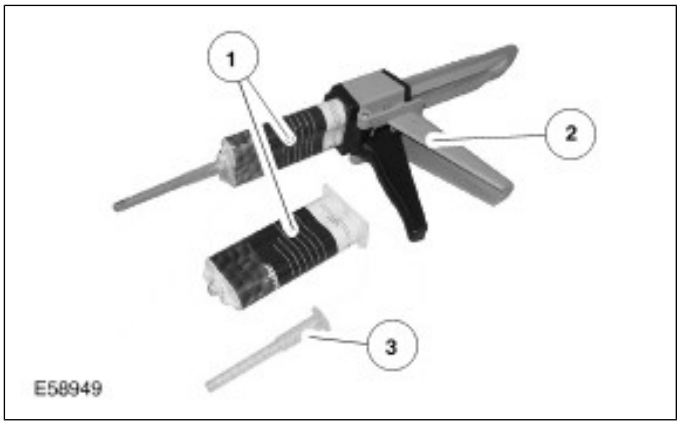
Tools and equipment also familiar from paint repairs can be used in making adhesive repairs to thermoplastic components.

Angle grinders and belt sanders can be used to grind out scratches and splits. Orbital sanders with extractors are used for fine sanding.

The infrared heater is used to provide fast and secure drying throughout.

DESCRIPTION AND OPERATION

Plastic adhesive set



Item	Description
1	2-component adhesive
2	Cartridge gun
3	Venturi tube

Apart from the components shown, other materials may be needed to bond plastics, depending on the repair position.

For large scale repairs, it may be necessary to insert reinforcement panel strips and reinforcement matting as fixing aids.

Repair sequence during plastic adhesive bonding:

NOTE: Follow the manufacturer's guidelines when using adhesives.

- Prepare the location of the bond. Remove paint residues and sand the area to be bonded. Drill out the ends of the split to stop it spreading further. Prepare the bond location into a V-shape and clean it with plastic cleaner.
- Apply the adhesive. The two-component adhesive is applied to the cleaned and primed repair location using a hand gun. Spread and smooth the adhesive using a flexible plastic spatula.
- Rework the bond location. After cooling, sand the raised adhesive. Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface. Apply paint.

GRP repairs

GRP material is hard and brittle in its strength properties. Because of these material properties, splits and openings often result in cases of serious damage.

The stability of GRP parts is impaired if the glass fiber reinforcement is cracked. The component must be replaced in cases of serious damage that affect the structure.

Minor damage (such as abrasion, splits up to 80mm, holes up to approx. 60mm diameter, etc.) can be repaired to a technically and visually perfect standard, provided that the damage does not occur in heavily used or hard-to-reach areas.

To ensure perfect repair results, observe the following points:

- The room temperature should be at least 15°C and the air should be as dry as possible.
- The repair location must be thoroughly dry and clean.
- Before the repair, the GRP part being repaired must be dried using an infrared heater or in a drying oven.
- In cases of large splits and fractures, the strength of the outer skin can be re-established by backing with a reinforcement material.

Tools and equipment from the paint shop can be used to carry out repairs to GRP parts. Angle grinders and belt sanders can be used to grind out scratches and splits. Orbital sanders with extractors are used for fine sanding.

GRP repair set

Item	Description
1	Polyester resin
2	Glass fiber mats
3	Hardener

Scissors, paintbrush and cleaning materials are other materials which will be needed to perform a GRP repair.

NOTE: Follow the manufacturer's instructions when using the repair materials.

The repair process for a GRP repair is as follows:

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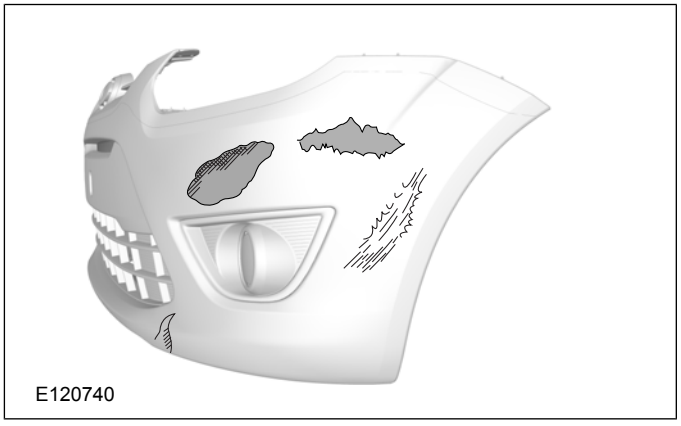
- Prepare the repair location. Remove paint residues and sand the repair area.
- Drill out the ends of the split to stop it spreading further.
- The repair location must be sanded by hand. If machine working is attempted, the resin will be heated so much that the surface structure will be changed. The result is inadequate adhesion.
- Perform the GRP repair. Apply polyester resin thinly to the repair location. Lay the glass fiber mat in place and apply polyester resin over it again.
- Rework the location of the repair. Sand away any polyester resin which stands proud after it has hardened.
- Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface and after it has dried apply the paint finish.

Paint Repair Process

- The plastic parts to be repaired according to the following repairing process are mostly large ones in size and PP, ABS, PC or PA materials.
- It is extremely important to confirm the plastic material of the part and select the appropriate repair materials. In repairing, pay particular attention not to cause deformation or other damages to the part due to drying heat and other conditions.
- Basically, the repair process for resin parts can be divided into two. One is for PP and “ ABS+PA” resin parts and another is for the other types of plastic materials.

NOTE: The states of damage and their way of repair are described below. Since the repair methods are different according to the repair materials, always check the paint manufacturer’s instructions.



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Steps of Repair Painting

The following are the steps taken for paint repair after the undercoat process has been completed.

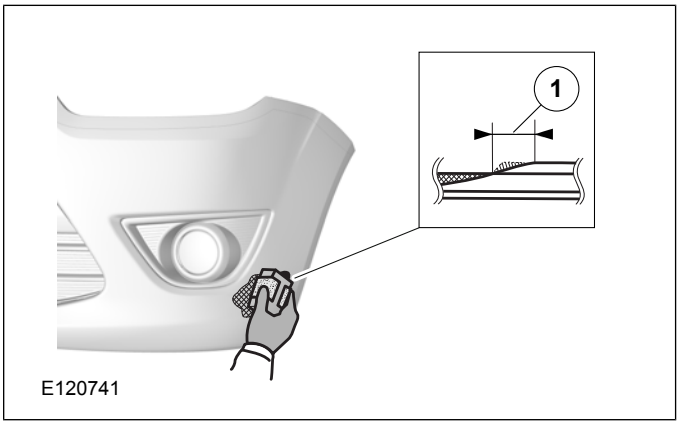
For filling and reforming, refer to the Body Repair Manual Body Basic.

Example of repair materials.

- **Primer surfacer:** Two-liquid mixing type (Bumper primer surfacer gray).
- **Top coat paint:** Two-liquid polyester urethane (2K type).

NOTE: Follow the paint manufacturer's recommendation.

1. Grinding for better adherence (for primer surfacer painting). Grind the old paint surface around the area to be repaired with P200 to P400 sandpaper to form featheredge.



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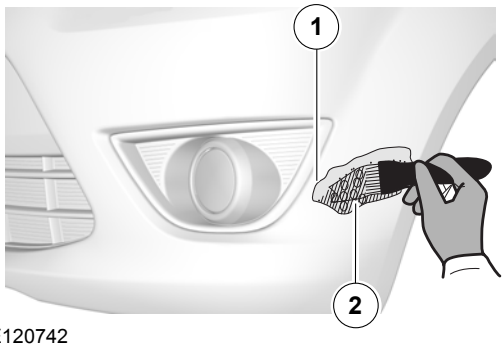
Item	Description
1	Feather edge

2. Paint PP primer (Raw surface exposed area). As the PP bumper cannot be painted directly on the raw surface, be sure to paint the PP primer on the raw surface first to secure tight adherence to the top coat.

DESCRIPTION AND OPERATION



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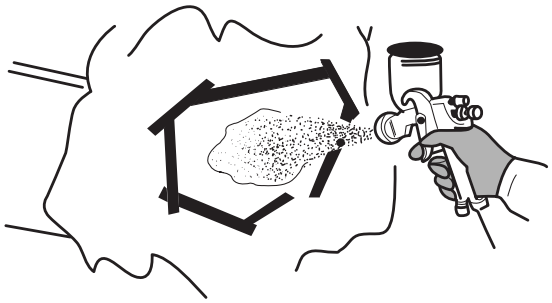
Item	Description
1	Exposed surface
2	Bumper primer

3. Clean the surface by air blow and wipe off all fat, oil and grease.
4. Paint primer surfacer and dry it. Spray the PP primer over the area a little wider than the painted area with a spraying gun. The paint thickness is aimed to be 20 to 30 m at 2 to 3 double coating sprayings. NOTE: Follow the primer surfacer manufacturer's instructions for drying time.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WARNING: Avoid contact with skin, wear a respirator, gloves, eye protection, and appropriate clothing when spraying.

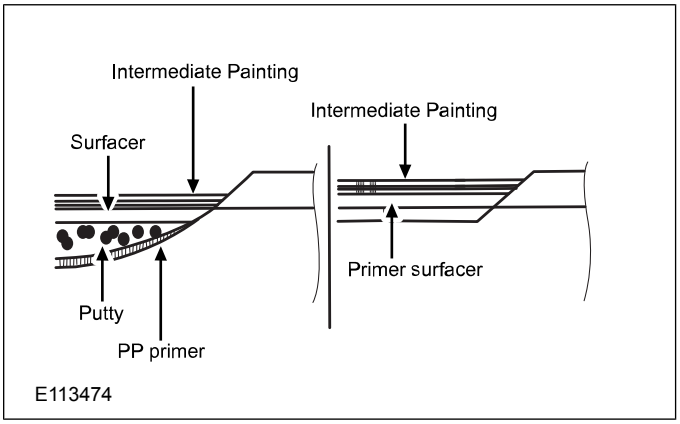
5. Polish with P600 sandpaper with water. Do not use a sandpaper lower than P600.
6. Clean by air blow and wipe off all fat, oil and grease.
7. Masking (in case of a partial repair).
8. Painting of intermediate coat and drying.

WARNING: Avoid contact with skin, wear a respirator, gloves, eye protection, and appropriate clothing when spraying.

- On PP plastic parts (bumper, side sill, garnish etc.), paint the intermediated paint to match the color.
- For the paint, use the top coat enamel paint.

NOTE: Mix it with thinner and softener or hardener according to the paint manufacturer's instructions on mixing ratio and dry it according to the instructions.

- Before painting, clean the entire surface to be painted with a tack cloth.
- The paint thickness is aimed to be 20 to 30 m at 2 to 3 double coating sprayings to hide the primer surfacer paint color.



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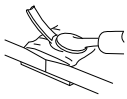
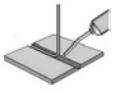
Plastic repair quick reference chart

REPAIR METHOD								
REPAIR STEP		A	B	C	D	E	F	G
1	Identify plastic	Thermoset Poly-urethane	ABS, poly-ethylene, nylon, polycar-bonate	PP, TPO, TEO, TPE, PE, or other	All thermo-plastics	SMC, UP, FRP, Fiberglass	ABS, SMC, Fiberglass, PC blend	ABS, SMC, Fiberglass, PC blend
2	Clean	**Clean part with soap & water and Super Clean Plastic Cleaner**						

DESCRIPTION AND OPERATION

REPAIR METHOD								
3	Repair	Thermoset Urethane Weld	Thermo-plastic Fusion Weld	Uni-Weld FiberFlex	Hot Air Welding	Two-Part Epoxy Adhesive	Insta-Weld Adhesive	PlastiFix Rigid Plastic Repair Kit
		 E120588	 E120588	 E124455	 E124456	 E124457	 E124458	 E124459
4	Fill	Grind, then apply filler that matches the hardness of the substrate						
5	Prime	Prime						
6	Paint	Apply Top Coat						

Identify plastic & determine repair method

The easiest way to identify the type of plastic you're working with is to look for the plastic ID symbol on the backside of the part. Simply match the symbol on the part with the table below and look at the suggested repair method, listed in order of preference. See the next page for tips when you can't find the plastic ID symbol.

DESCRIPTION AND OPERATION

	Recycling Symbol	Symbol & Type	Description/ How to Identify	Typical Applica-tions	Suggested Repair Method	Repair Tips
Thermoset		PUR, RIM, RRIM Ther-moset Poly-urethane	Usually flex-ible, may be yellow or gray, bubbles & smokes when melted.	Flexible bumper covers (esp. on domestics, filler panels, rocker panel covers, snowmobile cowls.	Method A w/ urethane rod (5003R1) or Method C w/ Uni-Weld FiberFlex	Don't melt base material! Melt rod into v-groove like a hot melt glue.
		SMC, UP, FRP Fiber-glass	Rigid, poly-ester matrix reinforced with glass fibers, sands finely.	Rigid body panels, fenders, hoods, deck lids, header panels, spoilers.	Method E - Two-part epoxy repair with fiber-glass rein-forcement.	Use backing plate over holes, layer in fiberglass cloth for extra strength.
		XPE, XLPE, PE-Xb, PEX, Cross-linked Poly-ethylene	Semi-flex-ible, usually semi-translu-cent, waxy or greasy feel, softens when heated but does not melt.	Gas tanks, kayaks, canoes, trash cans, use is declining.	Method C with poly-ethylene rod (5003R4), (5004).	Applying filler or painting is impossible. Browns when heated.
Thermoplastic	 E120589	ABS Acrylonitrile Butadiene Styrene	Rigid, often white but may be molded in any color, sands finely.	Instrument panels, grilles, trim moldings, consoles, armrest supports, street bike fairings, canoes, aircraft wing tips and interiors.	Method B w/ ABS rod (5003R3), or Methods D, E, F, or G.	PlastiFix is an optimal repair method. Weld repairs may be backed with epoxy for extra strength.
	 E120590	PS poly-styrene (Styro-foam)	Semi-flex-ible, usually expanded into foam.	Packaging material, insulation, food containers, light switch plates.	Method E - Two-part epoxy repair.	Very sens-itive to solvents and high heat.
		PA Poly-amide (Nylon)	Semi-rigid or rigid, sands finely.		Method B or D w/ nylon rod (5003R6)	

DESCRIPTION AND OPERATION

	Recycling Symbol	Symbol & Type	Description/ How to Identify	Typical Applica-tions	Suggested Repair Method	Repair Tips
				Radiator tanks, head lamp bezels, exterior trim parts, mirrors, plastic engine parts.		Preheat plastic with heat gun before welding, mix completely with base mat'l.
	 E120591	PC + ABS Pulse (Polycar-bonate & ABS)	Rigid, sands finely, usually dark in color.	Door skins (Saturn), instrument panels, street bike fairings.	Method B or D w/ polycar-bonate rod (5003R7) or Methods E, F, or G adhesive repairs.	Preheat plastic with heat gun before welding with Method B.
	 E120591	PC + PBT Xenoy (Polycar-bonate blend)	Very rigid, sands finely, usually dark in color.	Bumper covers (84-95 Ford Taurus, Aerostar, some M-B and Hyundai).	Method B or D w/ polycar-bonate rod (5003R7) , Method E or G.	Preheat plastic with heat gun before welding with Method B.
	 E120592	HDPE Poly-ethylene	Semi-flex-ible, melts & smears when grinding, usually semi-translucent, waxy or greasy feel.	Overflow tanks, inner fender panels, ATV fenders, RV water storage tanks, gas tanks, kayaks canoes, picnic tables, lumber.	Method B or D with high density poly-ethylene rod (5003R12)	Applying filler or painting is impossible.
	 E120593	PE/ LDPE Poly-ethylene	Semi-flex-ible, melts & smears when grinding, usually semi-translucent, waxy or greasy feel.	Overflow tanks, inner fender panels, ATV fenders, RV water storage tanks, gas tanks, kayaks, canoes, trash cans.	Method B or D with poly-ethylene rod (5003R4).	Applying filler or painting is impossible.

DESCRIPTION AND OPERATION

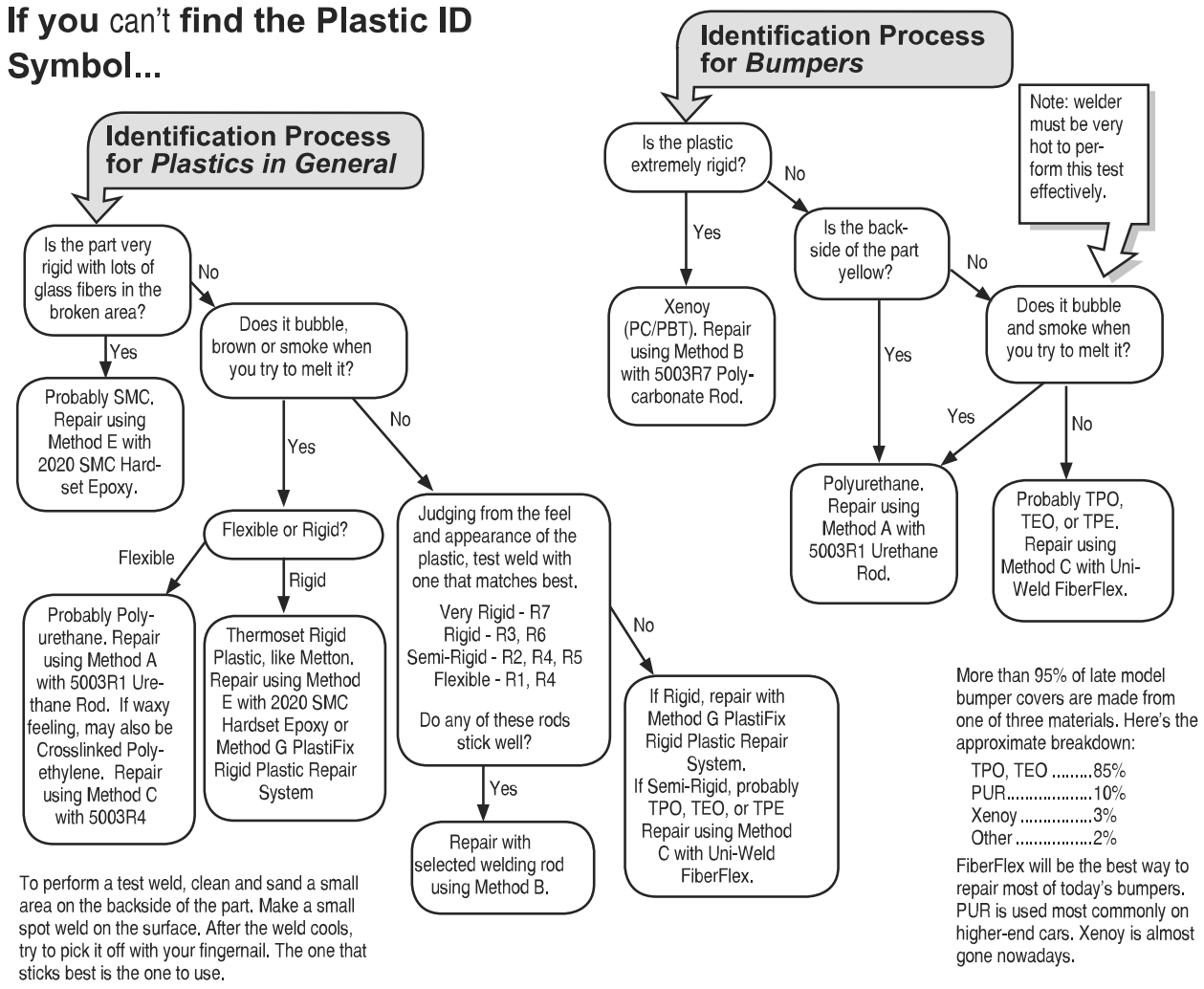
	Recycling Symbol	Symbol & Type	Description/ How to Identify	Typical Applica-tions	Suggested Repair Method	Repair Tips
	 E120594	PP Polypro-pylene	Semi-flex-ible, melts & smears when grinding, waxy or greasy feel, usually a bit stiffer than PEs.	Bumper covers (usually blended w/ EPDM), inner fenders, radi-ator shrouds, gas tanks, battery cases, pallets.	Method C with Uni-Weld Fiber-Flex (5003R10) or Method B or D w/ PP rod.	Use 1060FP Filler Prep before applying two-part epoxy filler.
		PPO + PA Noryl GTX (Nylon blend)	Semi-rigid, sands finely, usually off-white in color.	Fenders (Saturn & GM), exterior trim.	Method B or D with nylon rod (5003R6) or Methods E, F, or G adhesive repairs.	Preheat plastic with heat gun before welding with Method B.
	 E120595	PVC Polyvinyl chloride	Rigid, sands finely. Usually white or gray but can be made any color.	Pipe, siding, window frames, decking, gutters, speed bumps.	Method B or D with (5003R9) PVC welding rod	
Thermoplast ic		TPE Thermo-plastic Elast-omer	Semi-flex-ible, usually black or gray, melts & smears when grinding.	Bumper covers, filler panels, underhood parts.	Method C with Uni-Weld Fiber-Flex (5003R10)	Use 1060FP Filler Prep before applying two-part epoxy filler.
		TPO, TEO, PP/ EPDM, TSOP Thermo-plastic Olefin	Semi-flex-ible, usually black or gray, melts & smears when grinding.	Bumper covers, air dams, grilles, interior parts, instrument panels, snowmobile cowls.	Method C with Uni-Weld Fiber-Flex (5003R10) or Method B or D w/ PP or TPO rod.	Use 1060FP Filler Prep before applying two-part epoxy filler.
		TPU, TPUR Thermo-plastic Poly-urethane	Flexible, sands finely.	Bumper covers, soft filler panels, gravel deflectors, rocker panel covers.	Method B or D w/ urethane rod (5003R1) or Method C w/ Uni-Weld FiberFlex (R10)	

DESCRIPTION AND OPERATION

	Recycling Symbol	Symbol & Type	Description/ How to Identify	Typical Applica-tions	Suggested Repair Method	Repair Tips
	 E120596	PETE, PET Poly-ethylene Tereph-thalate	Flexible, strong	Soda bottles, various yarn fibers, head-liners, fuse boxes, door panels	Method B or D w/ slivers cut from scrap.	Can't make as strong as original part; manufac-tured in cris-scrossed layers and can't be duplicated.

DESCRIPTION AND OPERATION

If you can't find the Plastic ID Symbol...



E120598

Clean surface and align damage

Clean Surface Before Repair

In order to maximize strength and adhesion of the repair, it is important to thoroughly clean all contaminants from the surface in the damaged area.

Step 1. Clean both sides with soap and water. Dry off with a clean cloth or compressed air.

Step 2. Spray on 1000 Super Clean Plastic Cleaner and wipe off while wet with a clean, lint-free cloth. Wipe in one direction to avoid spreading contaminants back over the clean area.

Align Damage

If the plastic is distorted, heat with 6500VT high temp heat gun and reshape the distorted area. When heating plastic, it is important that the plastic be heated all the way through. Hold the heat gun on the area until the opposite side of the plastic is uncomfortable to the touch. Once heated, force

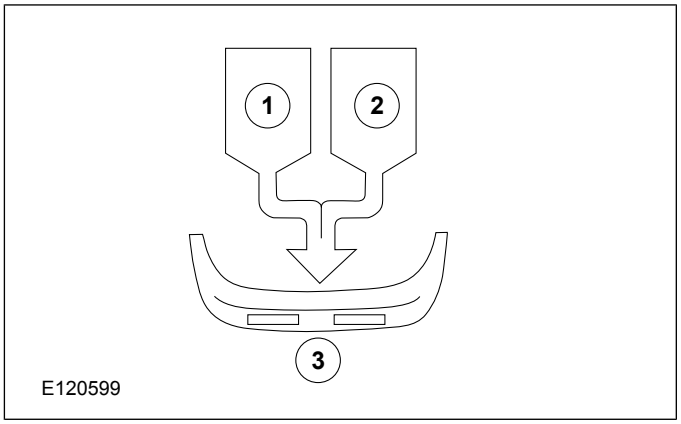
DESCRIPTION AND OPERATION

the plastic back into position with a block of wood or other tool, then cool the area with a clean cloth.

Thermoset polyurethanes (PUR, RIM) have a “memory” that will often cause them to go back to their original position if held under a heat lamp or in a heated spray booth.

If the part is cut or torn to the edge, align the outer surface with 6481 aluminum body tape and begin the repair process on the backside. By aligning the outer surface, you minimize the amount of filler required later to restore the proper profile to the part.

Repair Method A: thermoset urethane



E120599

Item	Description
1	A
2	B
3	Thermoset

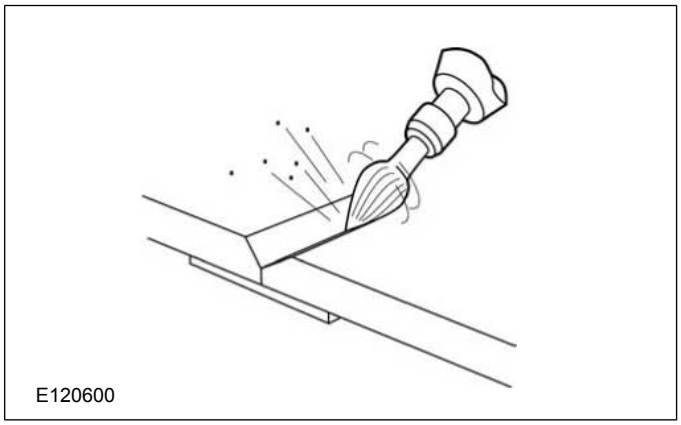
Repairing Thermoset Urethanes

Automotive urethane, or PUR, is a “thermoset” material. Similar to what happens when you mix body filler and cream hardener, it is formed when two liquid chemicals come together in the mold to form a solid. The point of telling you this is to say that you cannot melt urethane bumpers with the welder. Repeat: **YOU CANNOT MELT URETHANE BUMPERS WITH THE WELDER!**

A sure-fire way of identifying a urethane bumper is to lay your hot welder on the backside. If it’s a urethane, the plastic will liquefy and bubble and smoke will rise (note: welder must be extremely hot for this to happen). After this “melted” area cools off, it will still be sticky to the touch. This is an indication that the heat actually broke down the chemicals in the plastic. Thermoset urethanes can be easily repaired with the airless plastic welder, but the repair will be more like a brazing process rather than a true fusion weld.

V-Groove Damaged Area

Line up the outer surface of the tear with 6481 Aluminum Body Tape or with clamps. You can also tack the tear together with 2200 Insta-Weld 1 thin adhesive.

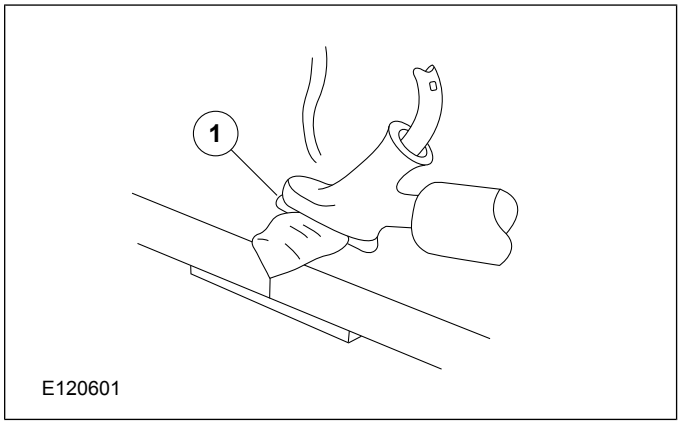

E120600

V-groove halfway through the backside of the part with the 6121-T Teardrop Cutter Bit. You cannot use a hot tool to melt the v-groove into urethane because it does not melt.

Sand the v-groove with coarse sandpaper (80 grit or coarser) to put some extra “tooth” in the plastic. Also remove the paint in the area surrounding the v-groove and radius into the v-groove for extra strength.

Melt the Rod into the V-Groove

Set the temperature setting of your airless plastic welder to the “clear” or “R1” rod setting. Using the 5003R1 Polyurethane welding rod, the rod should come out of the bottom of the welder’s shoe completely melted and clear, not discolored or bubbling.



E120601

Item	Description
1	Hold wlder tip off surface

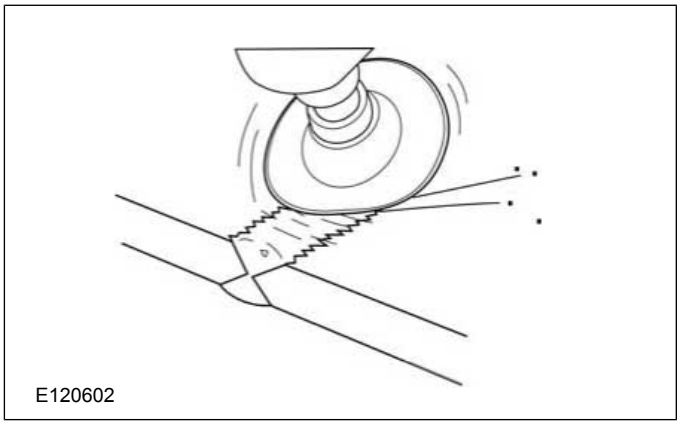
DESCRIPTION AND OPERATION

Holding the welder's tip off the surface of the plastic, melt the rod into the v-groove. Don't overheat the base material, simply melt the rod onto the surface. Again, you are NOT trying to melt the rod and the bumper together; the bumper material is NOT meltable!

Lay down no more than 2 inches of welding rod into the v-groove at a time. Remove the rod from the welder tip, and before the melted rod has time to cool down, go back over it with the hot welder tip and smooth out the weld. Don't overheat the base material.

V-Groove and Weld Opposite Side

After the weld on the backside cools, repeat the v-grooving and welding process on the opposite side.



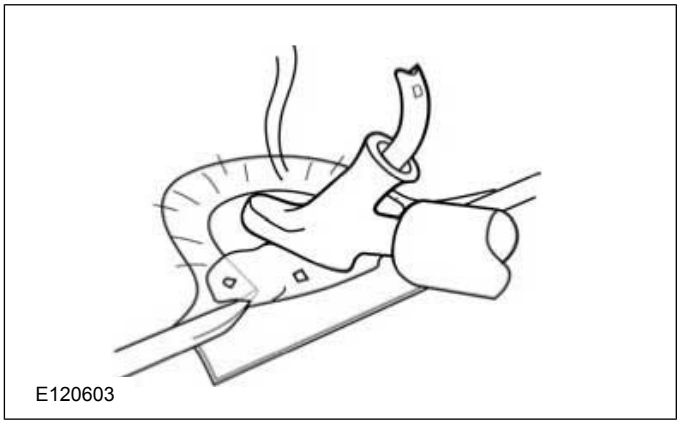
E120602

Grind Weld to a Smooth Contour

Using coarse sandpaper, grind weld to a smooth contour. The urethane welding rod will not feather very well, so it will need to be covered with 2000 Flex-Filler 2 epoxy filler to refinish completely. Grind the weld slightly flush so that filler can cover the welded area completely.

Repairing Torn Bolt Holes on Urethanes

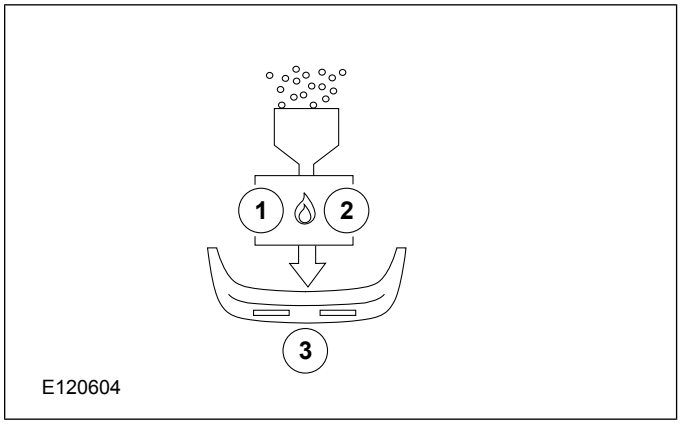
Taper the plastic all around the hole down to a point on both sides using a Roloc disc.



E120603

Use 6481 Aluminum Body Tape to create a bridge across the torn mounting hole. Melt 5003R1 urethane welding rod into the area. Drill out hole when finished.

Repair Method B: fusion welding



E120604

Item	Description
1	Heat
2	Pressure
3	Thermoplastic

Repairing Thermoplastics with Fusion Welding

Outside of urethane, all other bumpers, and most other plastics on automobiles, are made from thermoplastic materials. This means they can be melted with the application of heat. Thermoplastic parts are made by melting pellets of plastic and squirting the melted material into a mold, where it cools and resolidifies. This means that thermoplastic parts can be melted.

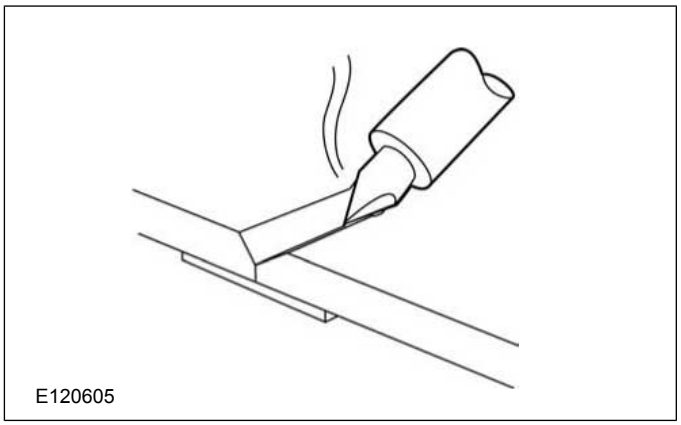
The most common thermoplastic automobile bumper material is TPO. TPO is fast becoming the most popular material for all sorts of interior and underhood plastics as well. TPOs can be welded using the fusion technique described on this page, but our FiberFlex rod often makes an easier and stronger repair on TPO (see Repair Method C).

The third most common bumper material, Xenoy, is best repaired using the following thermoplastic Fusion technique.

V-Groove Damaged Area

Line up the outer surface of the tear with 6481 Aluminum Body Tape or with clamps. You can also tack the tear together with 2200 Insta-Weld 1 thin adhesive.

DESCRIPTION AND OPERATION

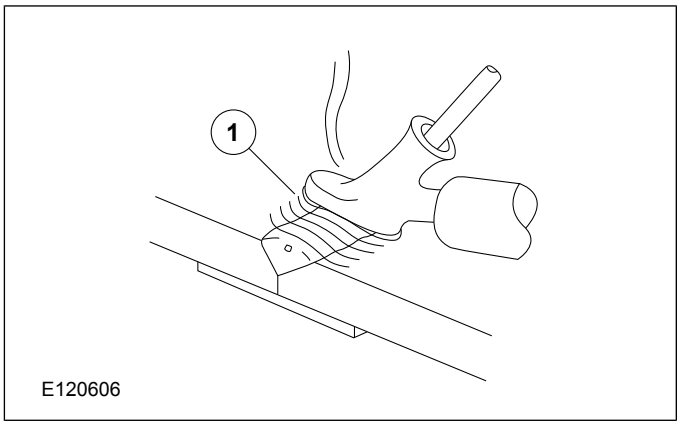

E120605

V-groove halfway through the backside of the part with either the 6121-T Teardrop Cutter Bit or the 6200VG V-Groovin'' Tool.

Remove the paint in the area surrounding the v-groove and radius into the vgroove with coarse sandpaper.

Melt the Rod Together with the Base Material

Set the temperature setting of your airless plastic welder to the setting that's appropriate for the welding rod you selected in the identification process. In most cases, the welding rod should melt cleanly and not be discolored (the only exception would be nylon, where the rod should turn a light brown).



E120606

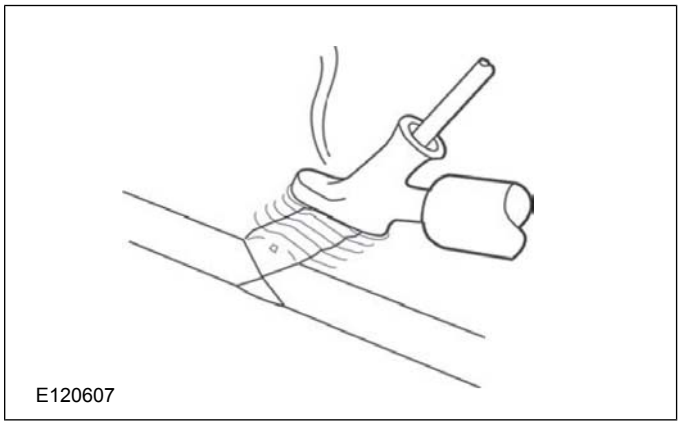
Item	Description
1	Melt rod and base material together

Lay the welder tip on the surface of the plastic and slowly melt the rod into the v-groove. Pull the welder toward you so you can see the welding rod fill the vgroove as you make your pass.

Lay down no more than 2 inches of welding rod into the v-groove at a time. Remove the rod from the welder tip, and before the melted rod has time to cool down, go back over it with the hot welder tip and thoroughly melt the rod together with the base material. It helps to press into the plastic with the edge of the welder tip to mix the materials, then go back and smooth it out. Keep the heat on it until you have a good mix between the rod and base.

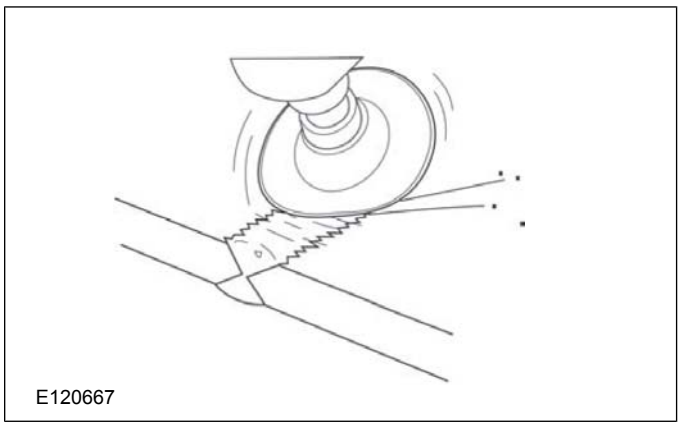
V-Groove and Weld Opposite Side

After the weld on the backside cools, repeat the v-grooving and welding process on the opposite side.


E120607

Grind Weld to a Smooth Contour

If you need to refinish the plastic, grind weld to a smooth contour with coarse sandpaper. Grind the weld slightly flush so that filler can cover the welded area completely.


E120667

Repair Method C: FiberFlex

Repairing with Uni-Weld FiberFlex Universal Rod

Uni-Weld FiberFlex is a unique repair material in that it sticks to any plastic substrate. It is not a true welding rod, but rather a thermoplastic or hot-melt adhesive. When you do a repair with the FiberFlex, you will actually be using the heat of the welder to apply an adhesive. FiberFlex has a very strong bond and is reinforced with carbon and glass fibers for outstanding strength.

FiberFlex is the best way to repair TPOs (aka TEO, PP/EPDM, TSOP), the most common automotive

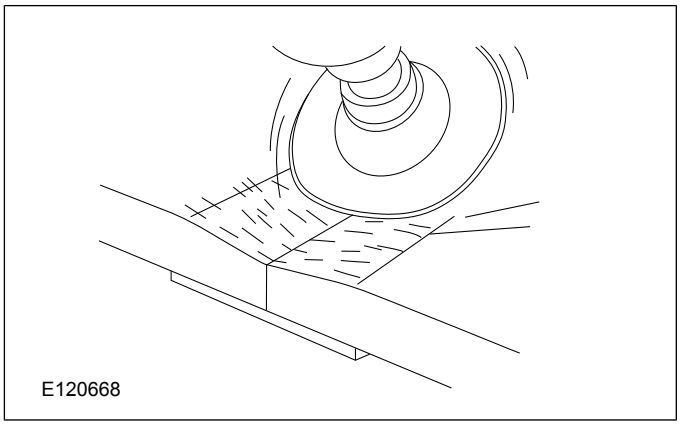
DESCRIPTION AND OPERATION

bumper material. The reason is that there are no two TPOs that are exactly alike. As a result, our 5003R5 TPO welding rod will not match any TPO exactly. The FiberFlex, with its fiber reinforcement, actually makes a stronger repair than the true welding rod. Therefore, you'll find the FiberFlex to be the easiest and best way to repair TPOs.

The FiberFlex can also be used to repair virtually any plastic. It will stick to urethanes and Xenoy also. When you are not sure what type of plastic you are repairing, try the FiberFlex.

V-Groove Damaged Area

Line up the outer surface of the tear with 6481 Aluminum Body Tape or with clamps. You may also tack the tear together with 2200 Insta-Weld 1 thin adhesive, however, instant adhesives don't stick well to TPO.


E120668

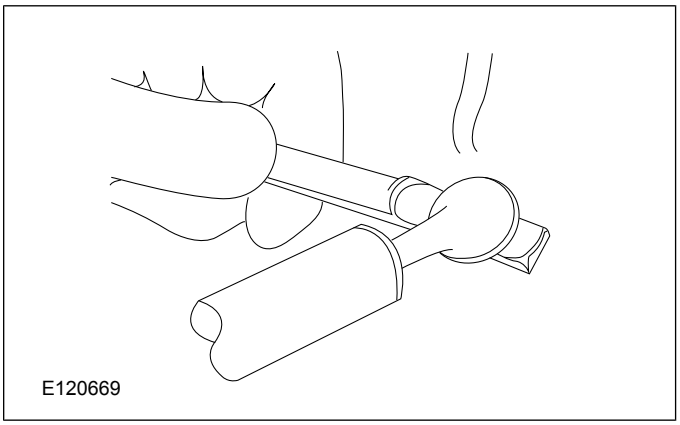
Remove plastic in the shape of a broad V-groove halfway through the backside of the part using a die grinder with either the 6122 or 6122NF Heavy Duty Round Burr or the 6134-R Round Cutter Bit. You'll want the v-groove to be about 1-1/2 inches wide when you get done.

It is very important to put some "tooth" in the plastic by grinding the v-groove with 50 grit or coarser sandpaper. Use a low speed grinder. Grinding at high speed will tend to melt many thermoplastics.

Using 80 grit in a DA sander, remove the paint in the area around the v-groove and radius smoothly into the v-groove. This will give you a better featheredge when you get ready to sand the FiberFlex.

Melt on the FiberFlex

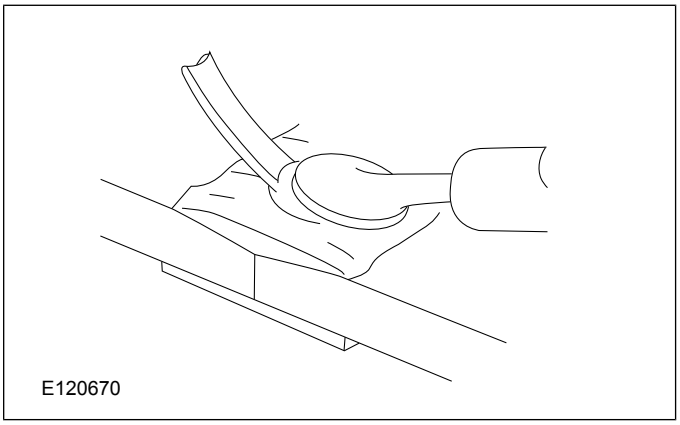
With the airless welder set to the highest temperature setting, use the 6028RT Round Tip to melt the 5003R10 FiberFlex welding rod onto the surface. Best adhesion is achieved by premelting one side of the end of the rod, then flipping the rod over so that the melted portion sticks to the plastic. Cut the melted part of the ribbon off using the edge of the welder tip and spread the FiberFlex into the v-groove. Do not attempt to melt the base material together with the FiberFlex. Repairing with Fiber-Flex is similar to a brazing process.


E120669

You may also apply the 5003R11 FiberFlex Round Rod with the 6030 Speed Welding Tip for faster application.

V-Groove and Weld Opposite Side

After the FiberFlex on the backside cools (you may force cool with water), repeat the v-grooving and welding process on the opposite side. Build the Fiber- Flex slightly higher than the surface. FiberFlex is also a sandable filler.

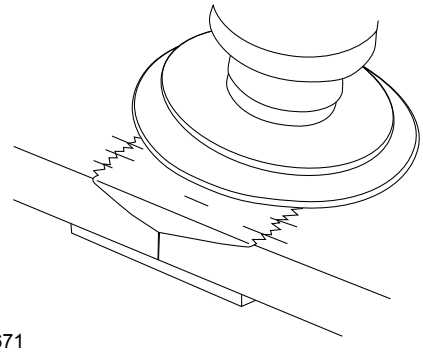

E120670

Finish Sand

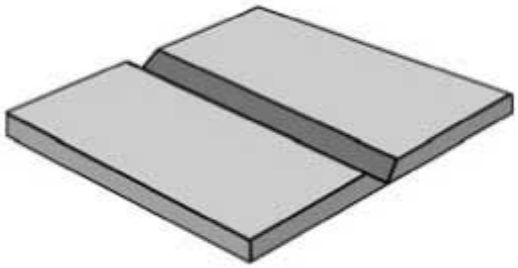
After allowing the FiberFlex to cool completely, sand with 80 grit paper in a DA sander at low speed. Progress to finer grits, ending with 320 grit.

Fill any low spots with more FiberFlex or with a skim coat of 2000 Flex Filler 2 or 2020 SMC Hardset epoxy filler.

DESCRIPTION AND OPERATION



E120671



E120672

Repair Method D: Hot air welding

Repairing Thermoplastics with Hot Air Fusion Welding

With practice, you will find welding plastics with hot air to be quick, strong, and very cost effective. Using our specialty welding rods, you will be able to repair virtually any type of thermoplastic part. With R-13 welding ribbon, you will be able to repair broken tabs and mounts on polypropylene based plastics like TPO without having to worry about strength.

V-Groove Damaged Area

Line up the outer surface of the tear with 6481 Aluminum Body Tape or with clamps. You can also tack the tear together with 2200 Insta- Weld 1 thin adhesive.

V-groove the part with either the 6121-T Teardrop Cutter Bit or the 6200VG V-Groovin' Tool making a V-groove almost all the way through the plastic where the plastic is cracked or needs to be welded. This will ensure the weld has optimal penetration into the plastic and will produce the strongest possible joint. The only exception to this is when making a weld using the R-13 welding ribbon. In that case, the increased surface area of the welding material makes up for the lost penetration in the seam.

Remove the paint in the area surrounding the v-groove and radius into the v-groove with coarse sandpaper.

The given image shows the V-groove made at the point where the pieces of plastic will be welded together. Notice the depth of the groove, this will allow a piece of plastic to have maximum weld penetration by allowing the welder to make one or more passes, filling the groove from the bottom to the top with filler rod.

Set the Temperature and Airflow

The key to properly setting the temperature and airflow is to match the type of filler rod you are using. Typically, the lowest balance of airflow and temperature that you can get to work for the material you are welding will produce the most satisfactory welds.

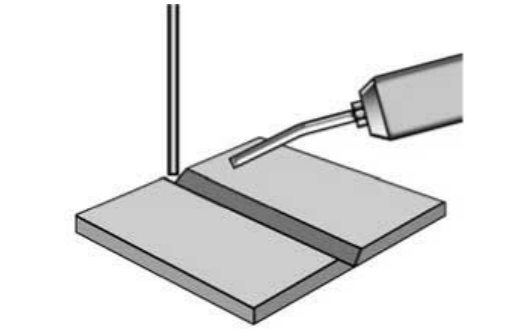
For the 6050HA, the airflow is usually set somewhere in the ballpark of 3 psi.

For the 6055, the airspeed is usually set in the lowest speed range.

At a distance of approximately ¼" to ½", direct the airflow at the rod or base material for a couple of seconds. The rod and the base material should turn glossy as the surface begins melt. If it takes longer than several seconds, you may need to either increase the temperature or adjust the airflow. Should the plastic begin to turn glossy and begin to bubble after only briefly heating the material, you will need to reduce the heat or adjust the airflow.

Aim the airflow and the welding rod

Hold the welder with the tip between ¼" and ¾" away from the material to be welded. Heat the base material and the rod until both become shiny and tacky.



E120673

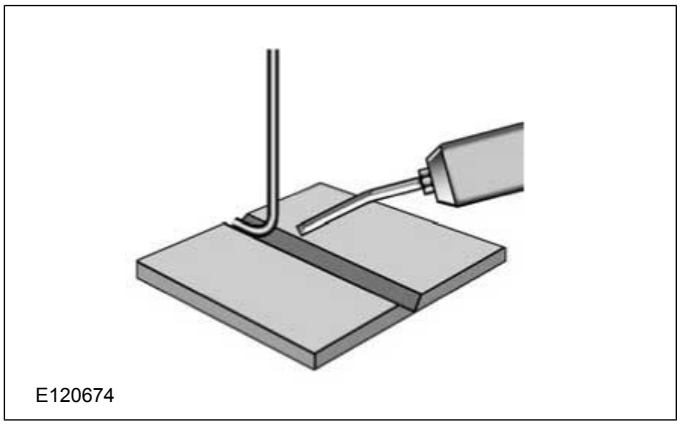
DESCRIPTION AND OPERATION

Because the base material acts as a heat sink it typically requires more heat than the rod.

The objective is melt the rod and base material simultaneously, so when they are pressed together they melt together, not just melt to one another.

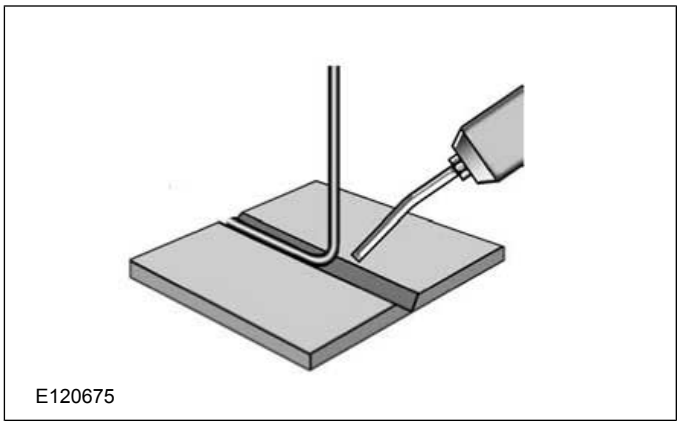
Welding the Joint:

Holding the welding rod at about a 45 degree angle away from the welder, begin pressing the rod into the v-groove of the material. Holding this angle on the rod, work your way down the v-groove steadily, melting the rod and the base material together.



E120674

Make sure the rod and the base material are heated equally to ensure a good weld. If the base material is allowed to overheat, the surface may scorch or the substrate will melt. Should the rod be heated and the base material left too cool, you will not get adequate penetration of the weld and the weld will be very weak.

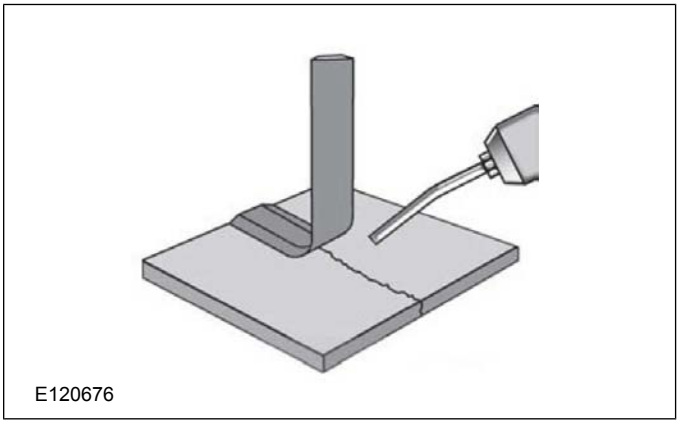


E120675

The approximate speed of a hot air weld is roughly 6 to 8 inches per minute depending on the thickness of the base material.

When welding plastic, a common misconception is that the welding rod should fl ow into the base material and produce a fi llet type weld. With metal welding, this may be true, but for plastic welding the strongest welds are those where the fi ller rod will retain its basic shape after being pressed into the joint.

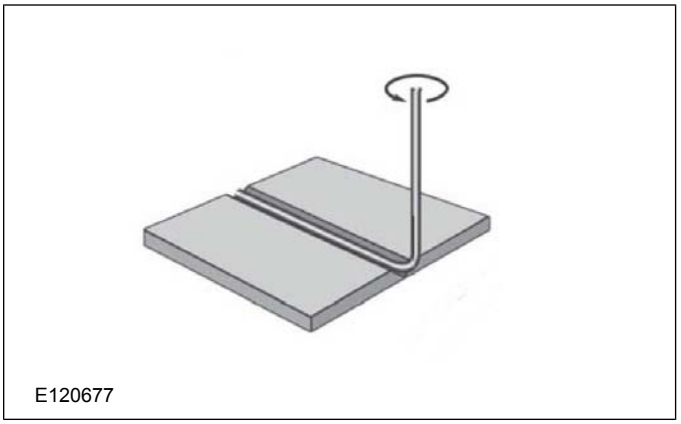
This can easily be seen when using the R-13 ribbon. Aside from some distortion of the edges, the basic profi le of the material remains intact after the welding process.



E120676

When welding very thick materials it may be necessary to make multiple passes with the welding rod. If possible, stagger the starting points of subsequent passes to achieve the strongest possible weld.

Once you complete the weld, you should not immediately pull the welding rod away from the surface being welded. This may cause the rod to break away from the base material. A better way of ending the weld is to remove the heat source and continue to apply pressure with the welding rod directed at the base material for several seconds. To remove the rod, release the downward pressure and twist the rod to break it off.



E120677

Using Speed Tips:

When using the speed tip that comes with the 6055 welder or the optional speed tip for the 6050HA welder (PN: 6050-NHS1), the principle is the same as with the tube tips or reduction nozzle; heat the rod and the base material suffi ciently to get the two to stick together. The difference is the speed

DESCRIPTION AND OPERATION

tip allows the heat to be more easily confi ned to the joint being welded and allows the rod to be more rapidly heated. This allows the user to make faster welds with less heat escaping into the surrounding areas. Using a speed tip also allows some shaping of the fi nished weld because the fi ller rod is melted on all sides and the tip can be dragged over the surface of the weld to press the material into shape.

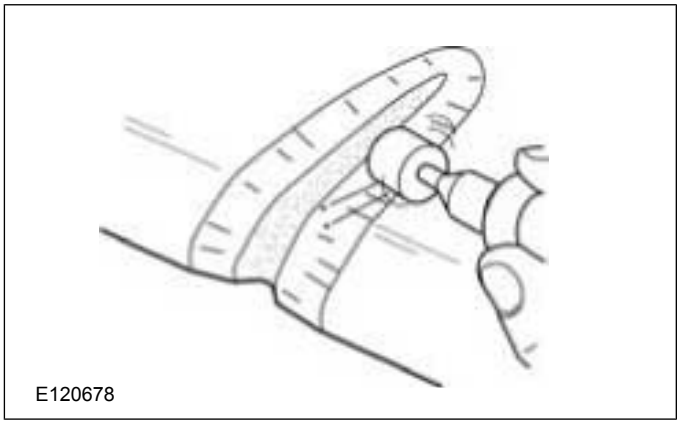
Because you cannot see the area being welded where the rod and base material are joined, it is our recommendation the weld be tested after it has cooled to ensure adequate penetration.

Heat levels and air speeds are roughly the same as with the tube tips and reduction nozzle. You will be able to make additional adjustments based on your need for speed and the thickness and type of base material.

Padded dash repair

Clean and V-Groove Damaged Area

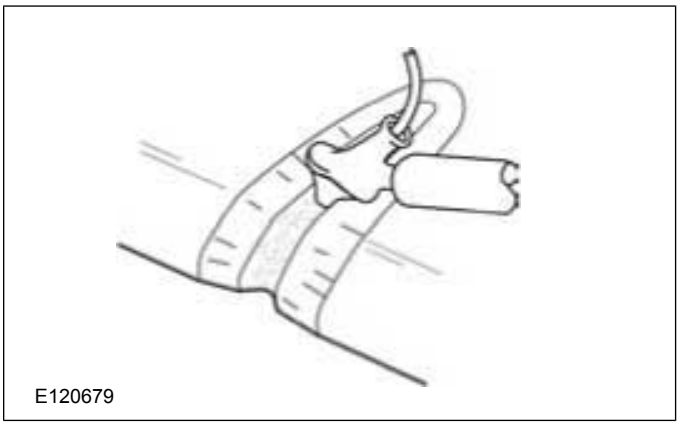
Clean the damaged area with 1000 Super Clean Plastic Cleaner. Bevel the edges of the area to be welded with 6275 Electric Die Grinder and open up a cavity at least 1/4” deep in the foam backing and vinyl cover. Sand and bevel the vinyl cover around the cavity to allow for featheredging of filler.



E120678

Fill Cavity with Urethane Welding Rod

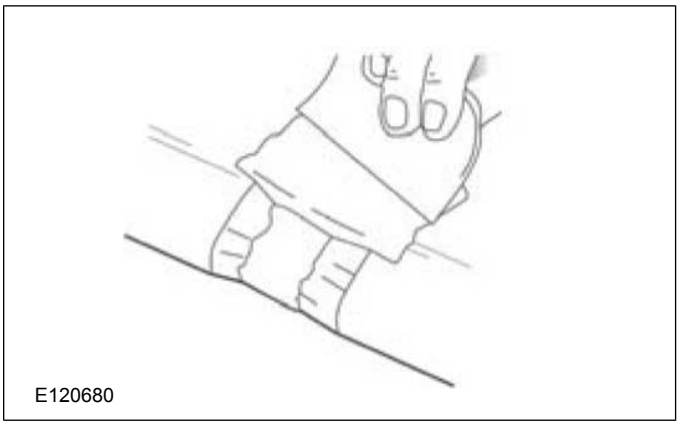
Using the 5003R1 Urethane Welding Rod, start your weld at the bottom of the cavity using your Airless Plastic Welder. Fill the cavity up with melted plastic and spread it out so that it overlaps the edges of the vinyl cover about 1/4”.



E120679

Sand and Apply Padded Dash Filler

After allowing the weld area to cool, grind the weld area smooth with the 6407 Drum Sander attachment for the 6275 Electric Die Grinder. Rough up the surrounding area to improve adhesion of the filler. Mix 2050-9 Padded Dash Filler and apply with plastic squeegee. Cover an area larger than the weld in order to feather out the repair to a smooth contour.

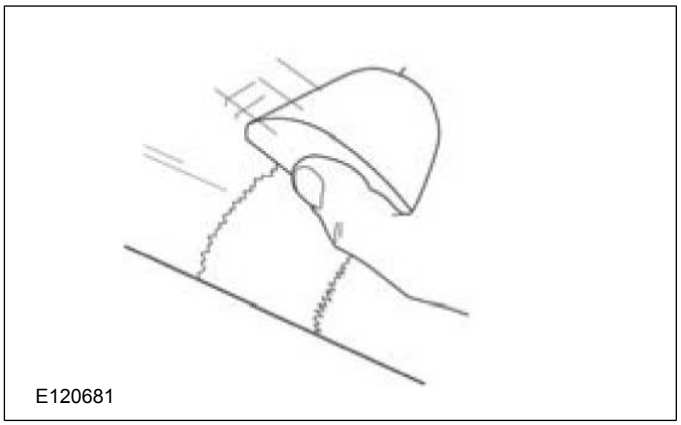


E120680

Finish Sand and Apply Texture Material

Allow the filler to cure at least 15 minutes, then sand to a smooth contour. Finish sand with 220 grit paper. Retexture the panel with 3800 Flex Tex flexible texture material according to directions on Page 9. Do not try to spot retexture. Retexture and blend the leading edge or most visible area of the pad all the way across. If there is a noticeable difference in texture, retexture the entire pad.

DESCRIPTION AND OPERATION


E120681

Repair Method E: Epoxy repair

Repairing Plastics with Epoxy Based Adhesives

Sand backside of area to be repaired with 50 grit paper or coarser. Heavy grooving of the plastic is desirable to maximize the mechanical strength of the bond. Afterward, sand lightly with 80 grit for finer grooving which will further improve adhesion.

If the material is TEO, TPO or PP, you must apply 1060FP Filler Prep Adhesion Promoter. Brush onto the sanded area and allow to flash off.

Apply 2044-2 Fiberglass Reinforcing Tape over the damaged area. If part is SMC, cut a backing panel from a scrap piece of SMC. Make sure the backing panel extends at least 2” beyond damage in all directions.

Choose a two-part epoxy adhesive system to match the hardness of the substrate.

Flexible	**2000 Flex Filler 2 (gray)**
Rigid	**2020 SMC Hardset Adhesive Filler (gray)**

Mix epoxy adhesive in equal parts, apply over fiberglass reinforcing tape on backside of repair. Allow 15 minutes to cure before handling. On SMC, apply a bead of 2020 SMC Hardset Filler to the backing panel and press into place. Allow epoxy at least 20 minutes to cure before handling.

Sand front side of damaged area with 50 grit paper or coarser and v-groove away from tear. The deeper and wider the v-groove is, the stronger the repair will be. Remove paint in the surrounding area and radius into the v-groove with 80 grit in a DA.

Again, if the material is a TPO or PP, apply 1060FP Filler Prep Adhesion Promoter.

Mix and apply selected epoxy adhesive. Build up slightly higher than the surface to allow for sanding. Allow at least 20 minutes to cure before sanding. On SMC, layer pieces of 2043-U Uni-Cloth fiberglass cloth into the v-groove between coats of epoxy. Use a saturation roller if necessary to fully wet the cloth with epoxy.

Contour and smooth the surface with 80 and 180 grit paper.

Repair Method F: Insta-Weld repair

Repairing Plastics with Insta-Weld Adhesives

Our line of Insta-Weld adhesives are specially formulated to provide maximum adhesion on a wide variety of common automotive plastics. Because Insta-Weld forms rigid bonds, it works best with rigid plastics like ABS, polycarbonate, and SMC. It may also be used to tack parts together while performing a welding repair.

Fixing Cracks Quickly

Prior to assembling parts, lightly spray area to be bonded with 2303 Insta-Weld Activator.

Assemble and align parts. Use clamps or 6481 Aluminum Body Tape to hold parts together while bonding.

Apply a small amount of 2200 Insta-Weld 1 thin adhesive to the joint or crack. Optimum results are obtained with the minimum quantity of adhesive needed to fill the joint. The adhesive is thin enough to allow it to be wicked down into the crack. Use 2250 Insta-Weld 2 thick gap-filling adhesive for parts that do not fit together perfectly.

Spray on additional 2303 Activator to complete the cure. Additional Activator and Insta-Weld 2 may be applied to fill any small remaining gaps.

Filling Gaps, Holes, and Gouges

Use 6481 Aluminum Body Tape as a back-up under the hole.

Rough sand and v-groove area around the hole and blow dust free.

Spray a light coat of 2303 Activator in and around hole.

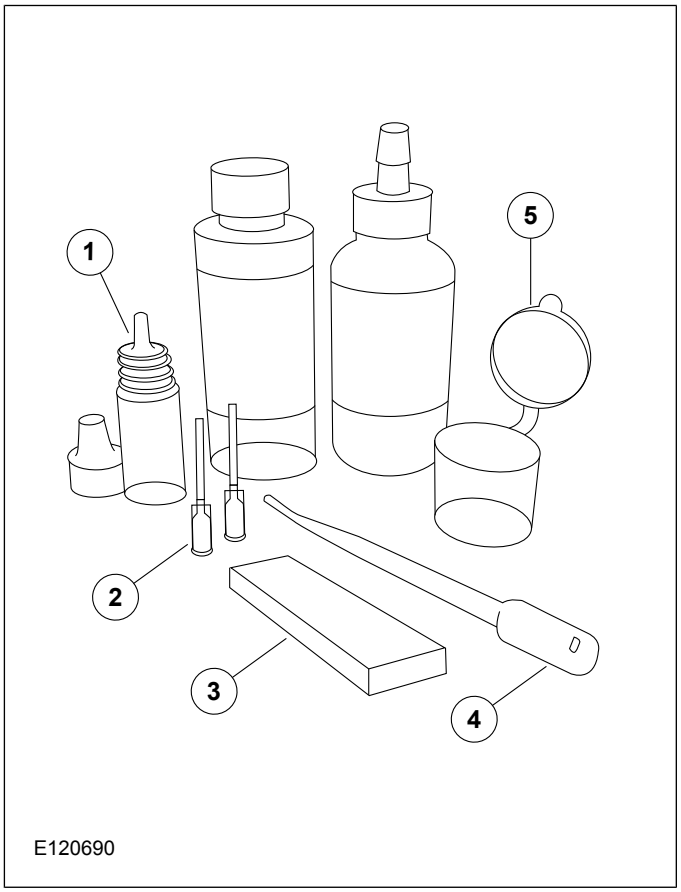
Fill hole with 2300 Weld Compound and saturate with a few drops of 2200-1 Insta-Weld 1. Smooth and saturate the Weld Compound with Insta-Weld using a disposable tool if desired. Wait 5 or 10 seconds and apply another light coat of 2303

DESCRIPTION AND OPERATION

Activator. The repair may be sanded or drilled immediately.

Repair Method G: PlastiFix repair

KIT COMPONENTS



E120690

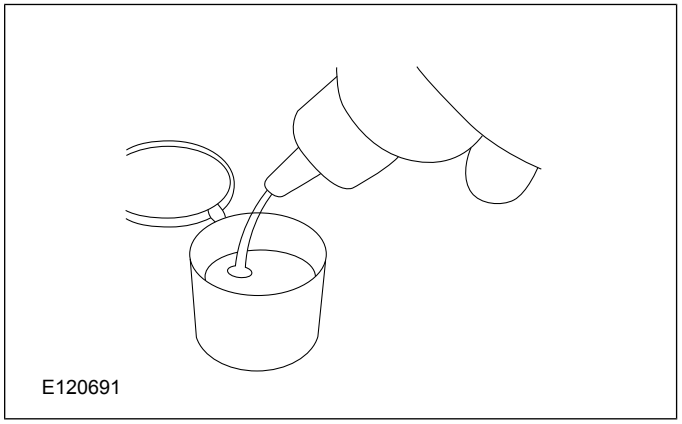
Item	Description
1	Dropper bottle
2	Needle applicators-2nos
3	Flexmold molding bar
4	Pipet
5	Powder cup

Repairing Plastics with PlastiFix® Rigid Plastic Repair Kit

The PlastiFix® Rigid Plastic Repair Kit is a revolutionary plastic repair system that allows you to repair cracks, fill gaps, rebuild tabs, and fix stripped threads. The most unique feature of the PlastiFix® Rigid Plastic Repair Kit is the FlexMold® flexible molding bar. The FlexMold bar allows you to replace a broken tab by forming a mold from an undamaged piece, then casting your new part using the PlastiFix acrylic adhesive system. This system does not work on olefinic plastics like PE, PP, or TEO.

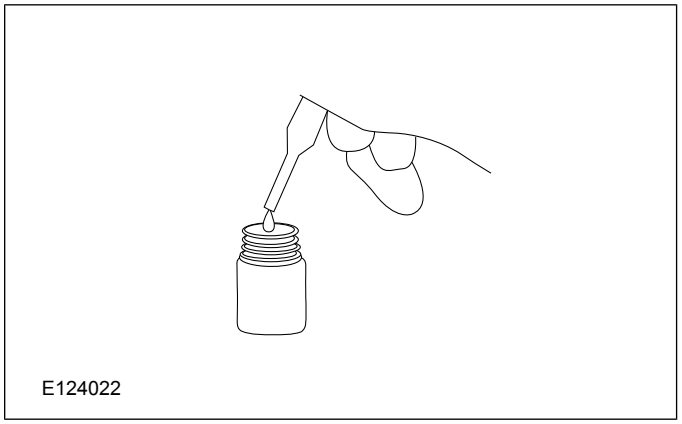
Getting Ready

Dispense powder into cup.



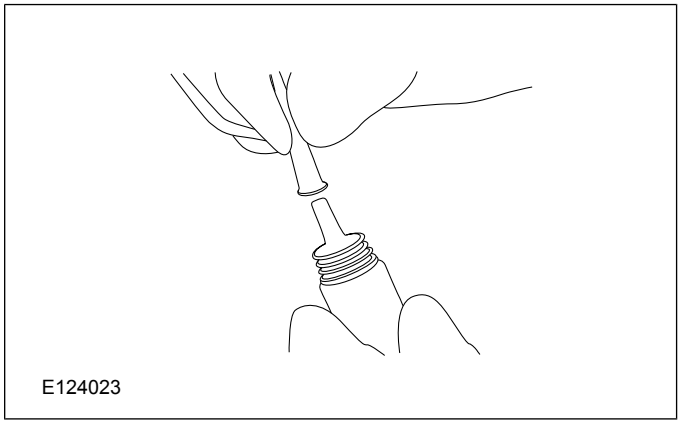
E120691

Use pipet to dispense liquid into the dropper bottle.



E124022

Insert dropper tip into the bottle and place applicator needle onto dropper tip.

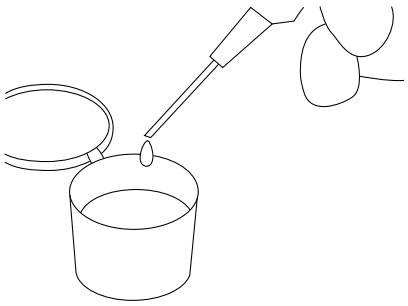


E124023

Application

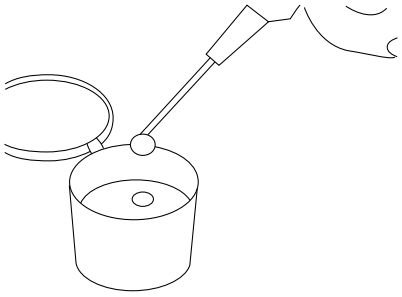
Squeeze one drop of liquid into powder.

DESCRIPTION AND OPERATION



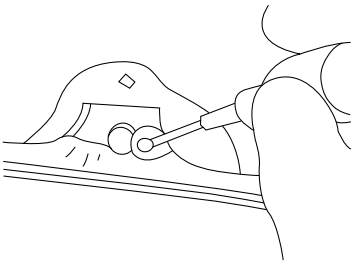
E120692

Pick up liquid/powder mix with tip of needle.



E124024

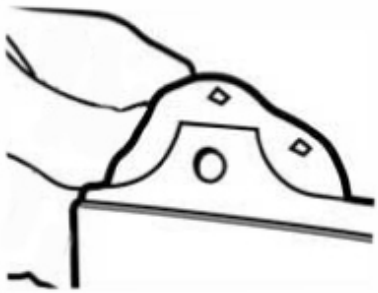
Squeeze bottle to apply liquid/powder mix to repair area.



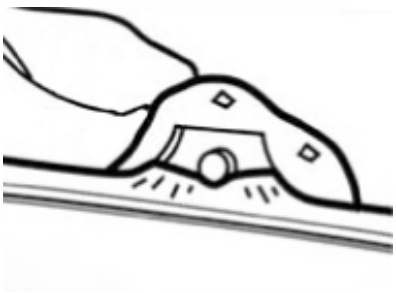
E124025

FlexMold Moulding Bar Use

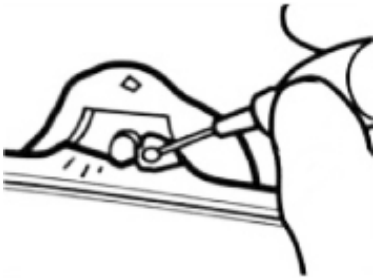
E120693



E120694



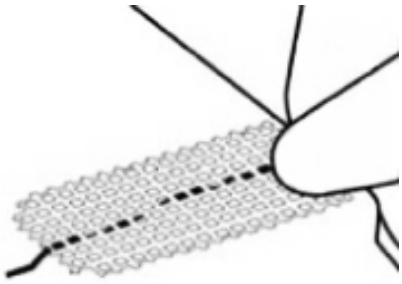
E120695



E120696

DESCRIPTION AND OPERATION

Reinforcing



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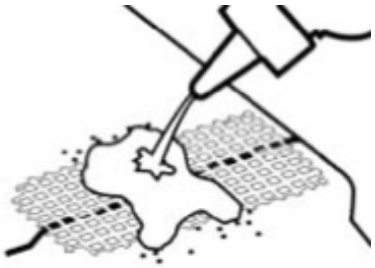
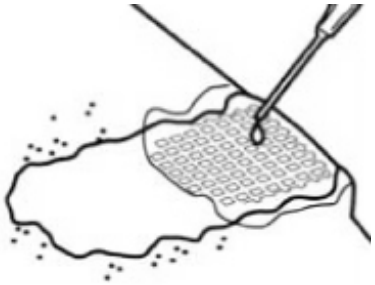
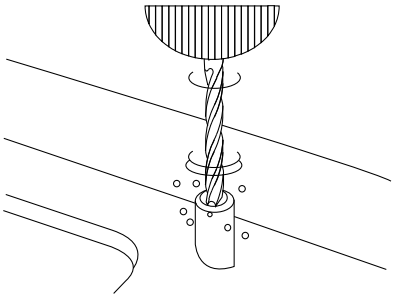


E120698



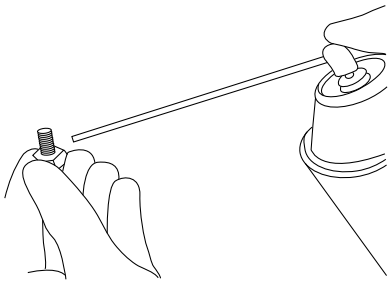
E120699

E120700



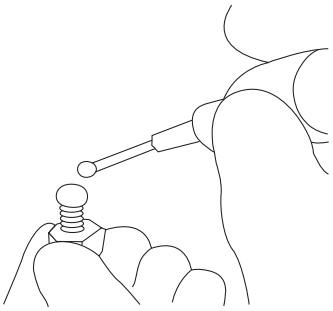
E120701

Apply lubricant to screw threads.



E120702

Apply plastifix powder/liquid mixture to screw threads.



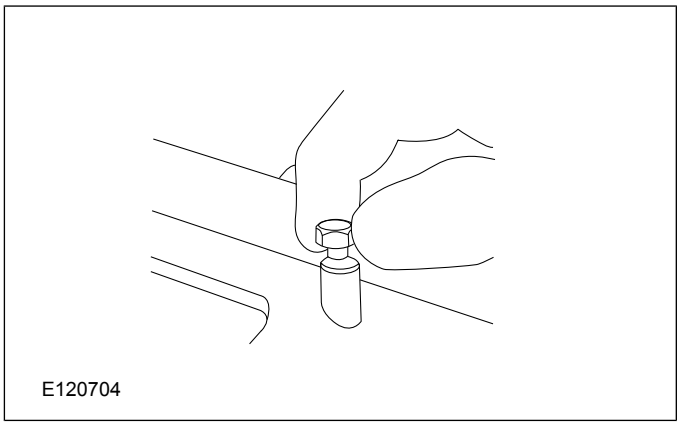
E120703

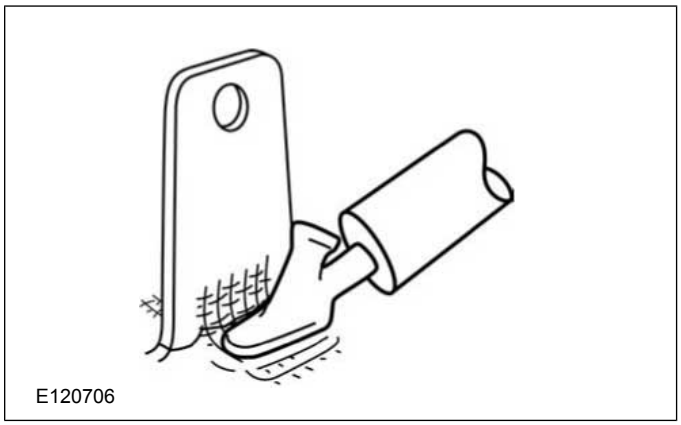
While adhesive is wet, insert into hole.

Repairing Threads

Drill or file threads from hole.

DESCRIPTION AND OPERATION

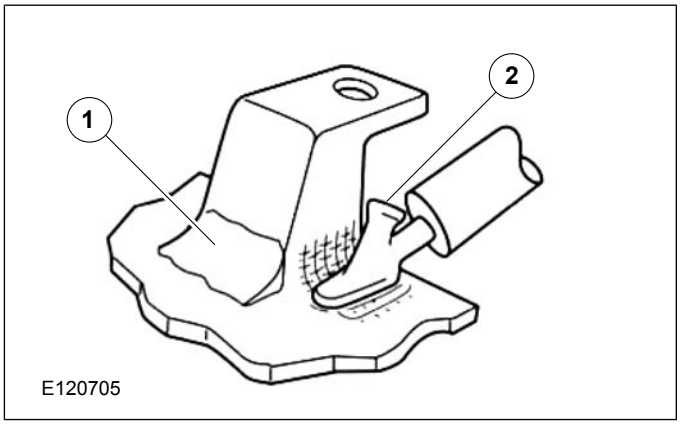

E120704


E120706

Repairing broken tabs

Repairing Flexible Tabs on TEO Plastics

Many TEO bumpers have mounting tabs that have to flex during installation. These can be repaired very durably with the mesh and FiberFlex. First, rough grind the area with a coarse Roloc disc.



E120705

Item	Description
1	Cover with fiberflex or welding rod
2	Melt mesh into corners

Cut 2045W Stainless Steel Wire Mesh to size to fit in the corner areas on both sides of the tab. Using the hot welder tip, bury the mesh directly into the plastic. After you've melted the mesh into the plastic, scuff the melted plastic with coarse sandpaper to remove the gloss.

Melt on a thin layer of FiberFlex over the mesh just to cover. In this repair, the mesh provides the strength and flexibility while the FiberFlex just gives a cosmetic covering.

Repairing Torn Tabs

Rough grind the area surrounding the crack with a coarse Roloc disc.

Cut 2045W Stainless Steel Wire Mesh to size to fit in the corner areas. Using the hot welder tip, bury the mesh directly into the plastic. (This won't work on urethane parts since they don't melt. See Page 5). After you've melted the mesh into the plastic, scuff the melted plastic with coarse sandpaper to remove the gloss.

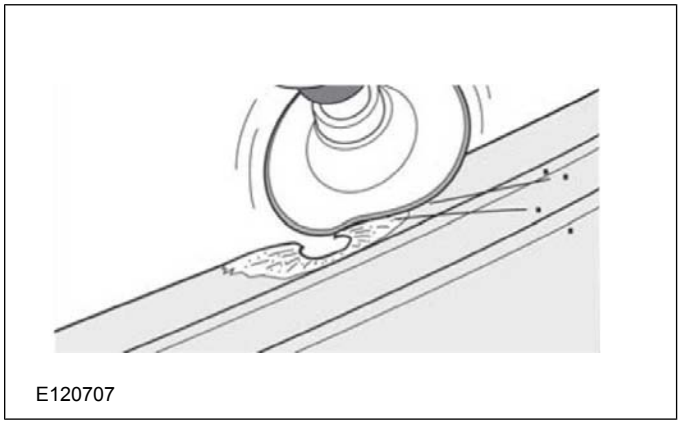
Melt either the FiberFlex or the matching standard plastic rod over the mesh. If using the standard rod, keep the heat on the plastic to make sure the rod melts thoroughly with the base material. Keep adding more rod to make a bigger fillet and increase strength.

Repairing broken bolt holes

There are many cases where the only damage on the part is a torn-out bolt hole or a broken-off tab. The welder is great for repairing such damage. Here are a few strategies for fixing the most common damage found on plastic parts.

Repairing Torn Bolt Holes in TPO with FiberFlex

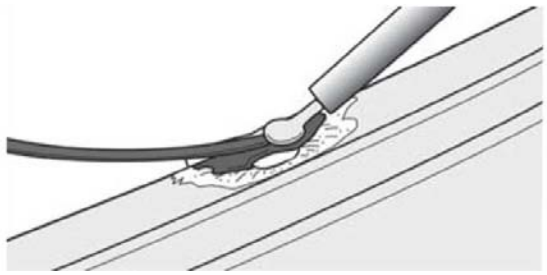
Taper both side of plastic to a point with a coarse Roloc disc. Grind and taper around the edges of the entire bolt hole. Taper back about 1 inch on all sides. Remove paint and radius into taper with 80 grit in a DA.


E120707

DESCRIPTION AND OPERATION

Apply 6481 Aluminum Tape across the gap to support the melted rod while it's hot.

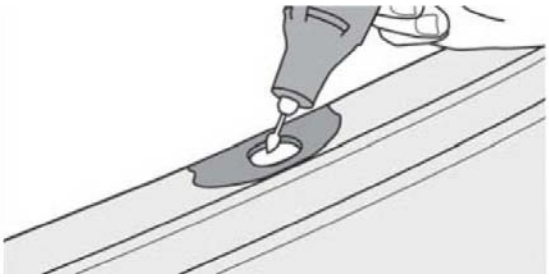
Melt 2045W Stainless Steel Reinforcing Mesh into the plastic across the gap if desired for extra strength. This step is often not necessary because FiberFlex is blended with glass fibers for strength.



E120708

Apply FiberFlex to area using the instructions on Page 7. After cooling, remove aluminum tape and repeat on opposite side.

Allow FiberFlex to cool completely. Open the hole with a die grinder or drill bit, then sand with 80 grit in a DA at low speed to finish the repair.



E120709

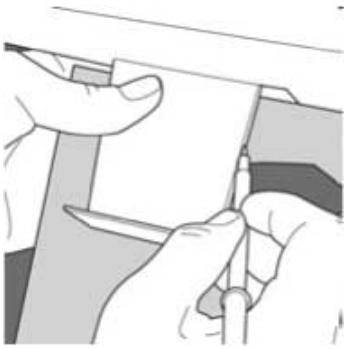
Applying epoxy filler

Grind area to be filled with coarse sandpaper. Slightly v-groove away from the damaged area. All gloss on the surface should be removed to maximize filler adhesion.

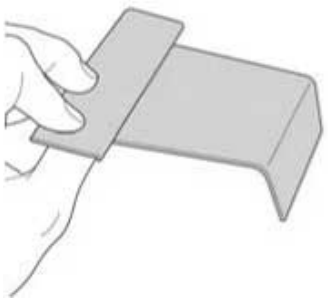
If the material is a polyolefin (PP, PE, TEO, or TPO), apply 1060FP Filler Prep Adhesion Promoter.

Choose a two-part epoxy filler to match the hardness of the substrate. If flexible, use 2000 Flex Filler 2. If rigid, use 2020 SMC Hardset Filler.

Mix epoxy adhesive in equal parts and apply. Build up slightly higher than the surface to allow for sanding. Allow at least 20 minutes to cure before sanding. Contour and smooth the surface with 80 and 180 grit paper.



E120711

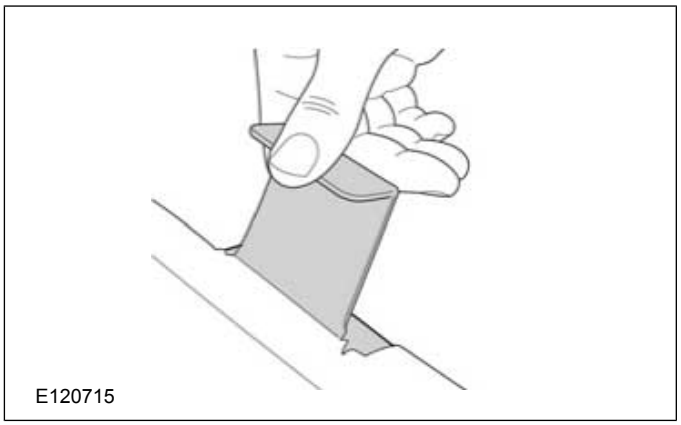


E120712

E120713

E120714

DESCRIPTION AND OPERATION


E120715

Repairing living hinges and tabs

Repairing Living Hinges on TEO Plastics

One of the most difficult tabs to repair are those which are designed to flex along a “hinge” line. The 5010-1 polypropylene sheet was developed to perform such repairs on TPO bumpers.

If you have a good tab left to trace, begin the repair process by tracing the tab onto the 5010-1 PP sheet using a marker or a razor knife. If you have no tab to trace, create a cardboard template for the tab, then trace the template onto the plastic sheet. When making the new tab, be sure to leave an extra strip of plastic past the hinge to allow a place to weld in the new tab into the bumper. Cut the tab out of the polypropylene sheet using a jigsaw or hacksaw.

To make the “living” hinge, clamp your tab into a vise along the hinge line, then bend back and forth to make the hinge line flexible. If the final shape of the tab has an “L” shape, bend this area only one way to keep it stiff.

Cut a notch in the bumper to receive the new tab. Trim the tab or bumper as needed for a snug fit.

Hold the tab in place using 6481-2 foil tape. Weld the tab onto the bumper using R13-W PP strip welding rod and a hot air welder.

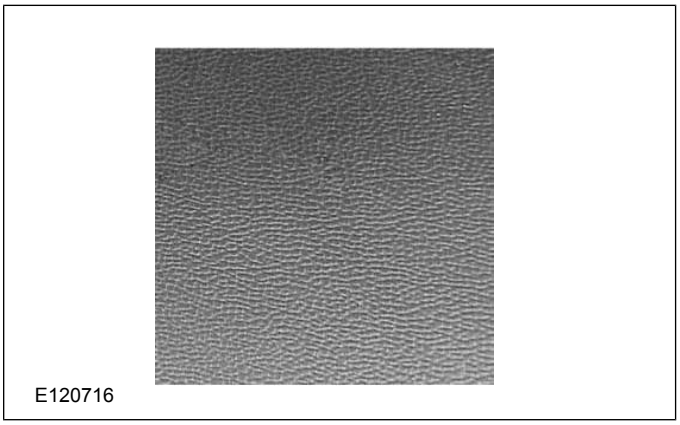
While still hot, burnish the R13-W strip into the tab and bumper using an airless plastic welder with the 6028RT tip. Let cool, then repeat the same procedure on the opposite side. Once cool, the tab should be a least as strong as the original.

Finish the repair by sanding the welded area slightly flush, then fill with 5003R10 FiberFlex. Allow to cool, then finish sand.

Retexturing plastic

Using 3800 Flex-Tex

Scuff Sand - After repairing the damage, scuff sand the area you intend to retexture with 320 grit paper and blow dust free.


E120716

Decide How to Blend Texture - Check the grain, texture, and contours of the panel to be repaired. It is not necessary to exactly duplicate the existing texture to achieve a quality repair. You may be able to blend the new texture out into the old or retexture to a natural break line in the panel to avoid having to retexture the entire panel.

Mix Texture Material - Stir 3800 Flex Tex flexible texture material and pour into a primer gun with a 1.8 - 2.0mm nozzle. Spray some test patterns on a scrap piece of paper and dial in the size and grain of the texture by adjusting the speed of the pass, the air pressure, and the fluid flow. A lower air pressure will give you a larger grain.

Apply Texture Material in Light Coats - When applying Flex Tex, hold the gun about 18 - 24 inches from the surface. Apply in light coats and allow flash time between each coat. Do not wet spray the material as it will flow out and destroy the grain effect. It may require as many as 8 - 10 light coats to achieve the necessary buildup.

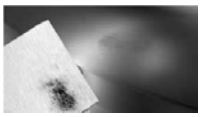
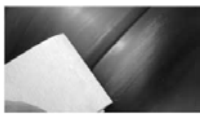
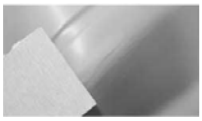
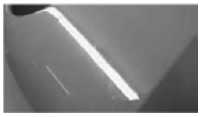
Nib Sand and Blend Texture - When the desired texture buildup is achieved, allow the texture to dry completely. Then, using a scuff pad, lightly nib sand the newly textured area. As you nib sand you will detect the repair area begin to blend into the original texture of the panel and the sprayed look will disappear.

DESCRIPTION AND OPERATION

E120717

Apply Flexible Color Coat - After sanding the texture, blow dust free and apply a flexible color coat. To match over 40 OEM shades of gray, topcoat with 3500 series Bumper and Cladding Coat Paint.

Priming Plastics: primer selection & use

	New Replacement Bumpers		Repaired Bumpers	
Types of Bumpers	OEM Primed Bumpers	RAW TPO Bumpers	RAW PUR Bumpers	OEM Painted Bumpers
	 E120597	 E120718	 E120719	 E120720
Identify Bumper	Domestic bumpers (GM, Ford, Chrysler) usually have OEM primer. Color is usually black with high sheen and uniform appearance. Occasionally gray. Sanding the surface lightly with 400 grit sandpaper will produce fine dust. The color or appearance of the painted side is different or if overspray is visible on the inside of the bumper. NOTE: Sometimes the inside is primed also.	Toyota, Nissan, Kia and Subaru are usually raw, unprimed TPO. ID symbol is PP, PP/EPDM, TSOP, TPO, TEO, or TPE. Usually black with dull finish, sometimes non-uniform in appearance, may have tacky mold release agent on surface. When sanded lightly with 400 grit sandpaper, virtually no dust is produced.	May be PUR if Toyota or Lexus with light gray color. All yellow plastic bumpers are PUR. ID symbol is PUR. When lightly sanded with 400 grit sandpaper will produce virtually no dust.	High Gloss. Color matches body color. Base material different color than top coat.

DESCRIPTION AND OPERATION

	New Replacement Bumpers		Repaired Bumpers	
Product Selection	 E120721	 E120722	 E120723	 E120724
Surface Preparation	(REQUIRED) Clean entire bumper with 1020 Scuff Magic Prep Soap and a red scuff pad. Rinse with clean water. Allow to Dry. Bumper surface and ambient temperature should be between 65˚F and 95˚F.	(OPTIONAL) Clean Bumper with 1020 Scuff Magic Prep Soap and a gray scuff pad. Allow to Dry. (REQUIRED) Bumper surface and ambient temperature should be between 65˚F and 95˚F. Clean entire surface to be primed with 1000 Super Clean Plastic Cleaner. Spray heavy, wet coat over a 1 to 2 square foot area, wipe dry with a clean cloth, exposing clean surface to plastic with each wipe. Repeat until the entire surface has been cleaned.	(OPTIONAL) Clean Bumper with 1020 Scuff Magic Prep Soap and a gray scuff pad. Allow to Dry. Bumper surface and ambient temperature should be between 65˚F and 95˚F. Clean entire surface to be primed with 1000 Super Clean Plastic Cleaner. Spray heavy, wet coat over a 1 to 2 square foot area, wipe dry with a clean cloth, exposing clean surface to plastic with each wipe. Repeat until the entire surface has been cleaned.	(OPTIONAL) Clean Bumper with 1020 Scuff Magic Prep Soap and a gray scuff pad. Allow to Dry. (REQUIRED) Bumper surface and ambient temperature should be between 65˚F and 95˚F. Clean entire surface to be primed with 1000 Super Clean Plastic Cleaner. Spray heavy, wet coat over a 1 to 2 square foot area, wipe dry with a clean cloth, exposing clean surface to plastic with each wipe. Repeat until the entire surface has been cleaned. Sand overall with 320 grit sand paper. Blow dust free.
Paint Preparation	Stir Prime Time, do not shake. Mix appropriate shade of Prime Time using 3030 series toners. Shades closely resemble Dupont® Value Shade® system. Catalyzed Prime Time has an 8 hour pot life. Catalyze appropriate amount to meet job requirements.	Shake or stir Bumper and Cladding Coat. Pour appropriate amount into gun to meet job requirements.	Stir Prime Time, do not shake. Mix appropriate shade of Prime Time using 3030 series toners. Shades closely resemble Dupont® Value Shade® system. Catalyzed Prime Time has an 8 hour pot life. Catalyze appropriate amount to meet job requirements.	Stir Black Cat, do not shake. If desired, Black Cat may be thinned with water up to 5% by volume. Catalyzed Black Cat has an 8 hour pot life. Catalyze appropriate amount to meet job requirements.

DESCRIPTION AND OPERATION

	New Replacement Bumpers		Repaired Bumpers	
Catalyst Mix Ratio	Mix 3103 catalyst with Prime Time 2% by weight. (weight of paint) x .02= weight of catalyst For example, if you are using 100 grams of Prime Time, add 2 grams of 3103 catalyst. If no scale is available, then mix 2 teaspoons of catalyst per pint of Prime Time. Mix thoroughly. Do not shake.	Not applicable. No catalyst required.	Mix 3103 catalyst with Prime Time 2% by weight. (weight of piant) x .02= weight of catalyst For example, if you are using 100 grams of Prime Time, add 2 grams of 3103 catalyst. If no scale is available, then mix 2 teaspoons of catalyst per pint of Prime Time. Mix thoroughly. Do not shake.	If using 3103 catalyst, then mix 2% by weight to Black Cat or 2 grams of catalyst for every 100 grams of Black Cat. If no scale is available, then mix 2 teaspoons of catalyst per pint of Black Cat. Mix thoroughly. Do not shake.
Paint Gun	Base coat gun with a 1.0 mm to 1.4 mm nozzle.	Base coat gun with a 0.8 mm to 1.3 mm nozzle.	Base coat gun with a 1.0 mm to 1.4 mm nozzle.	Base coat gun with a 1.2 mm to 1.4 mm nozzle for smooth finish. Primer gun with a 1.8 mm to 2.0 mm nozzle for high build.
Application	Apply one light coat. Immediately apply second light coat if needed to hide thin areas. If second full coat is desired, allow Prime Time to flash off before applying second full coat. Flash time varies depending on temperature and humidity. Flash time is usually between 10 and 30 minutes.	Apply one light coat. Immediately apply second light coat if needed to hide thin areas. If second full coat is desired, allow Bumper and Cladding Coat to flash off before applying second full coat. Flash time varies depending on temperature and humidity. Flash time is usually between 5 and 10 minutes.	Apply one light coat. Immediately apply second light coat if needed to hide thin areas. If second full coat is desired, allow Prime Time to flash off before applying second full coat. Flash time varies depending on temperature and humidity. Flash time is usually between 10 and 30 minutes.	Apply one medium coat. If second coat is desired, allow Black Cat to flash off before applying second full coat. Flash time varies depending on temperature and humidity. Flash time is usually between 10 and 30 minutes. Additional coats may be applied after sanding to achieve desired surface finish if needed.

DESCRIPTION AND OPERATION

	New Replacement Bumpers		Repaired Bumpers	
Dry Time	Allow at least 60 minutes dry time at room temperature or 30 minutes at 120°F. Dry time will vary depending on temperature and humidity. Prime Time **must** be completely dry before topcoating. The crosslinking process takes six hours at room temperature or one hour at 120°F. Prime Time may be topcoated before crosslinking is complete.	Allow at least 60 minutes dry time at room temperature or 15 minutes at 130°F. Dry time will vary depending on temperature and humidity. Bumper and Cladding Coat **must** be completely dry before topcoating. Any unused paint may be returned to the can for future use.	Allow at least 60 minutes dry time at room temperature or 30 minutes at 120°F. Dry time will vary depending on temperature and humidity. Prime Time **must** be completely dry before topcoating. The crosslinking process takes six hours at room temperature or one hour at 120°F. Prime Time may be topcoated before crosslinking is complete.	Allow at least 30 minutes dry time at room temperature or 15 minutes at 120°F before dry sanding. Black Cat may be wet sanded after 6 hours dry time at room temperature or after 60 minutes at 120°F. Dry time will vary depending on temperature and humidity. Black Cat **must** be completely dry before topcoating. The crosslinking process takes six hours at room temperature or one hour at 120°F. Black Cat may be topcoated before crosslinking is complete.

DESCRIPTION AND OPERATION

	New Replacement Bumpers		Repaired Bumpers	
Top Coat	No sanding required before applying the topcoat. If required, surface may be lightly scuffed or sanded to achieve desired smoothness. If sanded, blow or wipe dust off surface before applying topcoat. Apply any Base/Clear or single stage topcoat system according to the manufacturer's instructions. Topcoating window does not close. Prime Time may be topcoated at any time once fully dry.	No sanding required before applying topcoat. Although sanding Bumper and Cladding Coat Adhesion Primer is not recommended, trapped debris may be removed with very light sanding using 600 grit paper. Apply any approved Base/Clear system according to the manufacturer's instructions. Bumper and Cladding Coat Adhesion Primer may not be topcoated with 2K primers, single stage paint or catalyzed base coats. Topcoating window does not close. Bumper and Cladding Coat Adhesion Primer may be topcoated at any time once fully dry.	No sanding required before applying the topcoat. If required, surface may be lightly scuffed or sanded to achieve desired smoothness. If sanded, blow or wipe dust off surface before applying topcoat. Apply any Base/Clear or single stage topcoat system according to the manufacturer's instructions. Topcoating window does not close. Prime Time may be topcoated at any time once fully dry.	Finish Sand with 400 to 600 grit sand paper. Apply any sealer, Base/Clear or single stage topcoat system according to the manufacturer's instructions.

DESCRIPTION AND OPERATION

Impact of Insufficient Repair Quality

Body repairs usually require a significant level of intervention in the existing body shell structure. The corrosion protection, seals and NVH components are destroyed and must be replaced.

To prevent the vehicle quality from being reduced due to an insufficient repair quality, all repairs carried out in all repair sections must be inspected during and after the accident repair.

Simply checking the vehicle at the time of delivery is not sufficient to guarantee the repair quality. Rather, continuous checking of the work carried out is recommended.

NOTE: Logs of the acceptance of individual operations are a useful tool for quality assurance. A comprehensive final inspection can be carried out based on a final acceptance log.

In the process, the entire repair sequence must be split into reasonable sections, with the creation of check points to which particular attention must be paid.

The following are some possible sections:

- Completion of the body repairs.
- Completion of the paint repairs.
- Completion of anti-rust treatment
- Final assembly, ancillary components, functional tests.
- Inspection on safety
- Vehicle delivery.

NOTE: The following points offer an indication of possible test logs. They can be combined and supplemented differently, depending on the individual operating procedures.

Completion of the body repairs

After completion of the body repairs, the following areas should be checked:

- Manufacturing inspection for functionality and originality in the accident area.
- Check snug fitting of metal panel parts (welding and screw connections).
- Check snug fitting of ancillary components (doors, hoods, glazing).
- Check surface condition of the welded seams.
- Check seals, blanking plugs, NVH components.
- Check corrosion prevention measures
- Check that the repair work is in the correct condition for painting.

Completion of the paint repairs

The following points should be noted when checking the paint repairs:

- Originality of the paintwork.
- Transitions to the adjacent paintwork.
- Leftover paint and paint traces.
- Leftover masking materials and dirt.
- Underbody protection and cavity protection.

Completion of anti-rust treatment

The following points should be noted when checking the anti rust treatment:

- Under body: Inspect the state of undercoat application.
- Panel joint area: Inspect the range of the area applied with body sealer.
- Inspect for water leakage: Inspect the joint areas between any two of the panel, between a panel and a fitting part doors and weather strips for water.

Final assembly, ancillary components, functional tests

After final assembly, not only a visual inspection is required, but also the functionality of many components must be checked:

- Check repair area for originality.
- Check ancillary components for correct installation.
- Check precision fitting of all parts.
- Check that the doors and flaps are working correctly.
- Check that all mechanical parts, such as the window winder are working correctly.
- Check for leaks in the repair area.

Inspection on safety

The following points should be noted when checking the vehicle safety and ensuring road worthiness:

Inspection and adjustment of wheel alignment After the body has been restored to the original specification, it must be possible to adjust the wheel alignment to the standards.

- Camber
- Caster
- Toe-in

DESCRIPTION AND OPERATION

- Front wheel turning angle
- Side slip

Brake Inspect for brake fluid leakage, air mixing in the fluid, etc.

Lights Inspect and adjust, where necessary, the lighting of lights and lamps and their beam lines.

Fuel Inspect for fuel leakage.

Functional parts

- Door lock and door glass regulator operations
- Wiper and washer
- Climate control (Heating, Ventilation, and Air conditioning)
- Hood, trunk lid or tailgate operations

Vehicle delivery

Vehicle delivery again offers the opportunity of checking the repair quality. In the process, the following points are to be checked again:

- Check the accident area for originality.
- Visual inspection of the transitions and gaps.
- Check for corrosion prevention measures, insulation mats and rubber seals.
- Check for traces of leftover paint.
- Check the cleanliness of the vehicle.
- Functional check of the mechanical and electrical components.
- Road test the vehicle.
- Check for noise, vibration and harshness (NVH).
- Check for wind noise.

Thoroughly cross check the Repair Order for the list repairs identified while the damaged vehicle was received.

After repair work on the body and vehicle, not only the visual restoration of the damaged vehicle, but also the functional restoration must be guaranteed. Ensure that all the identified repairs by Service Advisor are completed as per the requirement and it is meeting the Ford safety and standard guidelines.

Additional repairs/component replacements identified during the operation is noted in the Repair order and proper approval has been obtained from customer to carry out those along with existing repair job.

Pay full attention to check the additional repairs are completed as per the norms and within the stipulated time frame agreed with customer.

Present the defect/replaced parts of the vehicle for customer inspection.

Customers are making increasingly high demands of vehicles, particularly in terms of driving comfort. Customers find noise, vibrations and harshness (NVH) as well as squeaking and rattling annoying, particularly after repair work. It is therefore important that the condition of the vehicle at the time of production be restored after an accident repair.

After body repairs, the entire repair area must be checked for any water leaks. It is crucial that a leak test be carried out as part of the final inspection so that water leaks can be detected and eliminated even before delivery of the vehicle to the customer.

Final body shop and mechanical workshop quality inspector has thoroughly checked the vehicle and signs the quality approval document prior delivering the vehicle to customer.

The requirements of the vehicle manufacturer are to be taken into consideration during all inspections. Only in this way can it be guaranteed that the vehicle quality is not reduced through insufficient repair quality.

DESCRIPTION AND OPERATION

Water Leaks

Water leaks can occur after body repair work, but can also occur on new vehicles. The test methods described below allow the various causes to be identified. In all cases, a systematic and logical procedure is required to locate water leaks.

General

When searching for faults, it must be taken into account that water can enter the vehicle passenger compartment in various ways and under different conditions. Therefore, it is sometimes not sufficient to perform a water test on a stationary vehicle.

Before beginning extensive checks, a thorough visual inspection must be carried out. The following points are to be taken into account in the process:

- Check the clearance and accurate fit of ancillary components such as the trunk lid and doors.
- Check for correct installation and possible damage to sealing elements such as blanking plugs, seals and rubber door seals.
- Check that the water discharge are not blocked.

Testers

NOTE: Further test methods and testers are set out in the "Wind noise" chapter.

Water leaks and wind noise can have similar causes. This means that test methods and testers can be used for both types of problem. The alternative tests are as follows:

- Stethoscope.
- Smoke pipe.
- Ultrasonic detector.
- Powder test.

Test method

Water leaks in the vehicle passenger compartment cannot usually be located at the first go, as the water frequently distributes itself across larger areas. For this reason, the passenger compartment must be dried before the leak tests. Any ancillary components that block the view must be removed.

Water test

During the water test, the vehicle is sprayed with water at the suspected location of the leak. At the same time, a second person checks the passenger compartment for places where water enters the vehicle.

- Start in the lower area and spray the whole area, working upwards in stages.
- Use a water spray nozzle with a variable water jet.
- In difficult cases, improve the free flowing of the water by adding a small amount of rinsing agent.
- Use a special mirror in areas with poor visibility.
- If necessary, use a contrast agent and UV lamp.

Washer test

Certain leak problems only appear in a car wash or can only be simulated there. The concerned area of the passenger compartment should be inspected with a torch during the wash procedure.

Road Test

Some leaks only appear when the vehicle is moving. If no leaks are detected during the above-mentioned tests, road tests should be carried out on wet roads.

- At various speeds.
- On various road surfaces (asphalt to cobbles).
- With loaded or unloaded vehicle.
- Driving through puddles (splash water).

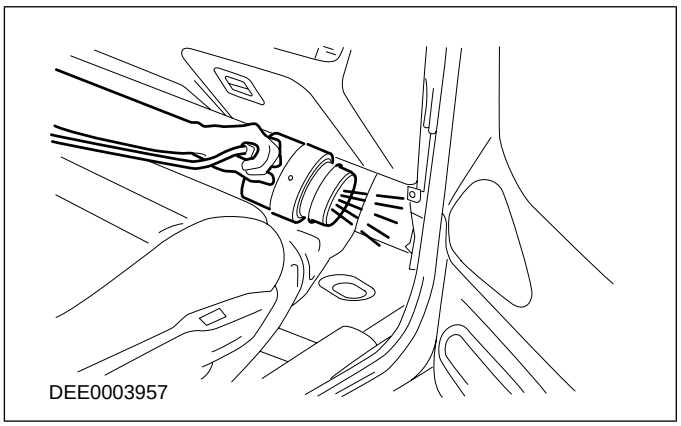
Test with UV lamp

As already indicated in the water test section, a leak test can be executed with a UV lamp and a special contrast agent. The advantages of using contrast agent are:

- No need to dry out wet areas beforehand.
- The water entry and its subsequent path can be seen more clearly.
- No need to remove most ancillary components from the vehicle.

DESCRIPTION AND OPERATION

NOTE: The equipment manufacturer's instructions must be followed when using a UV lamp and contrast agent.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Procedure for using a UV lamp.

- Wet the test area with clear water from the outside.
- Prepare test liquid and apply it from the outside using a suitable water sprayer.
- Illuminate the relevant area from the inside using the UV lamp. The test liquid will make the leak visible.

Chalk/powder test

In this test, the contact area of the seal is checked.

To do this, the door seal is coated with powder or brushed with chalk. A thin layer of grease is applied to the contact area of the seal. The door must then be slowly closed and reopened.

The width and continuity of the imprint can now be checked on the door seal.

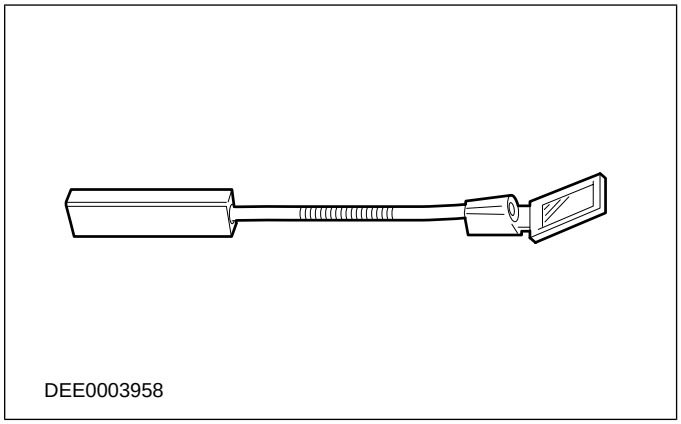
Smoke test

This test can be used to detect leaks visually. The process is as follows:

- Set the ventilation blower in the passenger compartment to the highest setting.
- Close all doors so that a slight overpressure can build up in the passenger compartment.
- Move the smoke pipe along the outside of the body to the areas to be checked.
- Leaks can be detected through the irregular movement of the smoke.

Special Mirror Test

The special mirror can be used to see into hard-to-reach areas.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Benefits

A switchable light is built into the mirror area.

The angle of inclination of the mirror can be set manually using the handle.

The connector between the handle and the mirror is flexible.

Stethoscope test

This procedure is very similar to the smoke test. Instead of the smoke pipe, move a stethoscope past the areas of the body that are at risk. Leaks can now be detected acoustically.

Ultrasonic detection

With this test, a leak can be found electronically. The procedure is as follows:

- Place the ultrasonic transmitter in the vehicle.
- Completely close the vehicle.
- Search the exterior of the vehicle using the detector.
- The detector provides a simple indication of a leak.

DESCRIPTION AND OPERATION

Sequence

Stage	Testing	Result	Action
1st	Ask customer for a detailed list of possible reasons for the water entry. Does this information allow the cause of the leak to be identified?	Yes	Dry out the vehicle and repair the damage. Perform a water test as a check (see test method).
		No	Step 2.
2nd	Perform an initial visual inspection on the vehicle. Look for signs of water entry. Can the cause of the leak be identified immediately?	Yes	Dry out vehicle. Repair damage. Perform a water test as a check (see test method).
		No	Step 3.
3rd	Is it possible that water is getting into the vehicle through a seal (door seal, trunk lid seal)?	Yes	Check the seal for damage. Check the creation of the seal using the chalk test (see test methods). Step 4.
		No	Step 5.
4th	Is the contact area for the seal adequate?	Yes	Step 5.
		No	Perform work as described under Areas with possible water leaks - Door seals. Dry out vehicle. Repair damage. Perform a water test as a check (see test method).
5th	Before starting any further work, use the VIN to look for model-specific information in eTIS. Perform Oasis query and check TSIs. Does this information allow the cause of the leak to be identified?	Yes	Dry out vehicle. Repair the damage using the information found. Perform a water test as a check (see test method).
		No	Step 6.
6th	Establish the extent of the damage. To do this, expose wet areas. Remove parts. Investigate the suspected area for signs of water. Does an investigation of the suspected area allow the cause of the leak to be identified?	Yes	Dry out vehicle. Repair leak. Perform a water test as a check (see test method).
		No	Step 7.
7th	Check exterior areas (seals, seal welds). Check interior areas: Signs of water, plugs, seal welds. Can the cause of the leak be identified?	Yes	Dry out vehicle. Repair leak. Perform a water test as a check (see test method).
		No	Step 8.
8th	Perform water test or ultrasound test. Can the cause of the leak be found?	Yes	Dry out vehicle. Repair leak. Perform a water test as a check (see test method).

DESCRIPTION AND OPERATION

Stage	Testing	Result	Action
		No	The water entry may only occur under dynamic driving conditions. This requires intensive tests to be repeated with the corresponding climatic influences (rain).

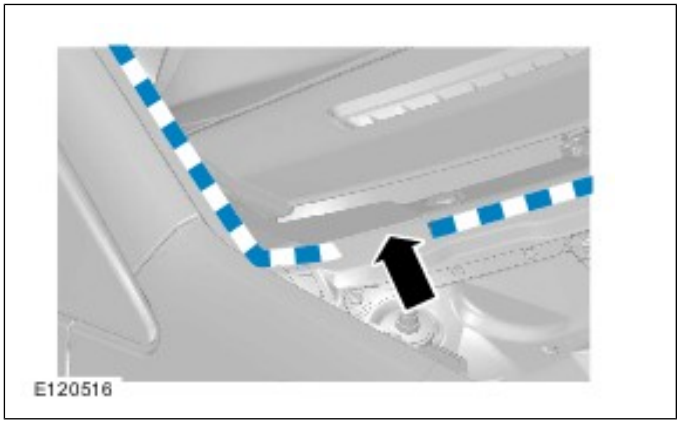
Possible complaints and corrective actions

NOTE: Water leaks and changed vehicle acoustics can have similar causes. For this reason, information from the Wind noise or Noise, vibrations, roughness chapters may be useful in identifying the fault.

An outline of the possible complaints due to water leaks is provided below. The causes of water leaks and the possible remedies are presented using selected examples. They are intended to provide troubleshooting tips and suggestions for the user but do not represent an exhaustive faults list.

Glued windows

A broken pasted seam can cause water to enter around the window. A broken pasted seam can be located using a water test or by carefully blowing compressed air onto the inside of the window seal.



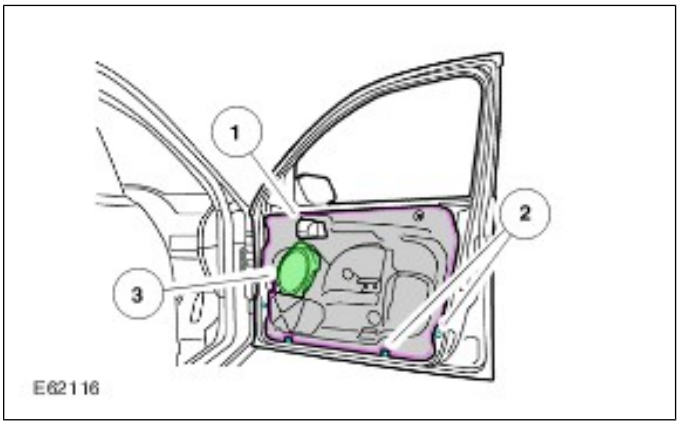
Corrective action

Broken pasted seams **-Arrow-** can be sealed from inside using PU adhesive.

If this seal does not resolve the problem or the broken pasted seam is too extensive, it is necessary to remove the window and glue it back into place.

Door seals

If water appears at the bottom of the door, it is possible that the door seal behind the door trim is damaged. If the door is intact, water can enter through the window weatherstrip and flow out through gaps on the underside of the door. If the door seal adhesion is faulty or the door seal is damaged, water can get into the interior.



Item	Description
1	Seal/adhesion
2	Clips
3	Door speaker

Fastening bolts could be loose or clips incorrectly positioned on door modules.

Corrective action

Depending on the door seals used, different sealing methods can be used.

NOTE: The drainage holes on the underside of the door may not be blocked - if they are, clean them. Defective films and foam seals must be replaced.

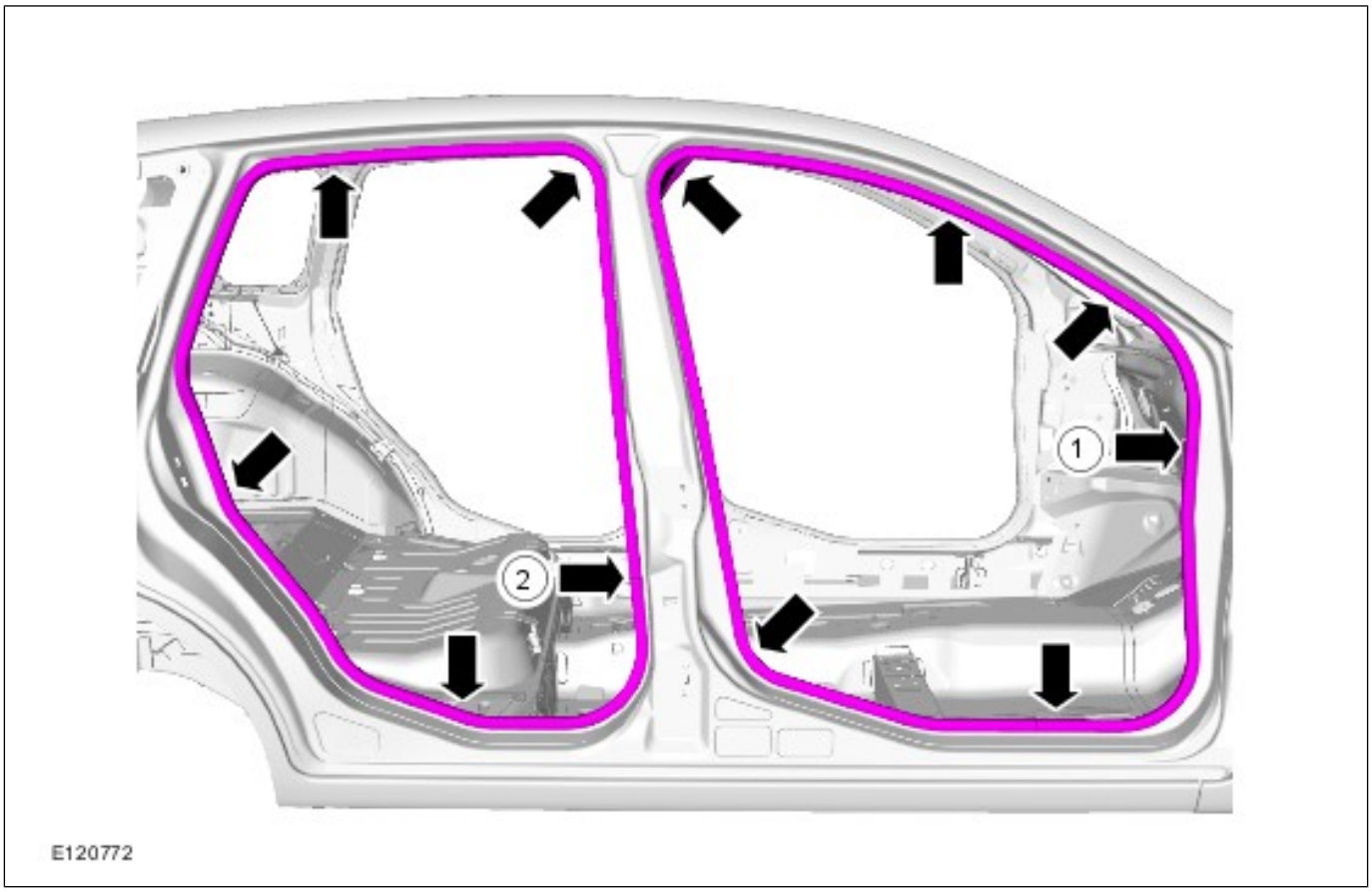
Once the adhesive surfaces have been cleaned, plastic films must be stuck with double-sided adhesive tape or replaced.

Leaky foam seals are sealed with Butyl tape or replaced.

DESCRIPTION AND OPERATION

Plastic door modules are fitted with a weatherstrip, which cannot be replaced. Seal the leaky point with Butyl tape or replace the part.

Door weatherstrip



Item	Description
1	Front door weatherstrip joining location
2	Rear door weatherstrip joining location

Leaks can be caused by badly fitted seals. In particular, areas with radii **-Arrow-** must be thoroughly checked.

Door seals can develop leaks due to:

- Damaged or expanded seals.
- Ageing.
- Insufficient contact pressure.
- Inadequate contact area for seal on body part.
- Uneven welding flange thickness.
- Kinks.

The contact pressure of a seal can be determined using a strip of paper. If a strip of paper trapped in the closed door can be pulled out easily, the contact pressure is too low.

Corrective action

Replace damaged or aged seals. Prevent kinks.

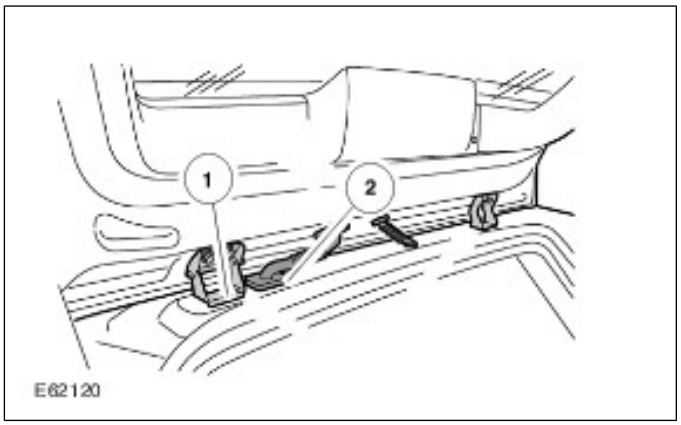
The contact pressure can be changed by adjusting the catch bolt or correcting the panel flange.

Realign uneven welding flange thicknesses. Properly repair any paint damage that occurs.

Rubber grommets / plugs

Rubber grommets or plugs are fitted at numerous points on the body. They are frequently used as seals for cables, hoses or actuating links. Rubber plugs are frequently used for gaps caused during production.

DESCRIPTION AND OPERATION



Item	Description
1	Hinge seal
2	Cable duct

Leaks can be caused by badly fitted or damaged rubber grommets and plugs.

Damaged cable insulation can also cause leaks.

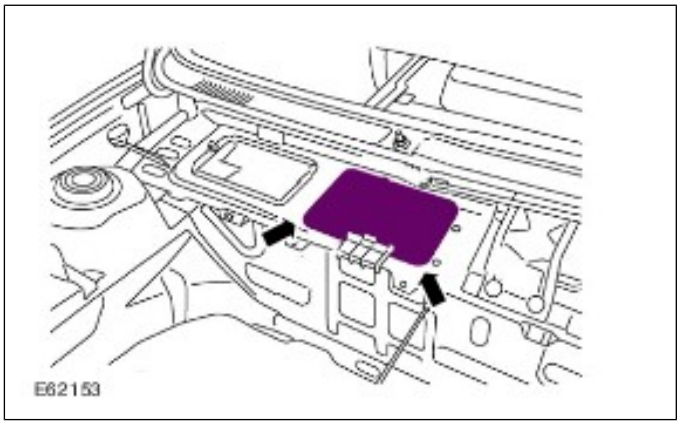
Where components are bolted on, water can enter if there are inadequate seals at the connection point.

Corrective action

Correctly fit rubber grommets / plugs. During fitting, ensure that the sealing lips are not trapped and are applied properly. The contact area of the rubber grommets / plugs can also be sealed with PU sealing compound. Replaced damaged rubber grommets and repair damaged cable insulation.

Heater housing/ventilation

Loose Butyl sealing strips, damaged sealing surfaces or a trapped carpet can cause leaks around the heater housing / ventilation **-Arrow-**. Badly positioned or badly fitted hoses can also be responsible for water entry. Water drains must not be blocked.



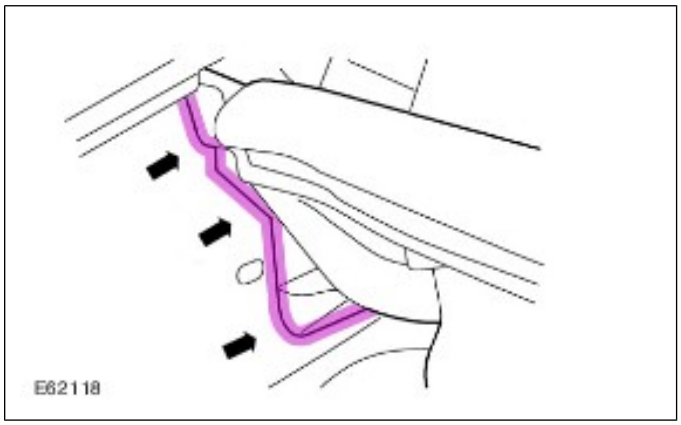
NOTE: A large quantity of water flows through the water tank. If there are leaks in this area, it is essential to ensure that the water drainage mechanisms function correctly. Drainage openings may not be blocked or stuck. Leaves and other dirt must be removed before troubleshooting.

Corrective action

Before the actual repair, make sure that the water drains are not blocked or stuck.

Remove the heater housing / ventilation and fit a new Butyl sealing strip. Damaged sealing surfaces must first be adjusted. A trapped carpet must be removed.

Seal welds



PU seal welds are applied to welded or riveted connections **-Arrows-** to seal the interior of the vehicle. Incorrectly applied or damaged seal welds can allow moisture to penetrate into the interior of the vehicle. It is also possible that seal welds that visually appear to be intact in terms of their shape and size actually have poor adhesion.

Corrective action

Incomplete seal welds must be supplemented with PU sealing compound. Damaged seal welds must be removed and re-applied properly. Make sure that any residual moisture is effectively removed before a new seal is applied.

Attached parts

The add-on parts include:

- Exterior mirros, handles, controls.
- Mouldings, roof mouldings, lettering.
- Roof aerial, roof rack or connections for roof rack systems.

DESCRIPTION AND OPERATION

- Bumper mountings.
- Injection nozzles, door contact switches, bump stop rubber.
- Control unit seals.
- Tail lamps.
- All kind of screwed connections (pedal block, door and tailgate hinges)

Add-on body parts must be fitted with seals, grommets or sealing compound to prevent water entry. However, even when a sealing system is fitted, the screw thread may still cause leaks.

Corrective action

Seals must be tested and, if necessary, replaced. Check contact surface and adjust if necessary. Points sealed with sealing compound must be thoroughly cleaned and the seal replaced. Check grommets and replace if necessary. At all screwed connections, seal the thread with an appropriate sealing material.

DESCRIPTION AND OPERATION

Wind Noise

Wind noise and noises in general are dealt with under the label Noise, Vibration, Harshness, or NVH in short.

NOTE: Basic and advanced training is offered for the following contents. For an overview of all training courses offered, please refer to the Ford Service Organization's training course brochure.

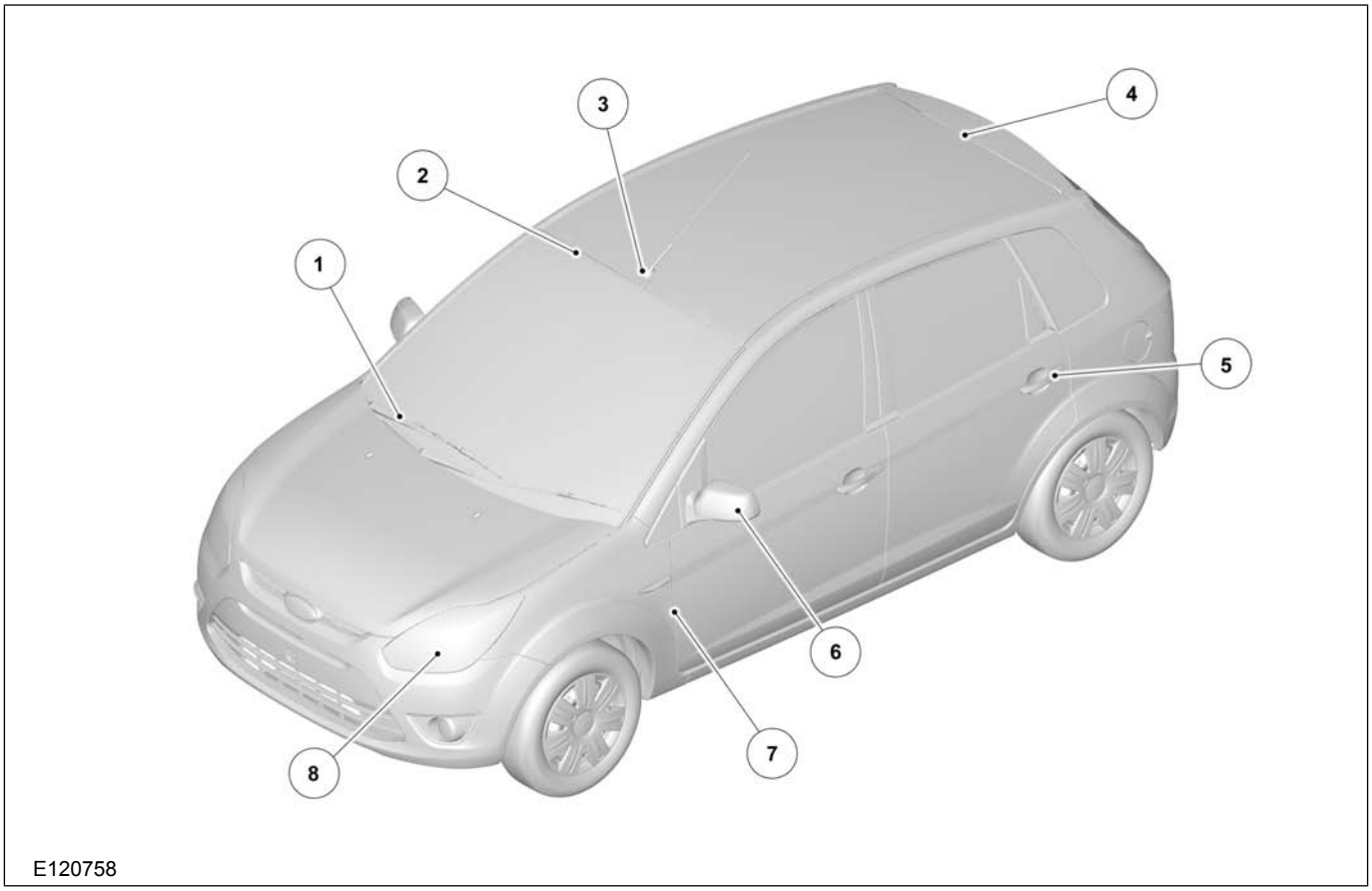
Due to the continuous reduction in drive noises, wind noise has come to the fore in the vehicle and is perceived to a greater extent by the customer.

There are various causes of wind noise. They can be due to the design of the vehicle, or they can occur after a repair. They are mostly caused by poorly mounted components, which must be located and installed in the correct position.

Diagnosis

In order to carry out targeted diagnosis, it is important to know the basics of noise formation and sound transmission.

Potential areas of wind noise



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Item	Description
1	Wiper arms
2	Windscreen seal
3	Antenna
4	Tailgate
5	Door handles
6	Rear view mirrors

Item	Description
7	Door seals
8	Headlamps

Normal air flow noises are caused by air blowing against even, flat vehicle surfaces, such as the roof, doors and side windows. When the vehicle is moving fast, air films (turbulence) form, which cause variations in air pressure. These variations in air pressure spread in the form of sound waves and are transferred to the vehicle interior via the side windows and seals.

DESCRIPTION AND OPERATION

If air flows over an edge on a vehicle, the air flow cannot follow the shape of the surface, but separates at the edge. Eddies are formed, which collapse again after a certain time or distance. The associated variations in air pressure create a corresponding sound wave.

Streaming noise occurs if there are leaks in the sealing system to the vehicle passenger compartment. The noise is caused when stationary air mixes with moving air. As a result, the noise increases as the streaming speed increases.

Cavity noises are noises that occur when the air column is caused to oscillate.

Workshop diagnosis

Before carrying out repair work, a visual inspection of the vehicle must be carried out. The gaps in the doors, the sunroof and at all other body parts must be checked in particular.

When the doors are adjusted to fit exactly, development of wind noise can often be eliminated at high speeds (lifting of doors off the seals).

The following points are also to be checked:

- Check that windows are completely closed.
- Check air ducts and vents for correct installation.
- Check protruding trims or plastic parts.
- Check that all blanking plugs are present.

Road tests

Wind noise can usually only be located through road tests.

NOTE: There should always be two people present during test drives to find noises. A driver who reconstructs the situation causing the noise, and a person to carry out the checks.

The following points should be taken into account for such test drives:

- Check that the tire pressure is correct.
- Remove non-standard ancillary components from the vehicle.
- Choose a dry, flat road with as little traffic as possible.
- Carry out the road test in all speed ranges. Use a high gear so that the engine noise is low.

If it is difficult to detect the noise sources, the search can be made easier by masking potential areas.

Sequence

A basic prerequisite for a problem description with subsequent diagnosis is the performance of a test drive with the customer..

Only once the customer's problem description is clear should the service technician begin with the diagnosis of the problem.

The service technician should carry out specific road tests to achieve further containment of the problem.

Sequence (schematic):

1. Customer concern

- What is the customer concern and what details can he supply about the wind noise?
- Under which conditions does the wind noise appear?

2a. Diagnosis and corrective measures **Sequence A:** The diagnosis is possible based on the information supplied by the customer.

- Carry out corrective measures to remedy the wind noise.
- Road test the vehicle to check that the concern is resolved. The vehicle must be driven in exactly same way as when the wind noise was produced earlier.
- The corrective measure performed based on the information supplied by the customer was not successful. Further fault finding must now be carried out in the workshop (see Sequence B).

2b. Diagnosis and corrective measures **Sequence B:** The diagnosis is not possible based on the information supplied by the customer.

- Test for faults, referring to any TSB (Technical Service Bulletin) which may be relevant.
- Visually check external seals, check gaps.
- Visually check the vehicle for traces of accident repair and retrospectively attached ancillary components.
- Perform a diagnosis based on the road test.
- Carry out corrective measures based on the diagnosis.
- Perform another road test. The vehicle must be driven in exactly same way as when the wind noise was produced earlier.
- If this road test does not show that the work has been successful, additional techniques such as powder testing, stethoscope testing or ultrasonic detection must be employed.

DESCRIPTION AND OPERATION

The vehicle acoustics do not always make it possible to draw up a clear diagnosis. It is therefore all the more necessary to use all methods of detecting and suppressing NVH problems.

3. Comparison of vehicles constructed in the same way.

If no clear diagnosis is possible based on a customer concern, a comparison test drive should be carried out on a vehicle constructed in the same way.

Test Equipment

Diagnosis of wind noise requires good hearing, basic knowledge of acoustics and experience. Tools can provide assistance for the diagnosis and reduce the fault finding duration.

Stethoscope

Here, the tightness of the vehicle passenger compartment is checked. The ventilated blower is set to the highest setting and the doors and windows are closed. There is now a corresponding overpressure in the passenger compartment.

The stethoscope is now used to listen to the door and window seals. The sound of the streaming air can be heard at the leaks.

Smoke Pipe

The preparatory work is the same as for the stethoscope test. By scanning past the seal areas with the smoke pipe, a leak can be visually detected based on the changed smoke path.

Ultrasonic detector

The ultrasonic detector is a further method of findings leaks in the vehicle passenger compartment. Here, an ultrasonic noise generator is placed in the passenger compartment. The closed vehicle is then inspected from outside with the corresponding detector. The detector will show any leaks present.

Powder

Door seals that do not make close contact can be detected by coating the contact surface of the door seal with white powder. to do this, the door is carefully closed and re-opened. In this way the door seals which do not touch will be visible.

Sequence for performing a wind noise diagnosis

1. Customer concern
   - What is the customer concern and what details can he supply about the wind noise?
2. Under which conditions does the wind noise appear?
   1. Sequence A: A diagnosis is possible based on the details supplied by the customer.
      - Carry out corrective measures to remedy the wind noise.
      - Road test the vehicle to check that the concern is resolved. The vehicle must be driven in the exactly same way as when the wind noise was produced earlier.
      - If the corrective measures based on the information supplied by the customer were not successful, further testing must be carried out in the workshop (see sequence B).
   2. Sequence B: A diagnosis based on details supplied by the customer is not possible
      - Test for faults in the workshop, referring to any TSB (Technical Service Bulletin) which may be relevant.
      - Visually check external seals, check gaps.
      - Visual check: Have any components been fitted to the vehicle after manufacture or has the vehicle been repaired after an accident?
      - Perform a diagnosis based on the road test.
      - Carry out corrective measures based on the diagnosis.
      - Perform another road test. The vehicle must be driven in the exactly same way as when the wind noise was produced earlier.
      - If this road test does not show that the work has been successful, additional techniques such as powder testing, stethoscope testing or ultrasonic detection must be employed.

Workshop diagnosis

Before repair work is carried out, a visual check of the vehicle must be performed, paying special attention to the fit of the doors. When the doors are adjusted to fit exactly, development of wind noise can often be eliminated at high speeds (lifting of doors off the seals).

DESCRIPTION AND OPERATION

Stethoscope testing

– The stethoscope is a simple and appropriate tool for finding bodywork air leaks. If the blower is turned on at the highest speed and all the doors, windows and other openings are closed, the air pressure inside the vehicle can be made higher than that outside. The outside of the vehicle is then checked for streams of escaping air.

Powder test

– By coating the contact surface of the door seal with white powder, door seals that do not make close contact can be found. To do this, the door is carefully closed and re-opened. In this way, the sealing surfaces which do not touch will be visible.

Ultrasonic detector

– It is also possible to detect leaks using an ultrasonic detector and a tone generator. To do this, the ultrasonic tone generator is put inside the vehicle and the outside of the vehicle is tested using the detector tuned to the generator. The detector will quite easily show any leaks present.

Road tests

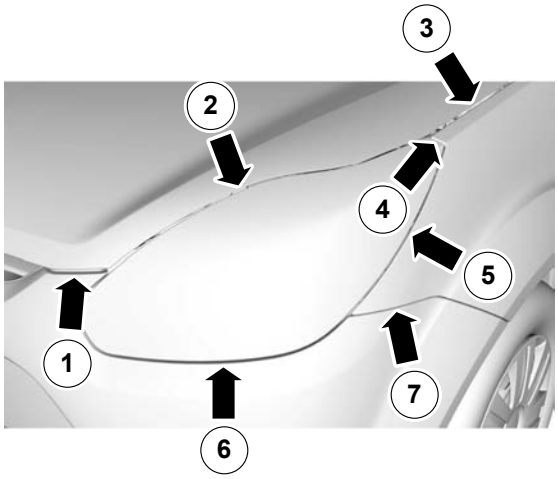
– The causes and origins of wind noises can often be located by a road test. Attention should be paid to the following points:
  – Choose a dry, flat and straight road with as little traffic as possible.
  – Make sure that the tyres are at the correct pressure, to avoid tyre noise.

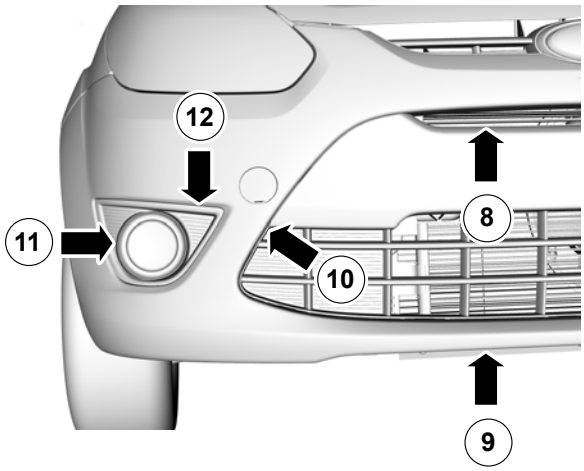
Driving technique

– Perform the road test at all speed ranges, using the highest gears (fourth or fifth).
– The road test should be performed by two persons, and different seating positions should be tested.
– Prepare the vehicle as necessary (use adhesive tape to blank off areas).
– Pay special attention to door openings and door seals during the road test.

Gaps and Flushness

Acceptance criteria





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O/F : Over Flush

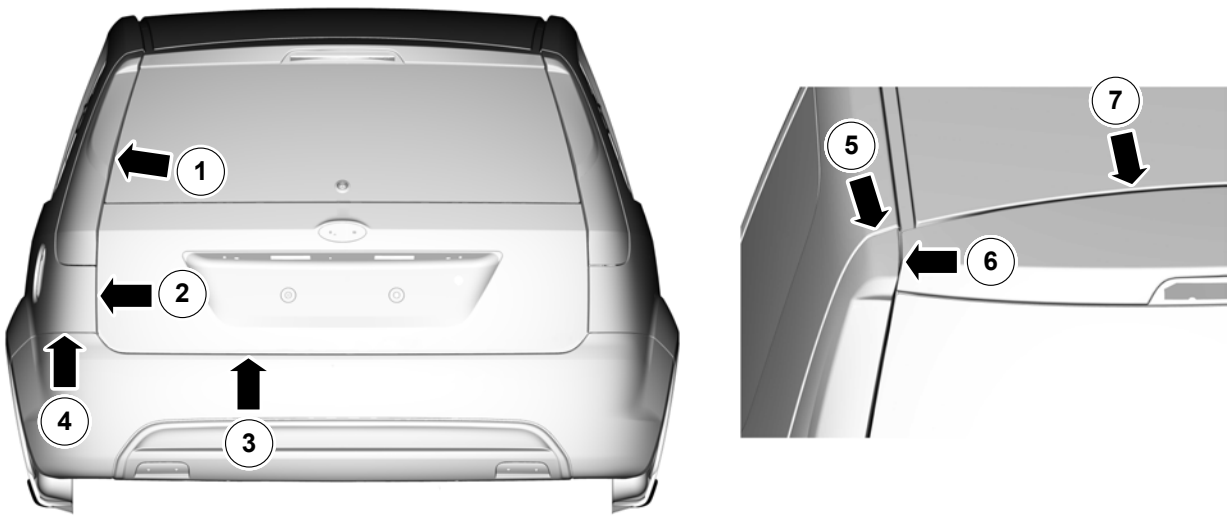
U/F : Under Flush

N/A : Not Applicable

NOTE: All Dimensions are in "mm" only.

DESCRIPTION AND OPERATION

Point No	Parameters	Gap	Flushness	Parallism		Symmetry	
				Gap	Flush	Gap	Flush
1	Hood to bumper	6.0±2.0	Bumper U/F 2.0±2.0	0.5	1.0	1.0	2.0
2	Hood to head-lamp	4.0±1.5	Hood U/F 1.5±1.0	0.5	1.0	1.0	1.0
3	Hood to fender	4.0±1.0	Hood U/F 1.0±1.0	0.5	1.0	1.0	1.0
4	Fender to head-lamp top corner	2.0±1.5	Fender U/F 0.5±1.0	0.5	1.0	1.0	1.0
5	Fender to head-lamp	2.0±1.5	0.0±1.0	0.5	1.0	1.0	1.0
6	Headlamp to bumper bottom	3.0±1.0	Bumper U/F 1.0±1.0	0.5	1.0	1.0	1.0
7	Fender to bumper	0.0±0.5	Bumper U/F 1.0±1.0	0.5	1.0	0.5	1.0
8	Bumper to bumper lower grill at top	1.2±1.0	Lower Grille U/F 2.0±1.0	1.0	1.0	N/A	N/A
9	Bumper to bumper lower grill at bottom	1.2±1.0	Lower Grille U/F 2.0±1.0	1.0	1.0	N/A	N/A
10	Bumper to bumper lower grill at side	1.2±1.0	Lower Grille U/F 2.0±1.0	1.0	1.0	N/A	N/A
11	Foglamp bezel to foglamp gap	1.0±1.0	Fog lamp bezel U/F 3.0±1.0	1.0	1.0	1.0	1.0
12	Foglamp bezel to bumper gap	2.0±1.5	N/A	1.0	N/A	1.0	N/A



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DESCRIPTION AND OPERATION

Point No	Parameters	Gap	Flushness	Parallism		Symmetry	
				Gap	Flush	Gap	Flush
1	Tail lamp to backlite	4.0±2.4-2.0	1.0±1.0	-	-	2.0	1.0
2	Quarter panel to tail gate	4.0±1.5	1.0+0.0-0.5	-	-	1.5	N/A
3	Tail gate to bumper	6.0±1.0	N/A	-	-	N/A	N/A
4	Quarter panel to bumper	0.0±0.5	Bumper U/F 1.0±1.0	-	-	N/A	1.0
5	Quarter panel to tail lamp top	4.0±1.5	1.0+0.0-0.5	-	-	N/A	N/A
6	Tail gate to tail lamp	4.0±1.8	1.0+0.0-0.5	-	-	1.8	N/A
7	Roof to tail gate	7.0±2.0-0.0	1.0+0.0-0.1	-	-	N/A	N/A

DESCRIPTION AND OPERATION

Noise, Vibration and Harshness

Noises means noises caused by the vehicle that are audible both inside and outside the vehicle.

Vibrations are oscillations that are palpable and noticeable in the vehicle passenger compartment.

Harshness means noises caused by the vehicle that are audible, palpable and noticeable inside the vehicle.

These terms are grouped together under the label Noise, Vibration, Harshness, or NVH in short.

The task of vehicle development and production is to ensure that noises caused by the vehicle do not disturb the driver and passengers. Moreover, the external noises emitted by the vehicle must not exceed the thresholds set by law.

The following section gives an overview of how noise, vibration and harshness can occur in the vehicle and what remedial action is possible.

NOTE: Basic and advanced training courses are offered for the following contents. For an overview of all courses offered, please refer to the Ford Service Organization's training course brochure.

Noise types and causes

Noises in and around the vehicle are assigned specific descriptions:

- Humming and droning are perceived as low tones.
- Buzzing and whirring are middle tones.
- Howling, whistling, squeaking are assigned to the high tones.

Low to middle tones are considered to be unpleasant. They are palpable and noticeable as oscillations and vibrations throughout the body. Loud howling and whistling is painful to the ears.

Where the different notes come from in a vehicle:

- Low notes are mostly produced by the engine.
- Low tones can also be produced by the roadbed, particularly on rough surfaces. This is a form of droning which can be felt by the vehicle occupants as vibration or roughness.
- High tones however, which are experienced as howling or whistling noises, are often air currents (wind noise) or come from ancillary components such as the generator, power steering pump or drivebelt.
- There are also clattering noises which can occur when driving over an uneven road. These jerking noises are produced by, for example, the shock absorbers, chassis components or loose articles inside the vehicle.

A noise usually consists of a superimposition of different tones which spread as oscillations.

Each of these oscillations has a specific oscillating time and can be measured in frequencies. The frequency describes the number of oscillations per second. The frequency unit is specified in Hertz (Hz).

The human ear can perceive frequencies between 20 and 20000 Hz.

Noises can already be contained where they occur or, if this is not possible, can be confined with suitable measures. The basic procedures are the damping of oscillating parts, the insulation of components or the absorption of the noises through appropriate materials.

Damping

If a damper is installed next to an oscillating mass, the characteristic of the damper will reduce the movement of this mass accordingly (e.g. bumper on chassis).

Damping affects the resonance of an object or system.

Isolation

In oscillation technology, the term isolation means decoupling (separation) of components and systems.

An engine is mounted in sprung elements, so that as little oscillation as possible is passed to the vehicle.

In automotive technology, the isolation technique used is nearly always rubber mounting. The elasticity of the rubber acts like a spring.

Absorption

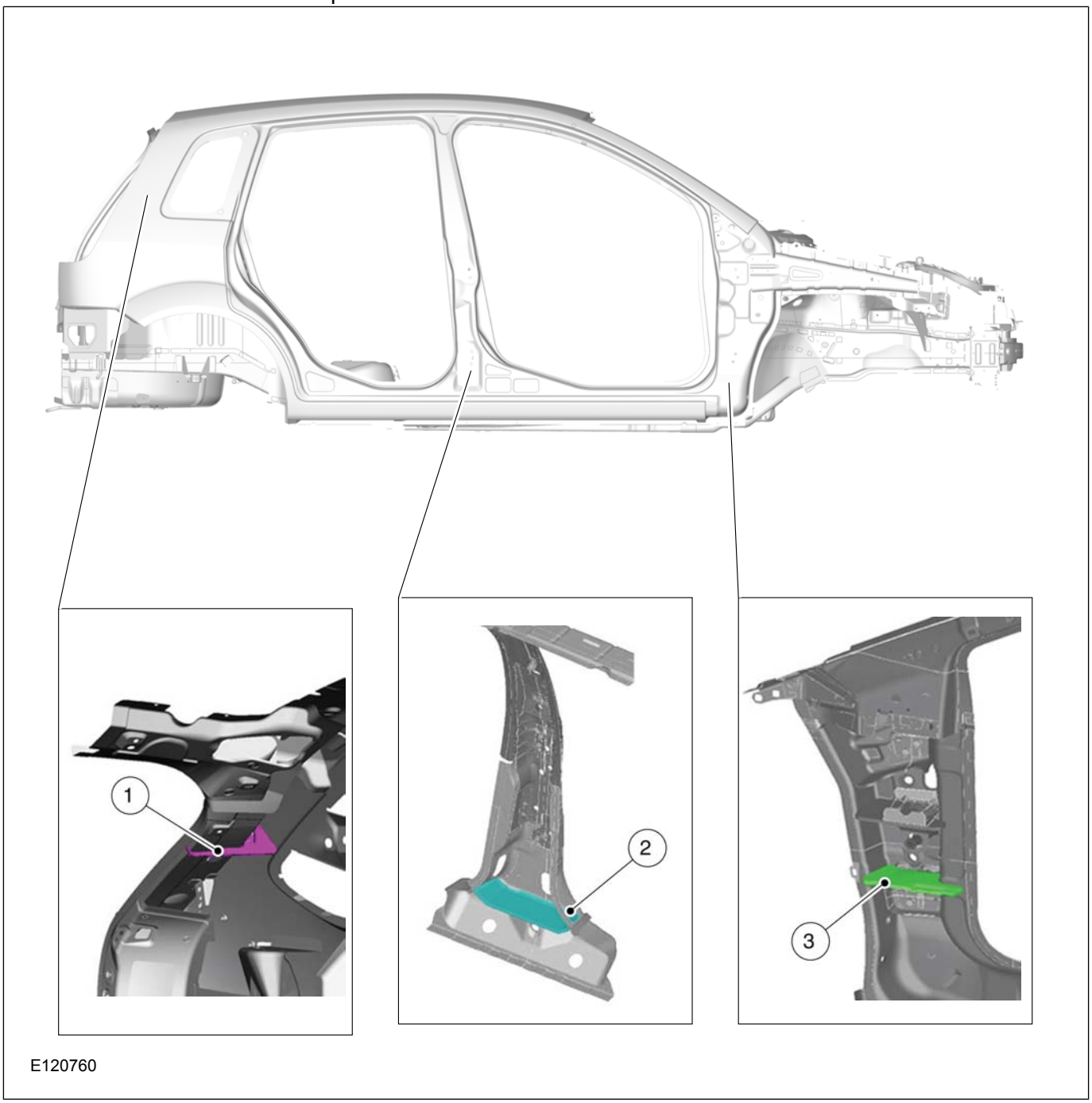
Sound waves are reflected from hard surfaces Through the use of absorption material, sound waves hit soft surfaces and are absorbed by them. The composition and thickness of the material used plays an important role here.

A soft surface, depending on its composition, absorbs the sound waves and reduces their energy.

DESCRIPTION AND OPERATION

NVH elements

NVH elements are installed to prevent airborne sound transfers to the passenger compartment in different body cavities.



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Item	Description
1	C-pillar area
2	B-pillar area
3	A-pillar area

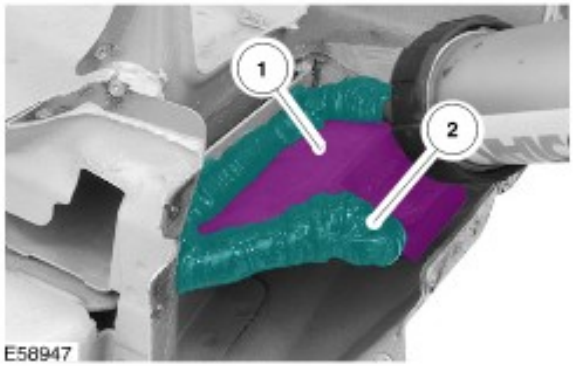
On the Focus 2004.75 (07/2004-) these elements are located in the cavities of the A, B and C pillars. On the estate version, they are also located in the D pillars.

The NVH elements consist of a carrier plate with a compressed isolation material at the edges. In the drying system of the painting equipment used in production, the body is heated to approx. 170° C. At this temperature, the isolation material expands, completely sealing the gap between the carrier plate and the bodywork.

NOTE:

DESCRIPTION AND OPERATION

- NVH elements must not be damaged during work on the vehicle body.
- NVH elements deformed through impact must always be replaced.
- PU adhesive must always be applied to the edges of new and reused NVH elements during repair work.



Item	Description
1	NVH element
2	PU adhesive

For the exact installation position of an NVH element, please refer to the vehicle-specific repair instructions.

If an NVH element is to be reused, the bonding on the body panel must be detached. To do this, the body panel must be heated in the area around the NVH element. The bonding can be detached at approx. 170° C. The damaged panel part can now be carefully dismantled.

Before installing the new panel part, PU adhesive must be applied to the contact areas between the panel and the NVH element.

Test techniques, measuring devices

The shortest route to an accurate diagnosis results from:

- general information on the problem vehicle and a comparison test with a vehicle of the same construction, without NVH problems.
- vehicle history, including repair history and usage patterns.
- condition history, especially any relationship to repairs or sudden change.
- knowledge of probable causes.
- application of diagnosis procedures in which the vehicle is split into corresponding areas.

The diagnosis and correction of noise, vibration and harshness concerns requires:

- a road or system test to determine the exact nature of the concern.
- analysis of probable causes.
- checking of the cause and elimination of the faults found.
- a road test or system test to make sure the concern has been corrected or brought back to within an acceptable range.

It is often very difficult to locate noises that are audible in the passenger compartment based on the problem description provided by the customer and the road tests performed. The direction of the noise can be detected subjectively, but the source of the noise cannot be found.

NOTE: For a selection of simple test tools, see the wind noises section.

Stethoscope

Using the stethoscope, you can listen to the entire vehicle passenger compartment to locate noise sources more easily. This test procedure can be carried out either while the vehicle is moving, or with the engine running and the vehicle stationary, depending on the concern. The noise source can be assumed to be where the stethoscope identifies the highest noise radiation.

NOTE: For safety reasons, only the passenger should carry out the stethoscope testing while the vehicle is moving.

Application examples:

- For very frequent noises in the passenger compartment.
- For engine noises that penetrate through the dashboard into the passenger compartment.
- Wind noise.
- Noise outside the vehicle that is routed inside, such as roadway, tire or water spray noises.

NOTE: With the stethoscope it is possible to locate medium and high frequency noise paths (caused by leaks) while the vehicle is moving. The stethoscope is not suitable for diagnosis of low frequency droning problems.

Ultrasonic measuring device

The ultrasonic detector is a good and reliable test method for acoustic problems. It is used in a similar way to the stethoscope. In principle, it is suitable for all high frequency interior noises and for leaks in the body seals.

DESCRIPTION AND OPERATION

The device consists of an ultrasonic transmitter and a receiver. During use, the transmitter sends an ultrasonic signal which is received at the problem zones by the receiver.

Electronic NVH tester

The measuring device described below is used for diagnosis of the solid-borne sound and solid-borne sound transmission paths. The device is particularly suitable for medium and high frequency noise analyses. In order to obtain a positive diagnosis of droning problems (low frequency noises) and their sources, you must have sufficient experience of how to use this measuring device.

NOTE: In the NVH area, diagnosis of droning problems is one of the most difficult tasks and sets high requirements of the service technicians.

The device works according to the following operating principle: Accelerometers (transmitters) are fitted on various vehicle components or body areas. The signals recorded here can be listened to one after the other on headphones or speakers via the different channels. Simultaneous illustration of several or all measuring channels (for comparison) is only possible visually on the display of the measuring device.

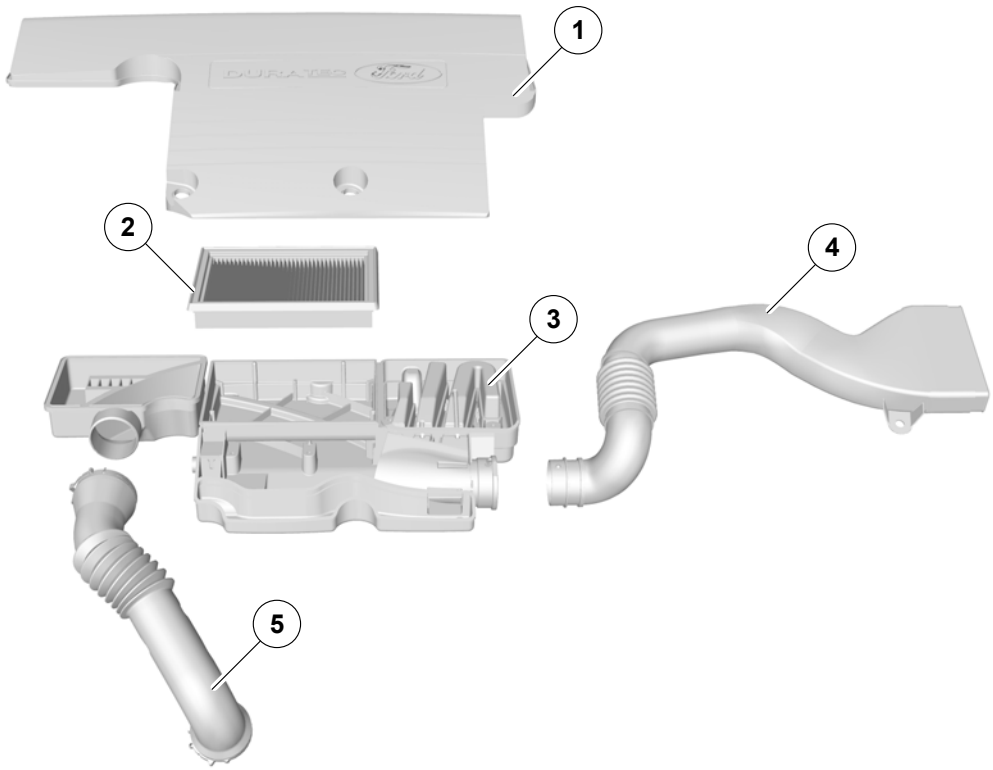
NOTE: Before using the NVH tester in the service, the service technician should take part in an NVH training course to ensure effective use of this device during the road test. A description of the function and application of the NVH tester is enclosed with the device.

Layout and operation:

- The test device has six different channels for noise diagnosis.
- Each channel is marked in color on the terminal, cable and test device.
- The solid-borne sound recorded is transmitted to the test device or the headphones by the magnetic accelerometers (transmitters).
- There is an amplifier on the test device with which the signal strength and the corresponding channel can be set.
- Only the noises from a transmitter are transferred to the headphones.
- All connected cables can be visually illustrated individually or simultaneously on the display.
- The test device saves the recorded data.
- The recorded data can be imported to a PC and evaluated.

DESCRIPTION AND OPERATION

Intake system



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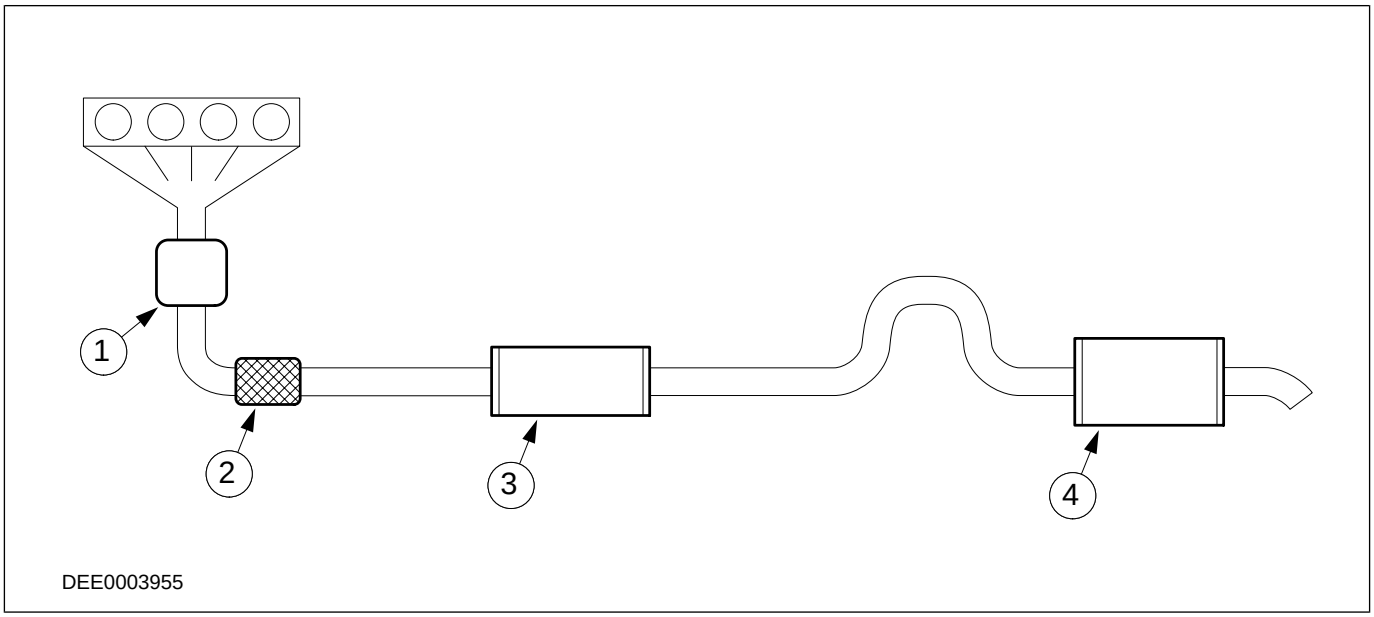
Item	Description
1	Air cleaner housing cover
2	Air cleaner element
3	Air cleaner housing
4	Air cleaner intake pipe
5	Air cleaner outlet pipe

- The volume and length of intake systems are matched exactly. No changes may be carried out during service or repair work. When attaching components (hoses and tubes), pay attention that all connections are air-tight.
- The surfaces of all components affected by the strong pressure variations in the intake system are especially subject to strong oscillations.
- The effects of temperature, such as warming of the air filter housing can cause changes in the rigidity of surfaces.
- In order to prevent solid body sound caused by surface oscillations of the intake system from being transmitted to the vehicle body, the following points must be observed during service:
  - The whole intake system must be isolated from the bodywork and mounted in rubber bushes without tension.
  - The air channels of the intake system must not contact the bodywork components.
  - Insert foam insulation at points of contact with bodywork or other components.

DESCRIPTION AND OPERATION

Exhaust system

Exhaust System General Construction



Item	Description
1	Catalytic converter
2	Decoupling element
3	Front silencer
4	Rear silencer

– Exhaust systems must be installed without strain.
– **NOTE:** The rubber mountings in which an exhaust system is suspended also transmit oscillations and under some circumstances can also cause a noise problem. For this reason it is important that the exhaust system is installed free of strain.

  The rubber mountings must not be over-stretched.
– The exhaust manifold and catalytic converter (if it is mounted directly at the engine) must have a solid connection to the engine (no splits in brackets).
– Simple problem testing:
  – Remove all mountings from which the exhaust system is suspended.
  – Support the exhaust system with rope at two positions at the most.
  – Check the noise level in the passenger compartment during a road test.
  – If this solves the problem, the exhaust mountings are the source of the noise.
  – Put back the exhaust supports one at a time, and road test the vehicle after fitting each one.
  – By proceeding in steps in this way, the mounting that is causing the noise in the passenger compartment can be found.

Bodywork

Function

– Different types of demand are made on the bodywork of a vehicle, particularly when it is being driven. Predominant here are vibrations caused mainly by other vehicle components, such as the engine and mountings. The

DESCRIPTION AND OPERATION

bodywork is therefore one of the most important vehicle components where NVF is concerned.

- The vehicle components described so far were, according to their function, individual self-contained noise sources. The bodywork however, connects and houses all the vehicle components.
- The bodywork is subject to vibration from both air borne sound and solid body sound.
- The bodywork must absorb all oscillations and impulses from all components and if possible transmit none of these to the vehicle interior.
- The largest proportion of NVH behaviour of a bodyshell is in the steel panels of the roof, sides and floor. They are strongly stimulated by the bodyshell structure and work like a loudspeaker transmitting noise.

Further demands on the bodywork

- Good crash behaviour
- Large interior space
- Corrosion resistance
- Low weight
- Good aerodynamic shape

A compromise must be made on some of these points. One example is between high body rigidity for good NVH performance and good energy absorption in an accident by the use of crumple zones.

Example:

- Watertight does not mean sound tight, therefore the following points must be taken into account:
  - Correct installation of the windows.
  - Correct installation of the seals.
- Further points
  - Openings into the engine compartment
  - Door and window sealing
  - Heater and ventilation openings
  - Sliding roof drainage hoses
- The side- and crossmembers in the body structure are often linking channels allowing sound transmission. Possible corrective measures are:
  - Installation of dividing walls at critical points such as the joint between the sidemember and the A-pillar in order to ensure good air borne sound insulation.
- **NOTE:** Foam pieces and foam filling are used in production to seal air borne sound transmission routes. If wind, tyre, engine or road noise is a problem, the position of the pieces of foam should be checked.

  Installation of foam plugs in affected areas.
- Filling hollow sections with foam.

SECTION 501-25B Body Repairs - Noise, Vibration and Harshness

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

Noise, Vibration and Harshness

Introduction

This chapter gives an overview of how noise, vibration and harshness (NVH) can be produced in a vehicle, and which corrective measures are possible.

What is understood by NVH in vehicle technology

N = Noise - Sound, can be heard

V = Vibration - Oscillation, can be felt

H = Harshness - Roughness, can be heard and felt

Types of noise in NVH technology

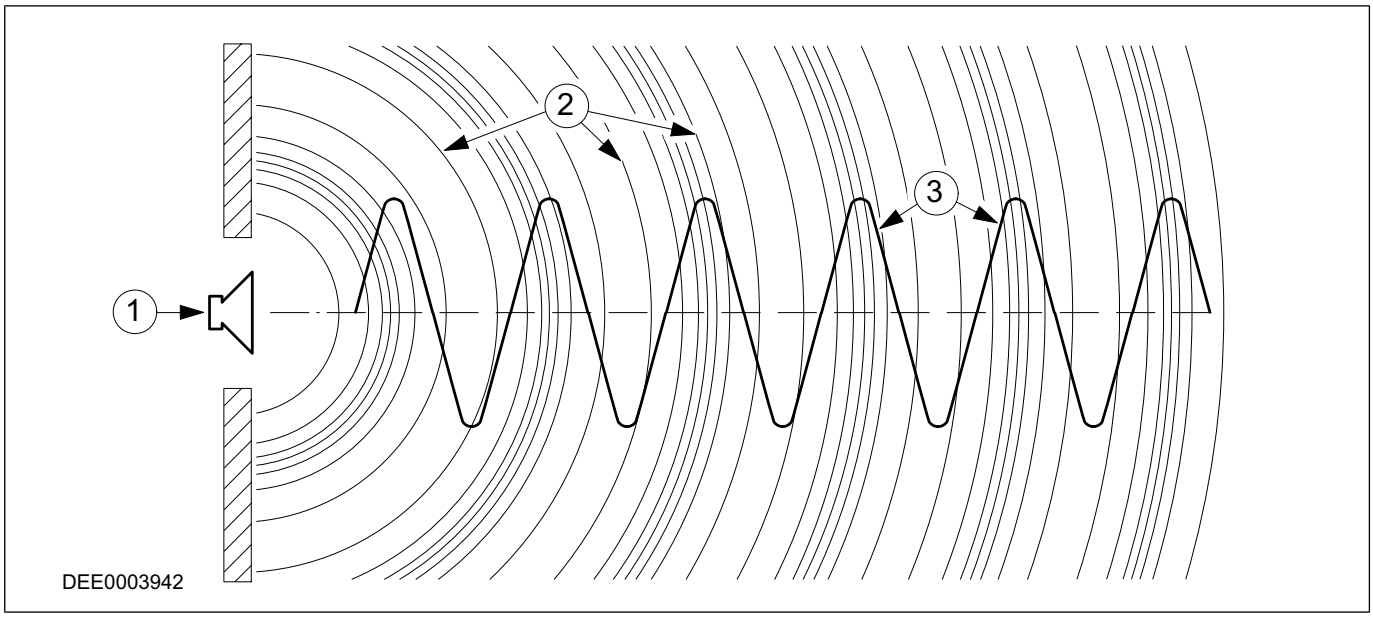
- Noises in a vehicle are classified by their notes:
  - Low notes - growling, droning
  - Mid-pitch notes - buzzing, whirring
  - High notes - howling, whistling, squeaking
- Loud howling and whistling is painful to the ears.

Where the different notes come from in a vehicle:

- Low notes are mostly produced by the engine.
- Low notes are also caused by the road surface, especially if the surface is rough. This is a form of droning which can be felt by the vehicle occupants as vibration or roughness.
- High notes however, which are experienced as howling or whistling noises are often air currents (wind noise) or come from attached components such as the generator, power steering pump or drivebelt.
- There are also clattering noises which can occur when driving over an uneven road. These jerking noises are produced by, for example, the shock absorbers, chassis components or loose articles inside the vehicle.

Noise transmission through air

Spreading of sound waves in the air



DESCRIPTION AND OPERATION

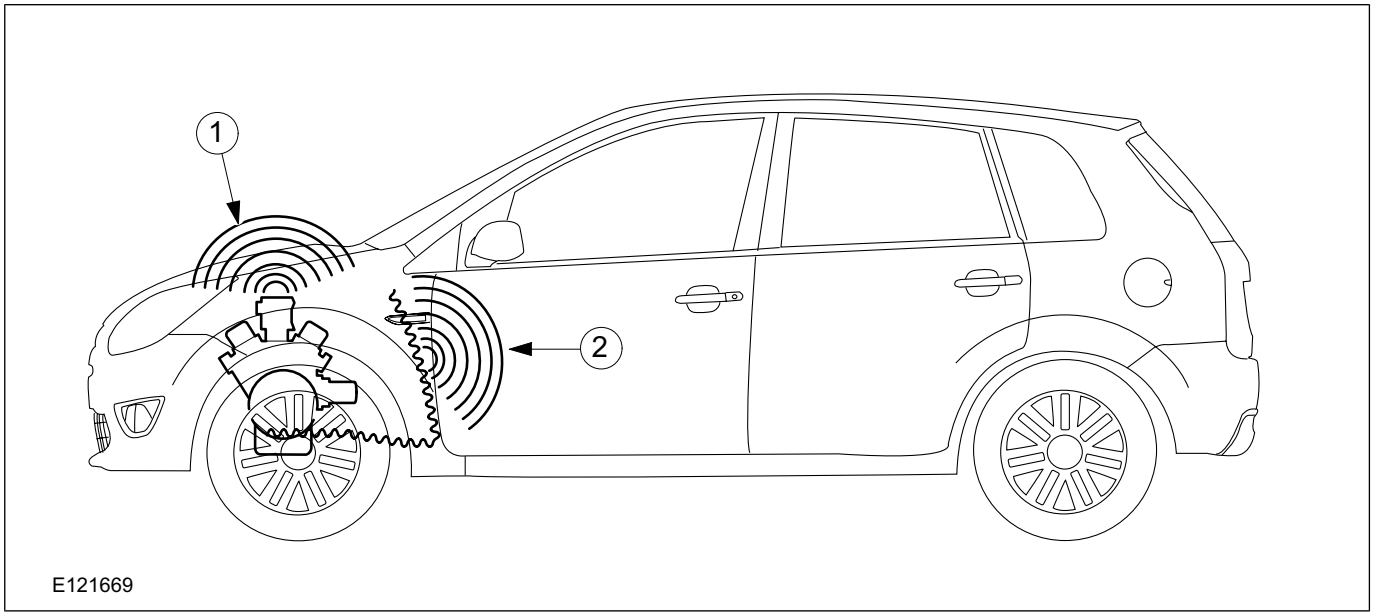
Item	Description
1	Sound source e.g. Engine
2	Sound wave
3	Amplitude

– The sound is spread by longitudinal waves in the form of pressure changes in the air.

Sound transmission through a body

Sound is passed through liquids or solids e.g. through the car bodywork.

Noise transmission in a vehicle



Item	Description
1	Sound through air
2	Sound vibrations

– Example
  – The source of the noise is the engine Engine noises are:
  – radiated directly through the air
  – transmitted as vibrations from the engine to the bodywork and radiated into the passenger compartment as air borne sound, for instance by the bulkhead,.

The speed of transmission (speed of sound) in liquids or solids depends on the material, but is generally faster than that in air (about 5 times faster).

Combination of transmission through air and bodies

NOTE: Sound transmission through both air and bodies is of prime importance in vehicle technology.

Vibration technology

– Frequencies below 20 Hz (low frequencies) and those above 20,000 Hz (20 kHz; high frequencies) are not heard by the human ear.
– The engine is made to oscillate vertically in its flexible mountings by unevenness in the road.
– Engine mountings which are not tuned will transmit oscillations to the bodywork and hence to the occupants.
– The following basic rules apply:
  – In vehicle technology, not only audible frequencies but also inaudible (low) frequencies must be considered.
  – Low frequency oscillations can usually be seen (large amplitudes).
  – High frequency vibrations can be heard, but will also be felt as vibrations in the floor, steering wheel or seat.

DESCRIPTION AND OPERATION

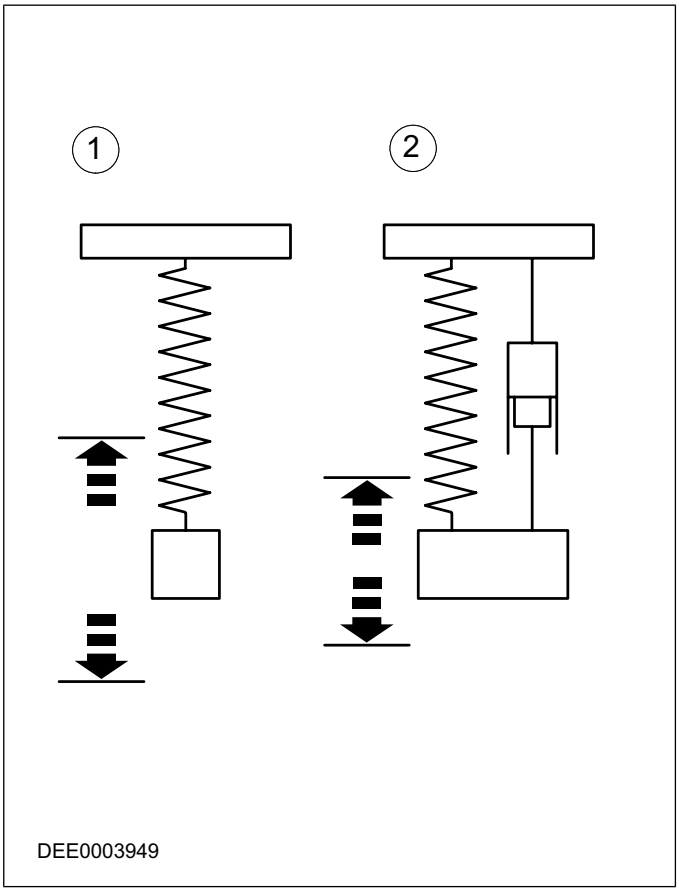
Resonance

- Every body has a natural frequency of vibration.
- If a system able to vibrate (a vehicle) is excited at its natural frequency of vibration, it will start to resonate.
- Uneven engine running appears for instance when the resonant frequency is reached (critical engine speed).
- Once the engine speed increases above this speed, the engine will very soon run smoothly again.

Damping

- If a damper is installed parallel to a spring, the damping characteristic acts to reduce the movement of a body.
- This is also the way in which a shock absorber on a vehicle works.
- Damping affects the resonance of an object or system.
- The mass being moved is damped by a correctly operating shock absorber, so that shaking of the bodywork stops immediately.
- The shock absorber in a vehicle is an oscillation damper, which allows the bodywork to oscillate in a damped manner.

Oscillation



Item	Description
1	Undamped oscillation
2	Damped oscillation

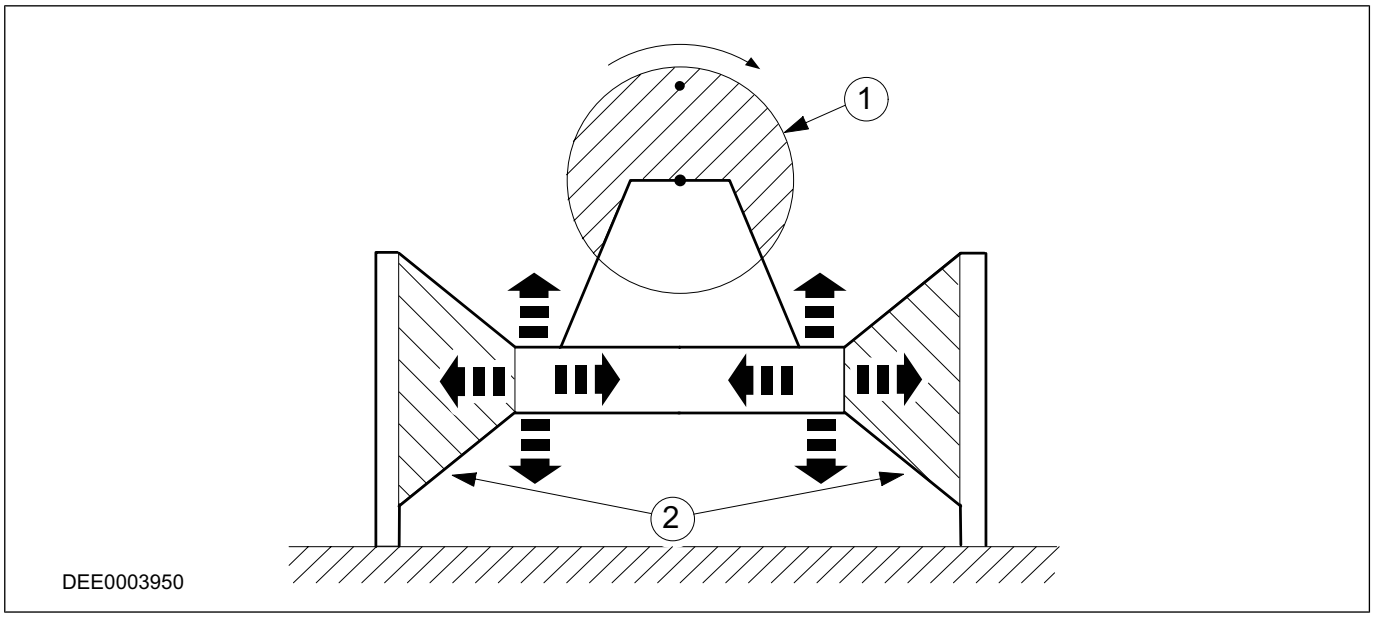
Isolation

In oscillation technology, the term isolation means decoupling (separation) of components and systems.

- Example:
  - An engine is mounted in sprung elements, so that as little oscillation as possible is passed to the vehicle.
  - In automotive technology, the isolation technique used is nearly always rubber mounting. The elasticity of the rubber acts like a spring.
  - The effectiveness of this type of decoupling depends on the construction of the component.

DESCRIPTION AND OPERATION

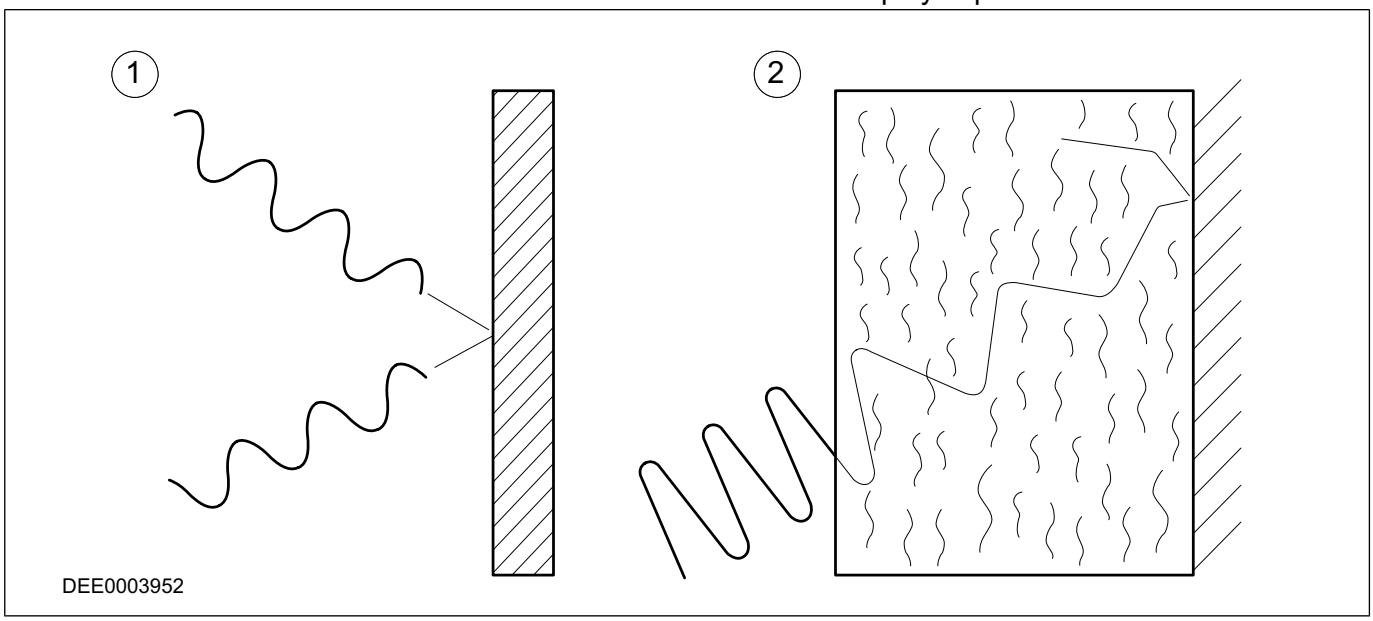
Directional loading of a rubber mounting in order to achieve optimum isolation



Item	Description
1	Engine
2	Engine mounting

Absorption

- Sound waves are reflected from hard surfaces
- If they meet soft surfaces, they are absorbed. Here both the material and the material thickness play important roles.



Item	Description
1	Reflection of sound waves
2	Absorption of sound waves

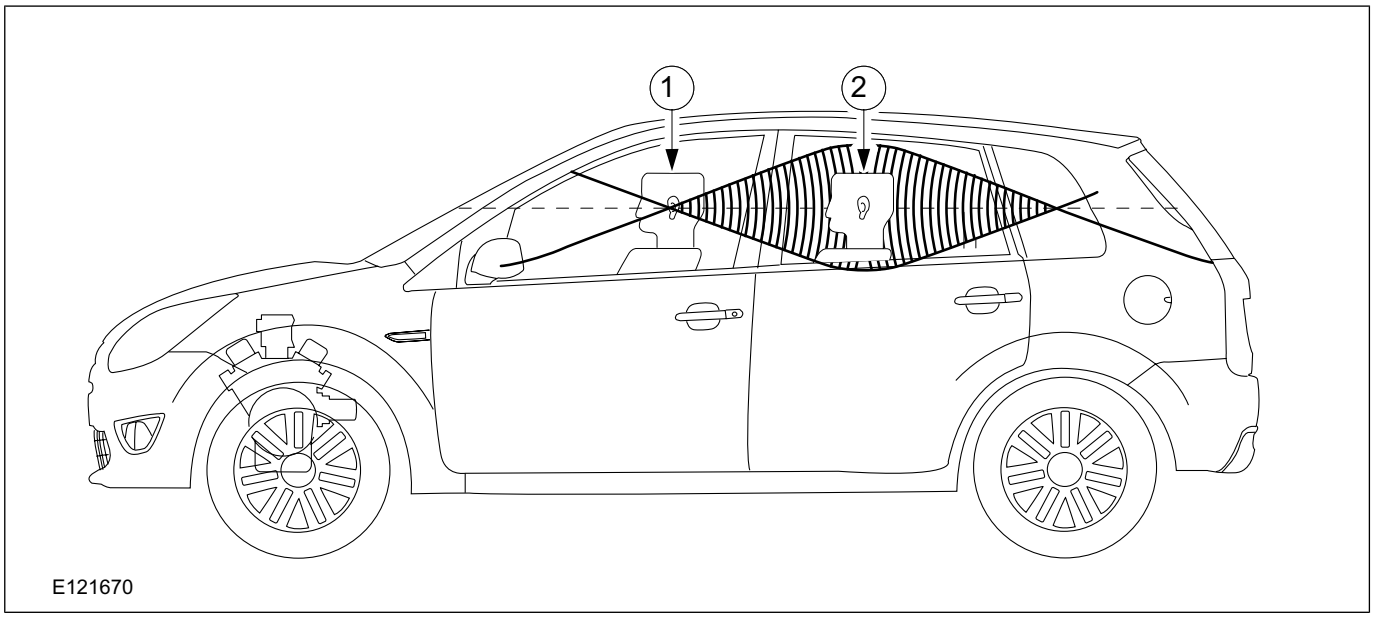
- Example:
  - All sound deadening components such as door trim, carpets, headlining, parcel shelves and the seats are removed from a vehicle.
  - The result of this is that the sound is directly reflected (the sound level rises), and a concert hall effect is produced.

DESCRIPTION AND OPERATION

Noise and oscillation behaviour in a vehicle

The occupants of a vehicle experience different levels of sound or noise depending on where they are sitting.

Sound/noise wave (standing wave) in a vehicle

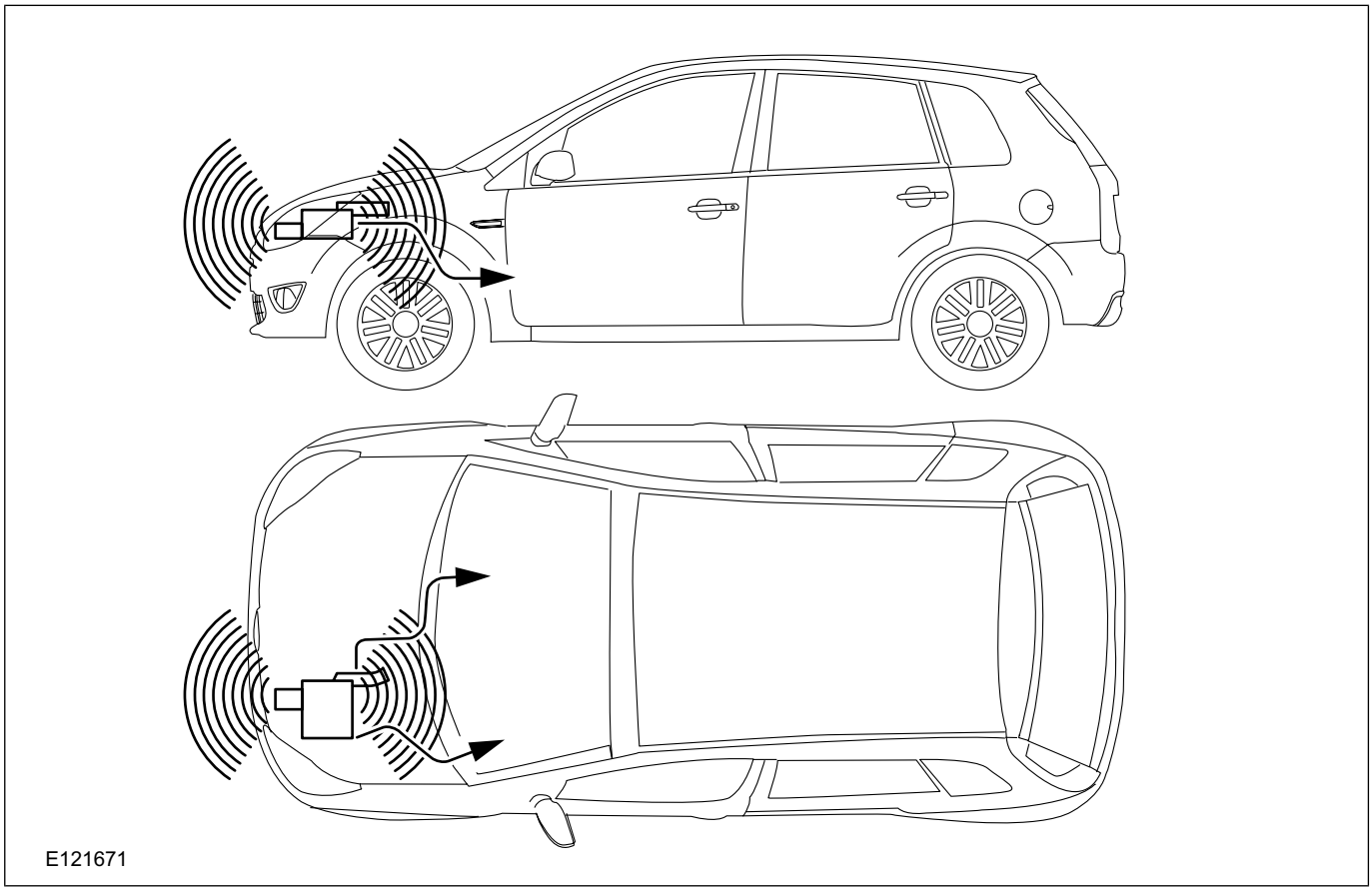


Item	Description
1	Driver sits in a "wave calm"
2	Rear passenger sits in a "wave swell"

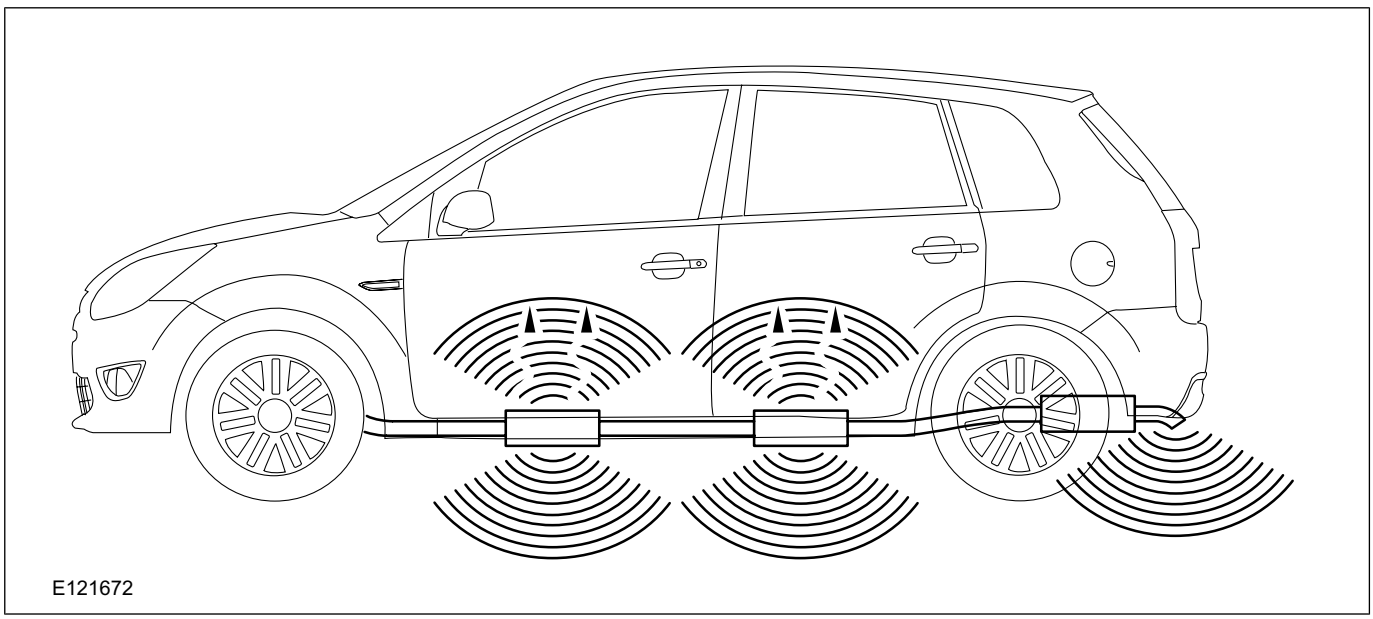
DESCRIPTION AND OPERATION

Noise and oscillation behaviour of intake and exhaust systems

The vehicle intake system as an air borne sound and solid body sound source



The vehicle exhaust system as an air borne sound and solid body sound source



DESCRIPTION AND OPERATION

- Ways in which sound is transmitted
  - The top illustration shows the ways in which sound can be transmitted from intake and exhaust systems.
  - Apart from air borne sound, solid body sound is predominant in both systems. In order to keep this proportion as small as possible, it is necessary for these type of oscillating components to be connected to the body using stiff connection points.
  - The exhaust system especially is an oscillating component and requires optimal isolation through its connection to the floor and also good routing and positioning of the fixing points in order to reduce the solid body sound transmission.

SECTION 501-25C Body Repairs - Plastic Repairs

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

Plastic Repairs

General

Because of their various constructions, repair work to plastic parts involves various repair methods:

- Thermoplastic straightening
- Plastic welding technology (PC, PP/EPDM etc.)
- Plastic bonding technology (all plastic parts)
- Plastic laminating technology (GRP parts with polyester resin only)

In repair work, the material characteristics of plastics are highly significant. Two main groups can be distinguished:

- Thermoplastics (plastomers)
- Duroplastics (duromers)

Thermoplastics (plastomers)

- Heat causes thermoplastics to change from solid state to thermoelastic state and then to thermoplastic state.
- When thermoplastics are cooled, they return to solid state.

Duroplastics (duromers)

- Duroplastics are much harder and more brittle than thermoplastics.
  - Their strength remains largely unchanged when they are heated.
  - Duroplastics are destroyed when the critical temperature point is exceeded.
  - Cooling down will not restore the original state.

Plastics used by Ford

Abbreviation	Description
ABS	Acrylonitrile butadiene styrene (polymer)
PA	Polyamide
PC	Polycarbonate
PP	Polypropylene
PP/EPDM	Polypropylene/ethylene propylene rubber
PC/PBT	Polycarbonate/polybutylene terephthalate
PBT/PC	Polybutylene terephthalate/polycarbonate
PUR	Polyurethane
GF	Glass fiber reinforced

Plastic identification

If a plastic has no identifying marks, the type can be established using two different procedures/methods:

- Visual Inspection
- Mechanical Check

The identification of a type of plastic is required for the plastic welding process in order to determine the correct allocation of the respective welding rod.

Visual Inspection

Visual inspections mainly serve to identify PUR and GRP materials. Thermoplastic components (e.g. bumpers) are often painted and are therefore difficult to identify.

Identification characteristics:

DESCRIPTION AND OPERATION

– PUR: if cracks form or similar damage occurs, visible pores of foam.
– GRP: identifiable glass fiber structure on the inside.

Mechanical Check

– Degree of hardness; the higher-pitched the tone, the harder the plastic.
– Elasticity; the more muffled the tone, the higher the elasticity of the plastic.

NOTE: Mechanical checks can identify the plastics group, but not the plastic type.

According to damage statistics, plastic bumper bars are most often subject to repairs.

NOTE: The PUR foam must not be removed for repair purposes if the foam polyurethane on the inside is bonded to the outer shell of the bumper bar. If there is serious damage such as cracking or fracturing (splitting) to the outer shell, do not perform any repairs to the foam area. The rule is this case is: renew the part.

The outer shell of plastic bumper bars is mainly comprised of thermoplastic materials. Depending on the degree of damage and accessibility, the following repair procedures can be applied:

– Thermoelastic straightening
– Bonding
– Welding

Thermoelastic straightening

Bumper bars often have deformations which occur in the elastic area. These normally take the form of dents, indentations and bends. Many of these deformations (e.g. to bumper bars) correct themselves of their own accord immediately or after a certain period of time. This self-correction depends on the extent of the damage and the temperature. Most flat deformations in the elastic area revert to their original form when heated with a hot air blower.

Flat elastic deformations

– **NOTE:** The necessary application of heat varies according to the type of plastic. The application of heat must not go beyond the elastic area. Deformation to plastic cannot be reversed. Never use a naked flame!

  Flat indentations or dents should be heated evenly to approx. 200°C using a hot air blower, if possible apply heat to both sides in turn. Provided there is no overstretching, the deformation reverts to its original form.
– To an extent, the "straightening" can be supported using mechanical tools such as the handle of a hammer, a plastic wedge, etc.

Stretch cracks and kinks

If there are stretch cracks or even kinks in the damage area, then the possibilities of thermoelastic straightening are limited. Bonding repairs are most suited to this kind of damage.

– To prevent tension in the material, cut off the cracked or kinked areas (using a hacksaw).
– Heat the depression to approx. 200°C (evenly, both outside and inside) and adjust to the original form using a narrow spatula or hammer handle.

Plastic welding

NOTE: Do not carry out plastic welding in the area of fixed foam backing.

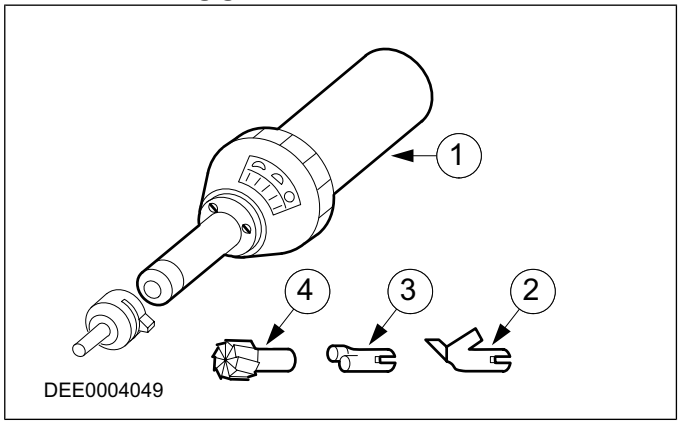
Plastic welding is the most suitable repair method for cracks to plastic bumper bars, where the rear side of the damaged area is unsuited to repairs by bonding. Examples: Ribbed section, box section, narrow rounded sections in reinforced areas.

Required tools and materials

– In addition to the tools available in the workshop (such as scrapers, grinders, etc.) the following tools are required for plastic welding:
  – Hot air blower (approx. 1500 W)
  – Welding nozzles
  – Various welding rods
  – Face cutter Ø 5.5 mm for processing the welding groove.
  – Scraper (heart-shaped).

DESCRIPTION AND OPERATION

Plastic welding gun

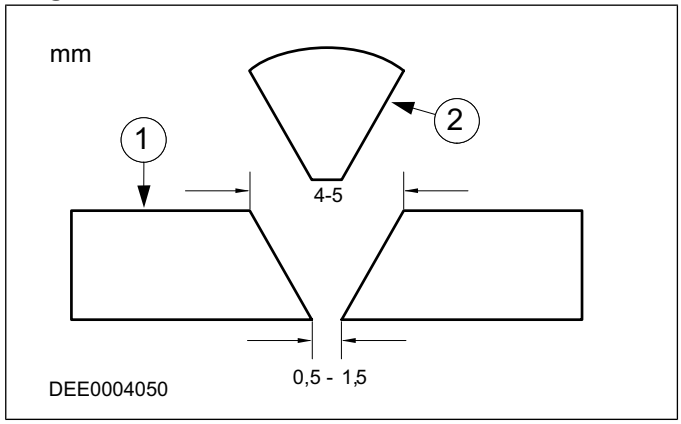


Item	Description
1	Plastic welding gun
2	Rapid welding nozzle
3	Wedge nozzle (fixed nozzle)
4	Face cutter

Preparing the repair location (crack)

Prepare cracking for the welding process in V-formation.

V-groove weld seam



Item	Description
1	Part to be repaired
2	Weld additive (shaped)

Preparing the V-groove weld seam:

- Form the welding groove using the scraper (face cutter).
- Keep the angle of the joint at 60° - 70°.
- **NOTE:** Boring out the end of the cracked (3mm drill bit) prevents further cracking. Where the edge alignment is uneven, fix the start of the crack using clamp pliers before starting welding.

  Finally, bore out the end of crack.

Preparing the hot air blower and welding rod

Convert the hot air blower into a plastic welding gun (extension nozzle and rapid welding nozzle).

- Set the weld temperature (200°C -700°C) according to the prescribed values.

Weld temperature

Two factors determine the weld temperature:

- Plastic material
- Thickness of the welding rod

Values for the most important materials and conventional welding rod thickness (5.7 mm x 3.7 mm)

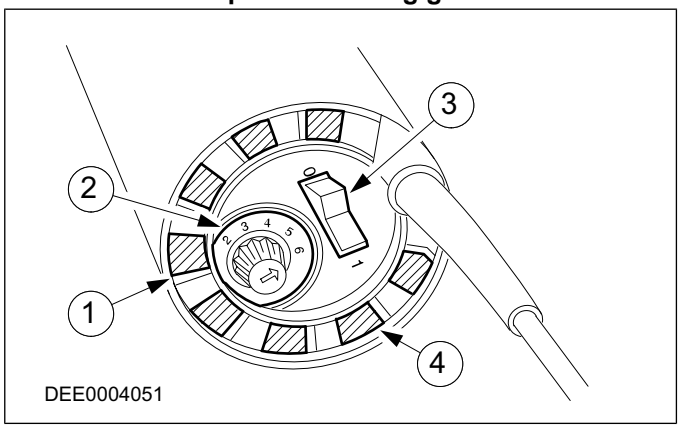
Thermoplastic	Weld temperature in °C (guide value)	Potentiometer control setting for plastic welding gun	
		Wedge nozzle	Rapid welding nozzle 5.7mm
ABS	350	4,5	5,3

DESCRIPTION AND OPERATION

Thermoplastic	Weld temperature in °C (guide value)	Potentiometer control setting for plastic welding gun	
		Wedge nozzle	Rapid welding nozzle 5.7mm
PP	300	3,8	4,5
PP/EPDM	300	3,8	4,5
PBT/PC	300	3,8	4,5
PA	400	5,1	5,6
PC	350	4,5	5,3
PC/PBTP	350	4,5	5,3

– Only weld PBT/PC plastic using a PP welding rod.
– Glass fiber reinforced plastics cannot be welded.
– Blue-dyed plastic parts on the Ford Ka cannot be painted and are therefore not suited to plastic repairs.

Rear side of the plastic welding gun



Item	Description
1	Air intake opening
2	Temperature control unit
3	Rocker switch
4	Air volume switch

– The temperatures given are air temperatures for the plastic welding gun. The temperature of the material is much lower.
– Observe the manufacturer's instructions when setting the temperature.
– Preheat the welding equipment to the preselected welding temperature for 3-4 minutes.
– Bevel the welding rod at the front to ensure gradual filling at the start of the crack groove.

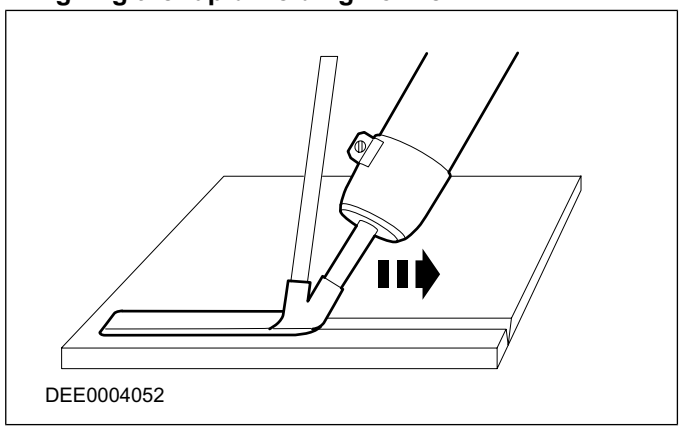
Carrying out the welding

The following requirements must be met for plastic welding:

– Correct temperature setting
– Even welding speed
– Even operating pressure

Push the beveled welding rod through the heated pre-heating chamber of the rapid welding nozzle until the tip of the welding rod emerges from the underside.

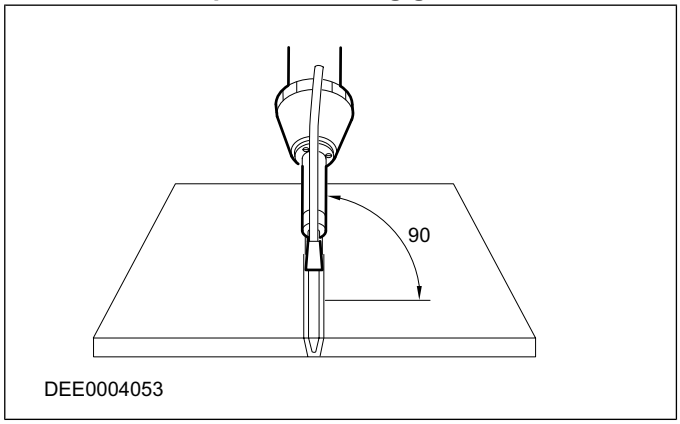
Aligning the rapid welding nozzle



The underside of the rapid welding nozzle must run parallel to the repair surface in a lengthways direction. Parallel alignment in a lengthways direction is achieved with the welding equipment at the appropriate inclination.

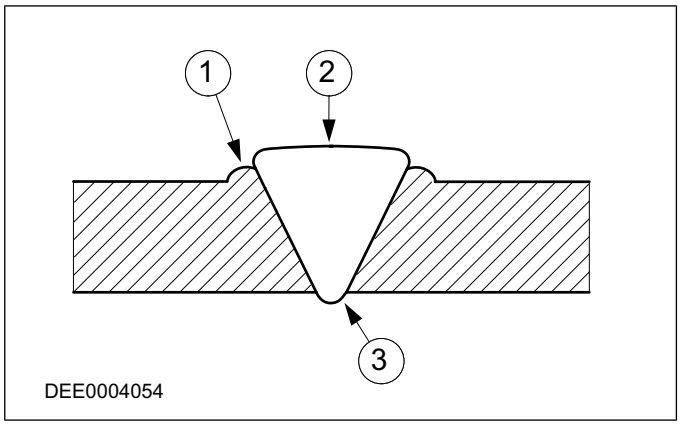
DESCRIPTION AND OPERATION

Position of the plastic welding gun



- Move the plastic welding gun in such a way that the welding rod is exactly vertical to the welding groove.
- The welding procedure can be started when the welding rod and the plastic to be welded are in a plastic state.

Weld seam



Item	Description
1	Bead of weld
2	Heightening of weld seam
3	Base of weld seam

- **NOTE:** The optimal connection is achieved when a small and even bead of weld has formed along the edge of the weld seam. It is essential to weld through the crack seam. Check the weld seam from the rear side and re-weld if necessary.

  The operating pressure when welding is only exerted across the welding rod.

Welding errors

Deformation:
- Repair area was overheated.
- Material tension present when welding parts.
- Plastic material too thin.

Poor welded joint:
- Weld temperature too low.
- Weld speed too fast.
- Welding together differing materials.

Weld seam sinks:
- Crack groove too wide
- Weld temperature too high.

Re-working the weld seam

- After cooling down, the raised part of the weld seam can be sanded down using an angle sander and abrasive paper of P80 grit.
- Surface grinding is then carried out using the orbital sander and abrasive paper of P120 - P220 grit.
- Clean the ground repair surface using plastic cleaner.
- Apply plastic primer thinly to the repair surface.

Plastic reciprocal welding

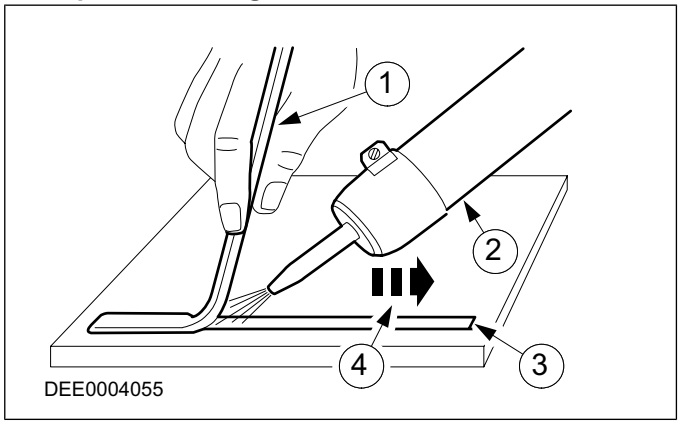
Reciprocal welding is the preferred method for crack damage in hard-to-reach areas.
- The welding rod is moved freely in reciprocal welding.
- The preparation of the crack groove is the same.

Carrying out the welding

- The plastic welding gun is only fitted with the extension nozzle.
- The welding rod and the crack groove are brought into plastic state by means of vertical reciprocating movements.
- The welding rod is pressed into the crack groove vertically in a plastic state.

DESCRIPTION AND OPERATION

Reciprocal welding



Item	Description
1	Welding rod
2	Plastic welding gun
3	Welding groove
4	Direction of welding

The following requirements must be met for reciprocal welding:

– Equal heating of welding rod and welding groove.
– Even welding speed.
– Vertical positioning and even pressure on the welding rod.

All other repair steps are described in the chapter Plastic Welding - Re-working the Weld Seam.

Plastic bonding

General

Bonding technology has some advantages over welding technology:

– Within the group of thermoelastics, all semi-rigid ancillary components (such as bumper bars, front grilles, etc.) can be repaired without identification.
– A two-component adhesive with a polyurethane basis must be used for all thermoplastic parts.
– Reinforcement strips can be attached to crack grooves (cracks up to max. 100mm) and fractures to ensure the original tensile properties.

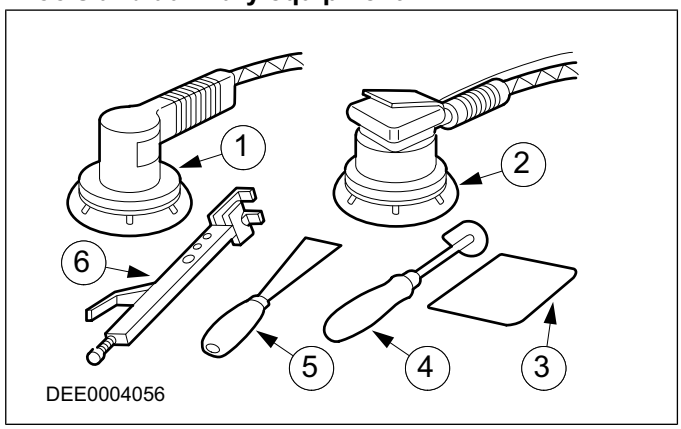
Required tools and equipment

Tools and equipment from the paint shop can be used to carry out bonding repairs to thermoplastic parts. Angle grinders and belt sanders can be used to grind out scratches and crack damage. Orbital sanders with extractors are used for fine sanding. An infrared heater ensures fast and effective drying.

Plastic repair set

– Plastic cleaner
– Plastic primer
– Adhesive repair set
  – Three double cartridges
  – Three emulsion tubes
– Metal reinforcement strips
– Reinforcing fiber

Tools and auxiliary equipment



Item	Description
1	Angle grinder with speed control
2	Orbital sander
3	Plastic stopper
4	Scraper
5	Paint spatula
6	Clamp pliers

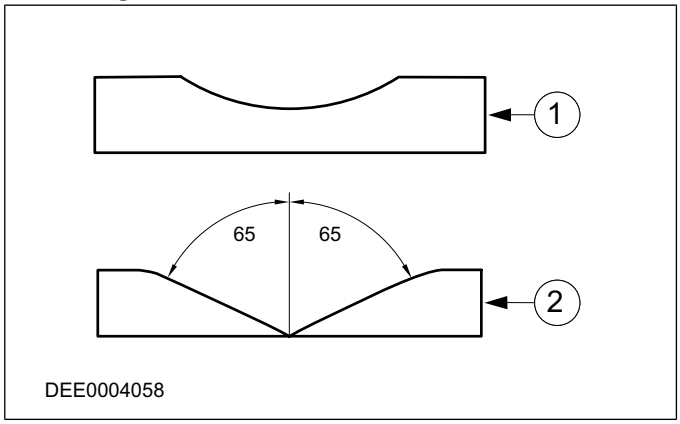
Preparing the repair location (scratch)

Before the repair, clean plastic parts on both sides using a high-pressure cleaner, and then dry.

– Clean the repair surface using plastic cleaner.

DESCRIPTION AND OPERATION

Grinding out the scratch



Item	Description
1	Preparation of the scratch
2	Preparation of the crack

– Grind out the scratches thoroughly flat using an orbital sander. Abrasive paper, P80 - P120 grit
– Fine sanding with orbital sander: Abrasive paper, P120 grit
– **NOTE:** Wear protective gloves for cleaning.

  Thoroughly clean the repair location using plastic cleaner and paper towels.
– Spray plastic primer evenly onto the repair location.

Preparing the repair location (crack)

– Grind out the crack on the front side so that it is flat using an angle grinder or belt sander. Grinding surface 40-60mm wide
– Regrind with an orbital sander. Abrasive paper: P120 grit.
– Bore out the end of the crack (Ø 3 mm) to prevent further cracking.
– Rub down the rear side along the crack.
– Clean the repair location on both sides using plastic cleaner and paper towels.
– Spray plastic primer evenly onto the repair location.

Preparation for bonding

– The two-component adhesive is applied to the cleaned and primed repair location using a hand gun.
– Operating the gun lever pushes the resin and hardener components from the double cartridge into the attached emulsion tube.

Scratch bonding

Even slight depressions such as cracks require preparation. The surface of the repair area also has to be processed to provide sufficient priming for the adhesive. This also prevents the repair area from subsequently sinking.

– After cleaning and priming, over-fill the ground out scratch cavity with adhesive.
– Dip the end of the emulsion tube in adhesive during the material application to prevent the ingress of air.
– Spread and smooth the adhesive using a flexible plastic stopper.
– Set using an infrared heater or in a drying oven.

Crack bonding with reinforcement

The repair location is reinforced to increase torsional strength in the case of cracking and fracture damage over a large area. To this end, suitable reinforcement materials (metal strips, reinforcement fibers) are affixed to the rear side.

– Cover the crack on the front side with a PE sheet and with adhesive tape.
– From the rear side, fill the ground out crack groove with plastic adhesive.
– A wide strip of reinforcing fiber is fixed over the crack groove in the bead of adhesive.
– The ends of the crack are reinforced by affixing a metal strip that is fastened to the plastic part using pliers.
– Then level out the reinforcement material over the whole surface.
– Dry using an infrared heater or in a drying oven.
– The PE sheet prevents the adhesive from overflowing at the front side of the crack.
– Pull off the PE sheet after drying the adhesive.
– Spread adhesive over the repair location on the front side.
– Set using an infrared heater or in a drying oven.
– Cool the adhesive to room temperature to prevent the adhesive being pulled off when sanding, and to prevent the abrasive paper becoming worn.

Sanding

– **NOTE:** In the case of dry sanding, use an extraction unit and wear a dust mask.

DESCRIPTION AND OPERATION

Sand down protruding adhesive using an orbital sander. Abrasive paper: P120 - P220 grit.

– Re-work sags and curved areas manually.
– Use an abrasive pad to roughen painted surfaces.
– Thoroughly clean the plastic part using plastic cleaner and paper towels.
– **NOTE:** Thoroughly dry out the plastic primer (matt surface).

  Spray plastic primer for the subsequent 2K filler application thinly onto the repair areas and sanded-through areas.

Two-component filler application

To prevent porosity at the edges and to smooth out uneven areas, it is advisable to apply 2K filler (MS, HS) with an elasticising additive.

– After drying, cool the 2K filler to room temperature and sand down using an orbital sander and fine abrasive paper.
– Re-work sags and curved areas manually (wet) using fine abrasive paper.
– Check the contour of the repair location and re-work if the contours are uneven.
– Perform painting in accordance with the manufacturer's instructions.

GRP repairs

General

GRP material is hard and brittle in its tensile properties. Because of these material properties, cracks and fractures often result in cases of serious damage. The stability and safety of GRP parts is impaired if the glass fiber reinforcement is cracked. This must be replaced in cases of serious damage that affect the structure of the part. Minor damage (such as abrasion, cracks up to 80mm, holes up to approx. 60mm diameter, etc.) can be repaired to a technically and visually perfect standard, provided that the damage does not occur in heavily used or hard-to-reach areas. To ensure excellent repairs, observe the following points:

– The room temperature should be at least 15°C and the air should be as dry as possible.
– **NOTE:** Fingerprints leave behind a film that prevents a proper joint.

  The repair location must be thoroughly dry and clean.

– Before the repair, the GRP part being repaired must be dried using an infrared heater or in a drying oven.
– In cases of large cracks and fractures, the strength of the outer skin can be re-established by backing with a reinforcement material.

Required tools and auxiliary equipment

– Hacksaw (body saw) for separating cracks.
– Axial grinder, angle grinder or belt sander for grinding out repair locations.
– Orbital sander for grinding out and grinding down the repair surface.
– Hand sanding block for grinding small surfaces.

Grinding the repair location

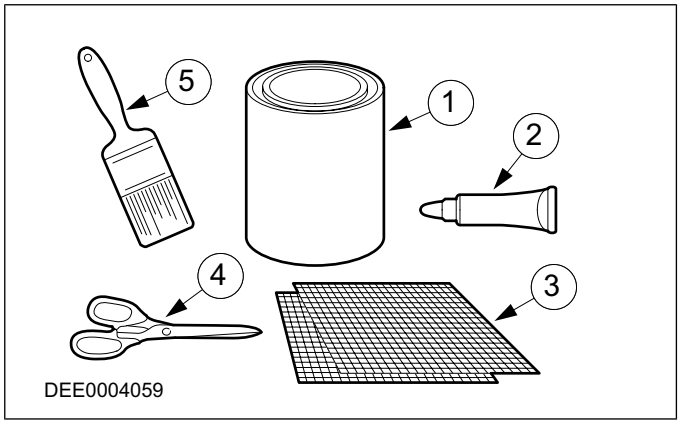
– Grind out the edge of the hole, in a V form and flat, using an angle grinder - abrasive paper P80 - P120 grit.
– Remove layers of filler and paint.
– If cracks have formed, these are ground out at the base of the crack by 3mm. This eliminates any tension.
– Careful, flat grinding is important for the subsequent adhesion of the repair material.
– **NOTE:** The surface must be re-ground by hand.

  Grinding with the angle grinder creates heat that causes a change in the surface structure of the resin. This results in reduced adhesive properties.

DESCRIPTION AND OPERATION

GRP repair material

GRP repair components



Item	Description
1	Polyester resin
2	Hardener
3	Glass fiber mats
4	Scissors
5	Brush

Apply polyester resin

– The polyester resin is mixed with hardener and applied thinly to the clean repair location with a brush.

Insert the glass fiber mat

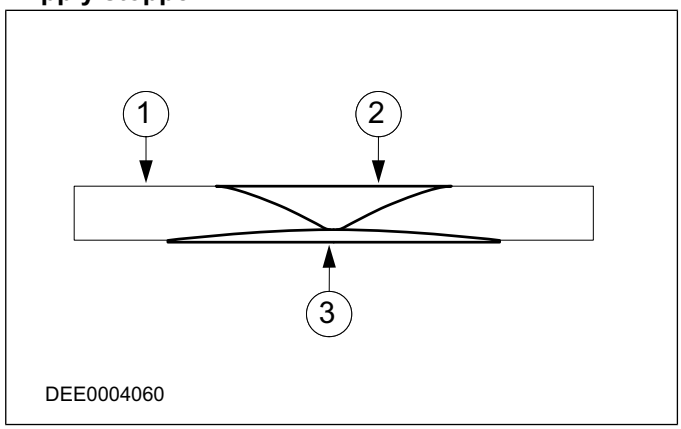
– Cut the glass fiber mat to size and insert it into the applied polyester resin.
– Applied more polyester resin over the glass fiber mat, and add a second or third mat if necessary.
– **NOTE:** Completely soak the glass fiber mat in polyester resin. No air may be trapped in the repair area.

  Apply polyester resin using a brush.
– Allow the polyester resin to dry at room temperature.
– Back larger cracks and fractures with reinforcement material to restore the strength of the outer skin.

Apply stopper

– The depression on the front side is filled with polyester fiber stopper to achieve a smooth, flat surface.
– Repeat the procedure if necessary.

Apply stopper



Item	Description
1	GRP part being repaired
2	Polyester fiber stopper
3	Glass fiber insert

Final application of stopper

– Re-create the surface contours by applying stopper or polyester filler.

Grinding with the orbital sander

– Sand down protruding polyester material using an orbital sander. Abrasive paper, P120 - P220 grit.
– The repair surface can be painted after grinding.

Safety measures

– Polyester resin, adhesive, solvents and thinners are inflammable and must be kept away from naked fire or flames.
– Sawing and grinding operations must only be carried out in rooms equipped with extraction systems.

DESCRIPTION AND OPERATION

– If no rooms with extraction systems are available, only use tools with extraction systems.
– Protective equipment such as gloves, protective goggles, aprons and breathing masks are essential.

For additional information, refer to Section 501-25A [Body Repairs - General Information] / 501-25B [Body Repairs - Noise, Vibration and Harshness] / 501-25C [Body Repairs - Plastic Repairs] / 501-25D [Body Repairs - Paintless Dent Removal]. It is also important to observe all applicable regulations, accident prevention legislation, information sheets, safety notices and guidelines for the processing of adhesives containing isocyanate, polyester resin, adhesives, solvent and thinners.

SECTION 501-25D Body Repairs - Paintless Dent Removal

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DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

Paintless Dent Removal

General

Small minor dents can be repaired without damage to paintwork. The dent is worked from the inside using special levering tools (pressure tools). The pre-conditions are that the diagnosis is certain, the correct repair method is identified and that the technician has enough experience in the use of the special tools and knowledge of the working materials.

– This option is limited to those bodywork surfaces which are accessible from both sides. This repair technique is seldom possible on double skinned bodywork components or closed bodywork profiles. The same applies to edge areas, beads and folds in bodywork components which are very rigid.
– Satisfactory results are only possible for minor dents that are shallow and with a small deformation radius. This method is therefore particularly suitable for damage arising from hail, parking and transport.

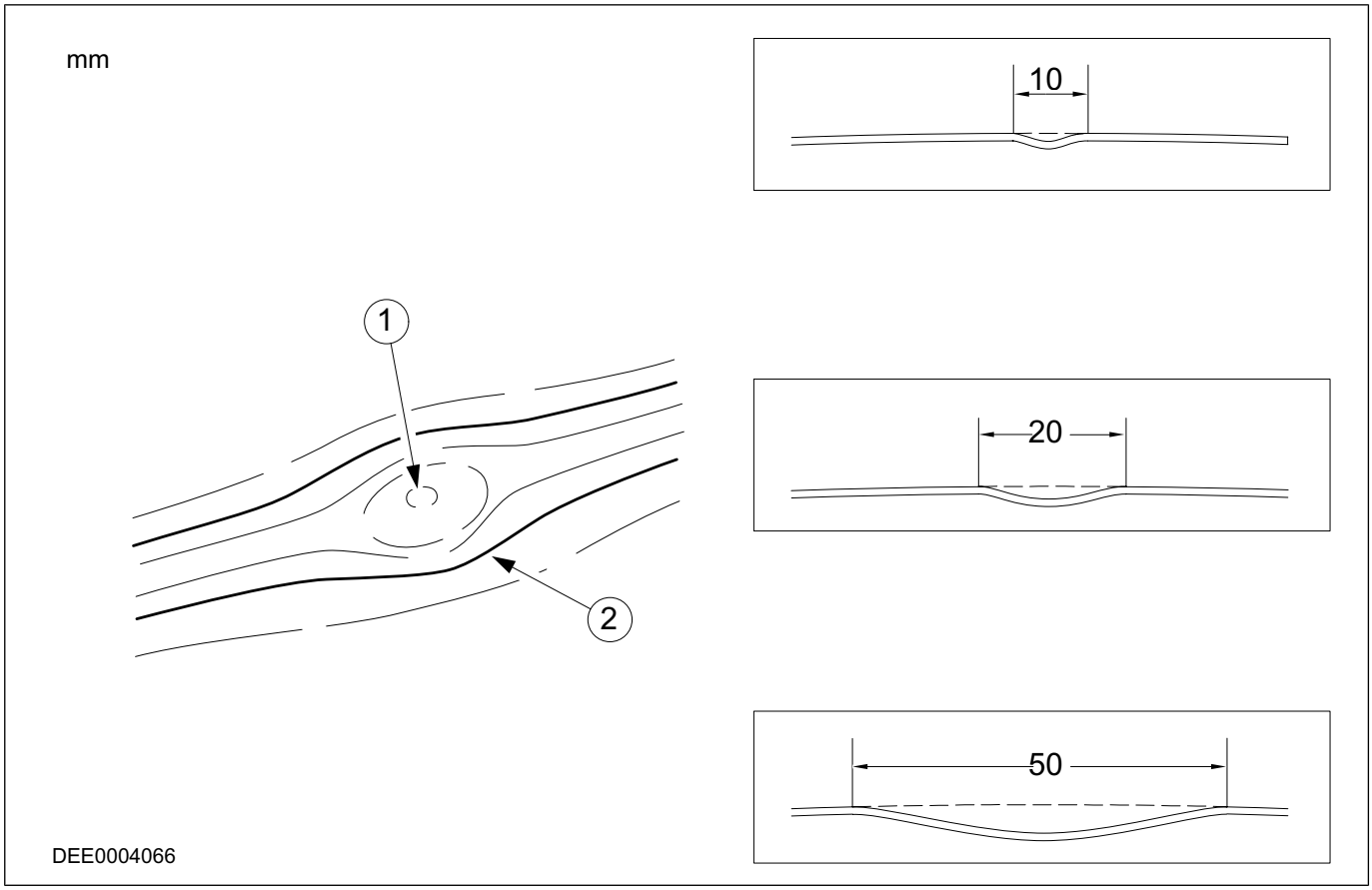
Economic considerations

– Whether it is economically worthwhile to carry out paintless dent removal depends on:
  – The area and depth of the dent.
  – Access to the repair area.
  – Rigidity of the repair area.
  – Suitability of the material
  – The number of dents over a particular body panel area.
  – Whether there is already any paint damage present

Extent of the damage

The repair method is suitable for dents up to approx. 50 mm diameter.

Damage assessment according to the size of the dent



DESCRIPTION AND OPERATION

Item	Description
1	Centre of the dent
2	Edge of the dent

Pre-requirement for the repair

The material at the centre of the dent must not have stretched.

Repair procedure

– Diagnose the damaged area.
– Mark the dent.
– Prepare the area to be repaired.
– Put the adjustable lamp in position.
– Reshape the dent.
– Renew the corrosion protection.
– Carry out quality control.

Repair tools/aids

– Special dent removal levering tools
– Adjustable lamp

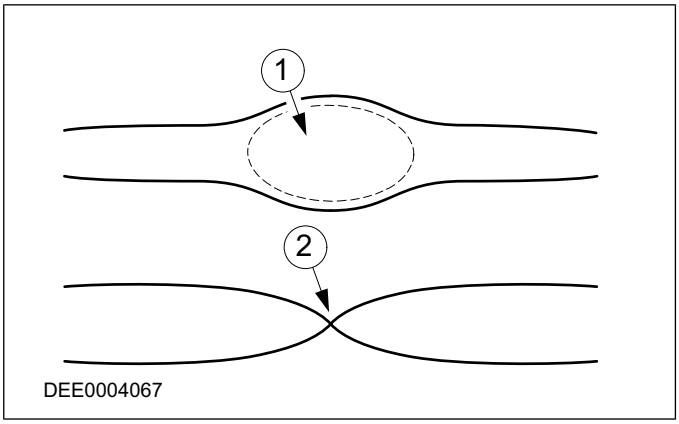
Repair Procedure

1. Decide on the repair method.
2. Mark the dent

   NOTE: Do not use a pen containing solvent (paint damage).

   - The dent is marked in the repair area to help recognition.
3. Prepare the repair area
   - It must be certain that the inside of the dent is accessible. Repair openings must not be made.
   - Clean the bodywork in the damaged area. Good visual checking is vital to success.
   - Polish the repair surface if it is matt. The repair procedure can only be checked exactly if there is enough reflection of light.
4. Place the adjustable lamp in position.
   - The adjustable lamp should be positioned and adjusted so that the dent can be clearly seen in the reflection on the paintwork (oval shape).
   - When pressure on the dent is increased the oval shape changes into lines which cross over each other. The point where the lines cross is the pressure point for the pressure tool.

Light reflection when pressing

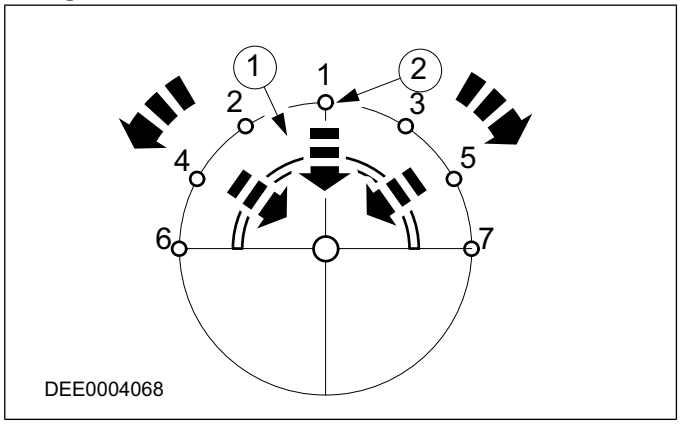


Item	Description
1	No pressure on the dent
2	Pressure applied to the dent

5. Position the pressure tool
   - Position the tip of the pressure tool on the edge of the dent.
   - By moving back and forth with light pressure applied on the dent with the tip of the tool, the reflected light shows the position of the pressure tool.
6. Working principle while applying pressure
   - The operation concentrates on forming a half circle, working chronologically.
   - To restore the surface, all that is needed is to work on one half of the dent.
   - The unworked half of the dent restores on its own, through tension produced by the pressure.

DESCRIPTION AND OPERATION

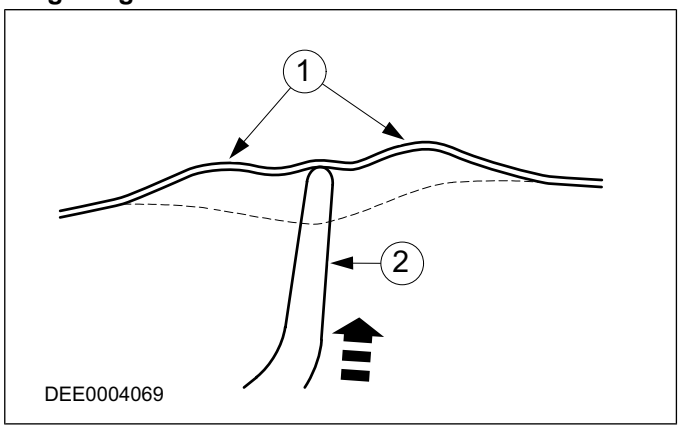
Diagram



Item	Description
1	Sequence of pressure
2	Starting position

NOTE: Never begin in the centre of the dent. If a dent is worked from the centre first, the edge will be lifted up and will remain visible as a high area (material stretching). This lifted edge can only then be restored by lengthy reworking.

High edge



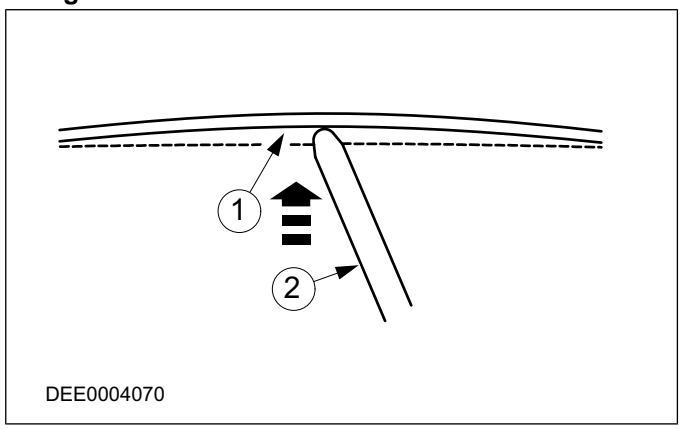
Item	Description
1	High edges
2	Pressure tool

- Exception:
  - Sharp edged dents with minimal material stretching are first worked on at the centre.
  - After pressing out the dent, slightly raised areas can be seen. This is caused by the excess steel in the centre of the dent, caused by material stretching.
  - Use a plastic drift to even out the slightly raised area.

Unstable pressure area

If large, relatively weak body areas are worked on, the path of the pressure tool while pressure is applied is correspondingly larger. The restoration process takes longer.

Large area dent



Item	Description
1	Reforming path
2	Pressure tool

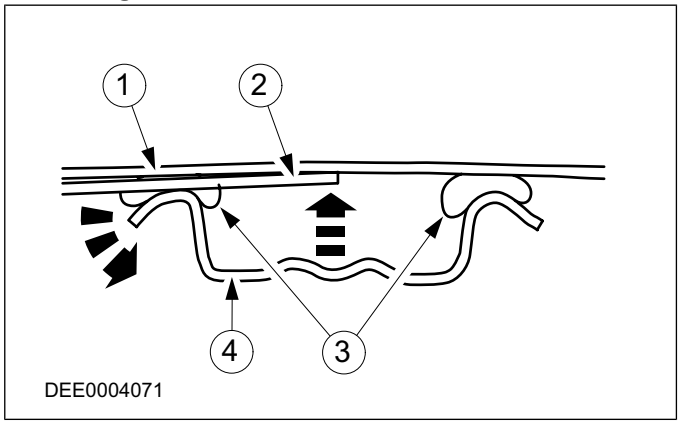
Stable pressure area

- **NOTE:** Work areas near internal reinforcing with only light pressure, so that high areas are not formed (material stretching).

  Stable pressure bodywork areas with inner braces have a much more stable surface than weak pressure areas. Only short pressure movements are required here because the steel of the bodywork is less sprung.
- Particular care must be taken with the pressure procedure if tools with a small contact face are used.
- Optical check:
  - It is only possible completely to remove all remaining unevenness by making continual visual checks of the surface using the adjustable lamp. In addition, towards the end of the pressure procedure, the dent must be checked several times from different directions. To do this, change position by about 90°.

DESCRIPTION AND OPERATION

Pressing out a dent near a brace

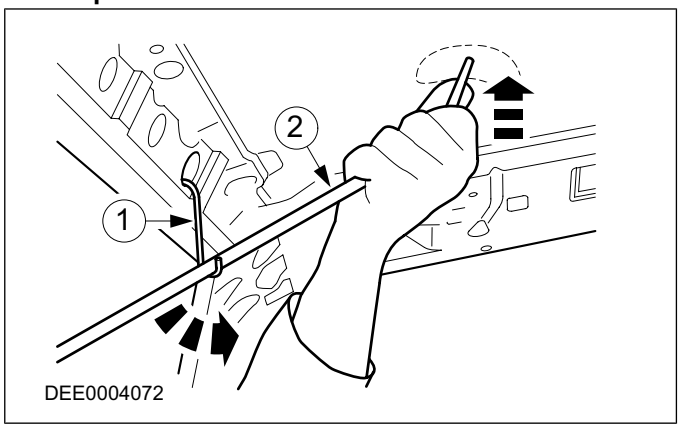


Item	Description
1	Roof surface
2	Pressure tool
3	Adhesive bead
4	Roof brace

Accessibility of individual bodywork components

Roof area

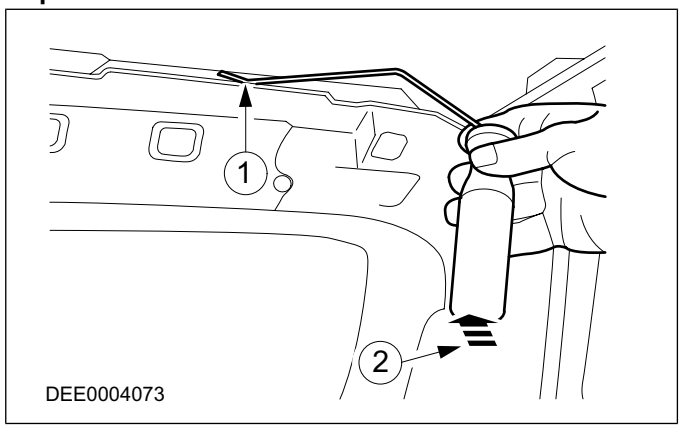
Support (pivot) of the pressure tool using an S-shaped hook



Item	Description
1	Pivoted using an S-hook
2	Pressure tool

- In order to make it possible to exert force in the roof area, a pivot in the form of an S-hook must be used.
- Only loosen the headlining locally, depending on the number of dents and their location.
- Dents near interior components can be reached by removing the component (interior lamp).
- Check accessibility before starting repair work if the dent is near the sliding roof.
- Repairs near inner braces are worked using the special tools found in the tool kit.
  - Separate the adhesive bead of the brace using a metal spatula, so that the pressure tool can be put in position.

Special lever for dents near inner braces.



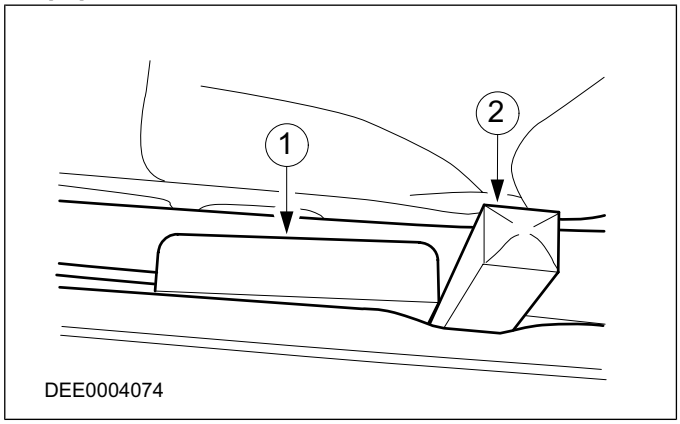
Item	Description
1	Contact point
2	Direction of movement

Door area

- Dents in the upper half of the door can usually be worked on without removing the inner trim.
- When the window is open, access is obtained through the window cavity. A protective assembly is inserted into the window cavity to prevent damage to the window.
- The plastic wedge ensures access.

DESCRIPTION AND OPERATION

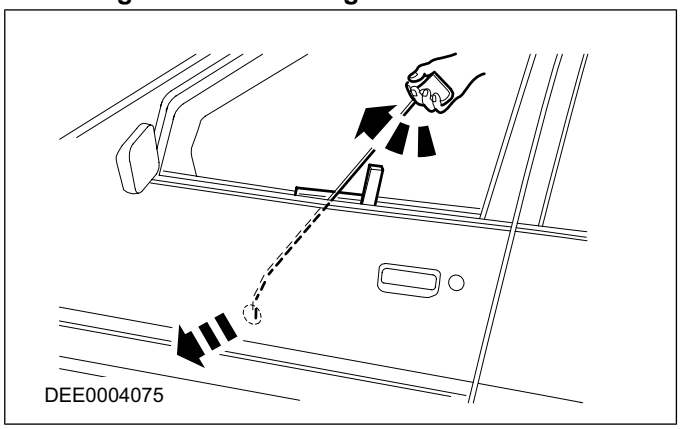
Equipment



Item	Description
1	Protective assembly
2	Plastic wedge

– The pressure is applied in this case without use of an additional support by simply turning the bent pressure tool.

Pressing out a dent through the window channel.



Hood

– The hood is moved into working position using telescopic struts and held in position using the "rubber cords".
– In the region of the braces the adhesive bead must be partially opened using a metal spatula to give access to the dent.

Renewal of the corrosion protection.

– All repair inner areas must be reworked, where accessible the paintwork must be refinished.
  – Clean the inner area with silicone remover.
  – Prime and paint the inner repair area.
  – Finally, spray in cavity protection where the repair is not accessible.

Quality control

– In order to achieve a repair quality that meets production standards, the following points must be observed:
  – Check the repair area for unevenness. Do this optically by looking at the surface from different angles.
  – Paint the repaired surface area, clean it and polish it if necessary.
  – Check that the attached components and inner trim are seated correctly and are not damaged.

SECTION 501-26 Body Repairs - Vehicle Specific Information and Tolerance Checks

VEHICLE APPLICATION: 2010.25 Figo

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DESCRIPTION AND OPERATION

Body and Frame

Introduction

The bodywork of this model is a completely new development and comprises the following model variants:

- 5-door version

Construction features

The front and rear side members, windshield frames, doors and D-pillar inner reinforcement are made of thick walled body panels. Because of the shape of the individual components and the built-in reinforcements, the bodywork is very resistant to torsion. For the first time, body panels reformed from tailored blanks are integrated into the crash and strength relevant areas. Because of this, the deformation performance of the chassis and the occupant protection are distinctly improved.

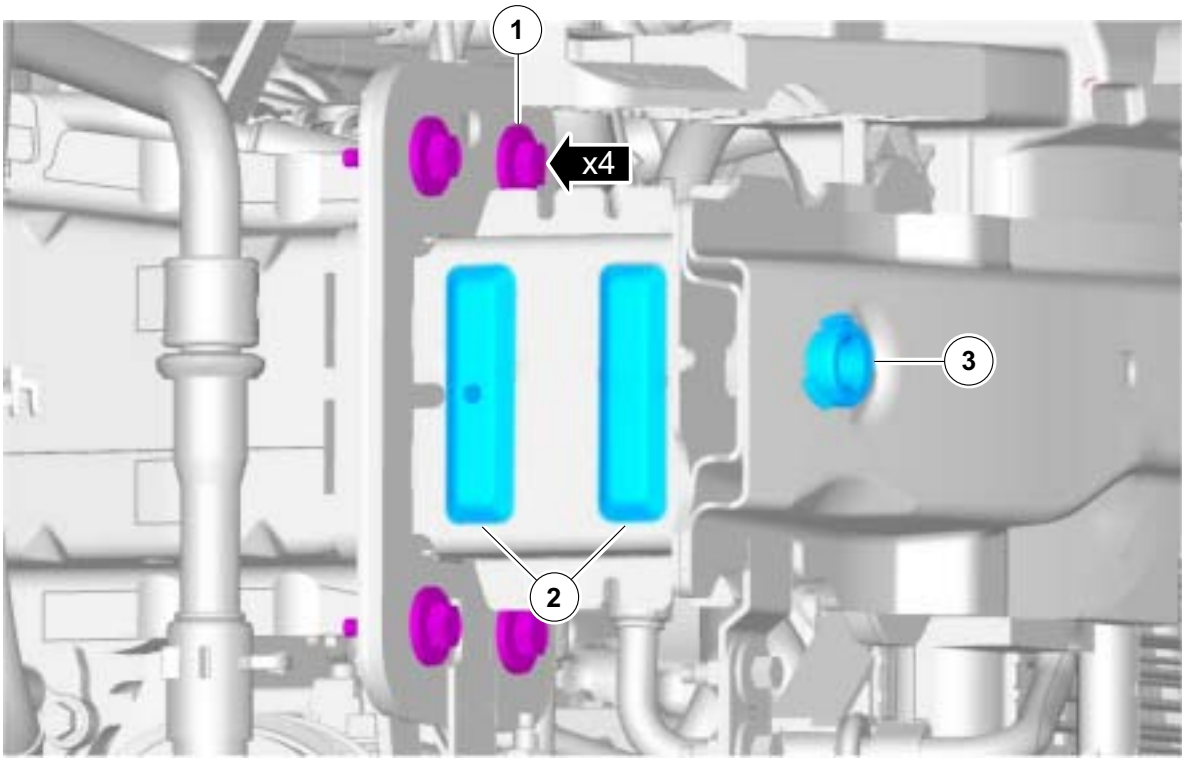
Overall, the bodywork of this model proves to be very easy to repair. The overall body structure is made and assembled in such a way that individual body panels can be replaced without problem. Body components which are prone to deformation (e.g. front side member, A-pillar inner panel etc.) are made of several individual parts which are joined together. The majority of the welded joints which may need to be repaired can be re-created using resistance spot welding.

Other changes relate to the increase in wheel base, overall length and vehicle height, deformation areas on the front and rear side members and the front and rear crash elements.

Front crash element

The front crash element consists of a steel crossmember with two deformation elements welded onto it. The energy of an impact is absorbed by the crossmember and is dissipated through the deformation elements. It is attached to the bodywork by threaded connections.

Crash element



E119866

DESCRIPTION AND OPERATION

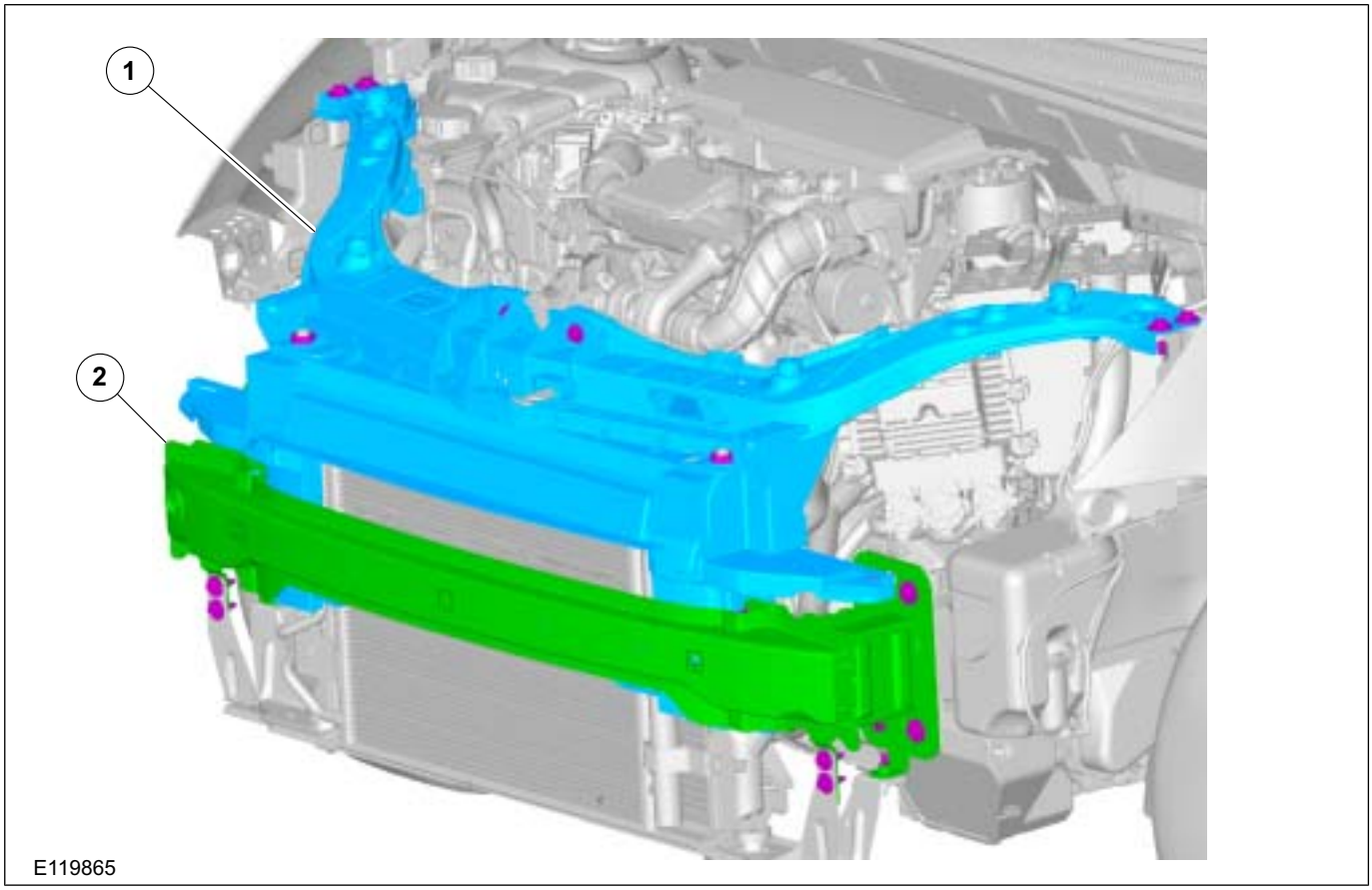
Item	Description
1	Retaining bolts
2	Pre-determined folding points
3	Threaded bore for the towing eye

Hood lock panel

The hood lock panel is made of plastic and is reinforced with high-resistance foam in the areas of most load. Attachment to the crossmember and to the upper side members is achieved by threaded connections. The hood lock panel supports a variety of other components (e.g. the radiator, radiator fan and hood lock). Minor damage can be repaired using the applicable plastic repair process.

NOTE: If there are penetrating cracks, partial breaking away of material or part of it is missing, a new hood lock panel must be installed.

Front module



E119865

Item	Description
1	Hood lock panel
2	Crash element

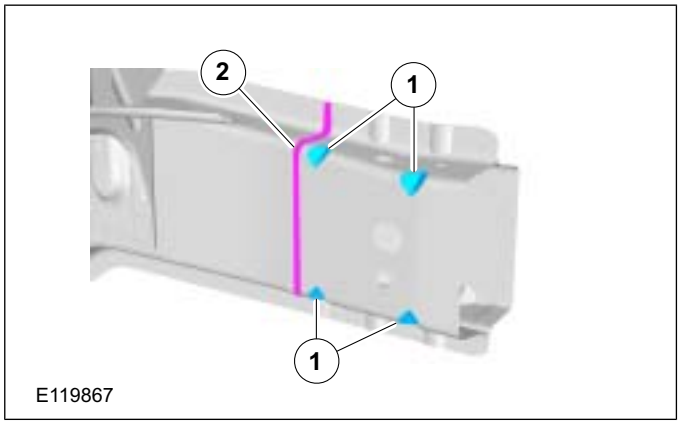
In the case of repairs, the front module, consisting of the crash element and the hood lock panel, can be detached as a unit together with the components which are bolted to it.

Front side member

In contrast to the previous model, the side member is made of several parts, and the inner sides are made of tailored blanks. If the frontal damage extends past the crash element, the impact energy is absorbed by the side members and dissipated in the area of the intentional yield points (deformation area). A deformation area has no inner reinforcement. Sectional replacement is possible if the damage does not extend past the deformation area (intentional yield points). If there is deformation inside the engine compartment, the front section can be replaced individually.

DESCRIPTION AND OPERATION

Front side member



Item	Description
1	Pre-determined folding points
2	Laser butt weld

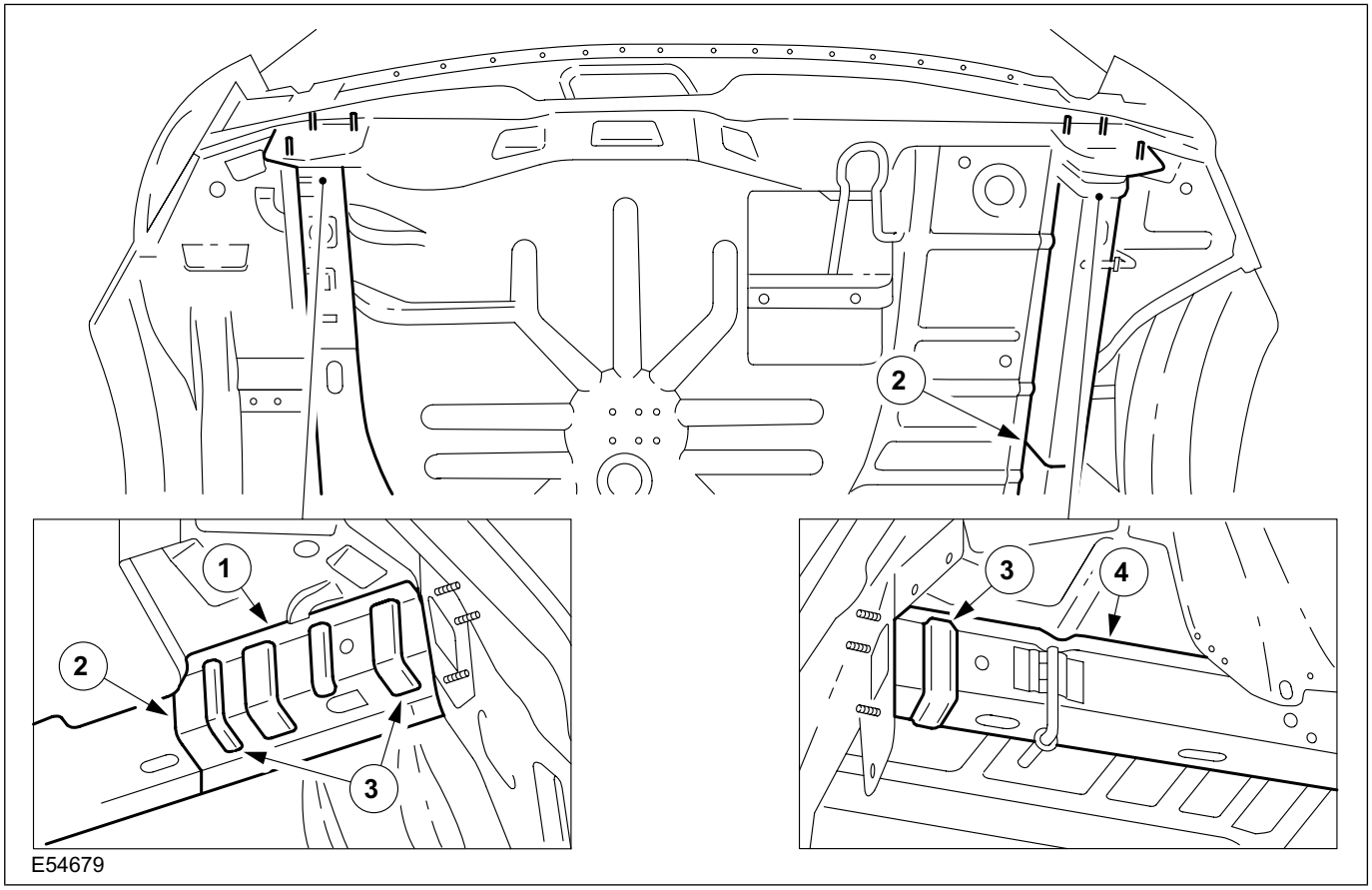
Rear crossmember

The rear crossmember is secured to the side members by threaded connections. Because the crossmember is curved, impact energy is more easily converted into deformation energy. For light impacts this prevents deformation of the side members and therefore of the vehicle body also.

Rear side member

If a heavier rear impact occurs, in addition to the crossmember, the ends of the side members are deformed. The remaining energy is dissipated in a controlled manner in the area of the intentional yield points. Sectional replacement is possible if the damage does not extend past the deformation areas.

Rear side member



Item	Description
1	Left-hand side member
2	Laser butt weld
3	Pre-determined folding points
4	Right-hand side member

NVH measures

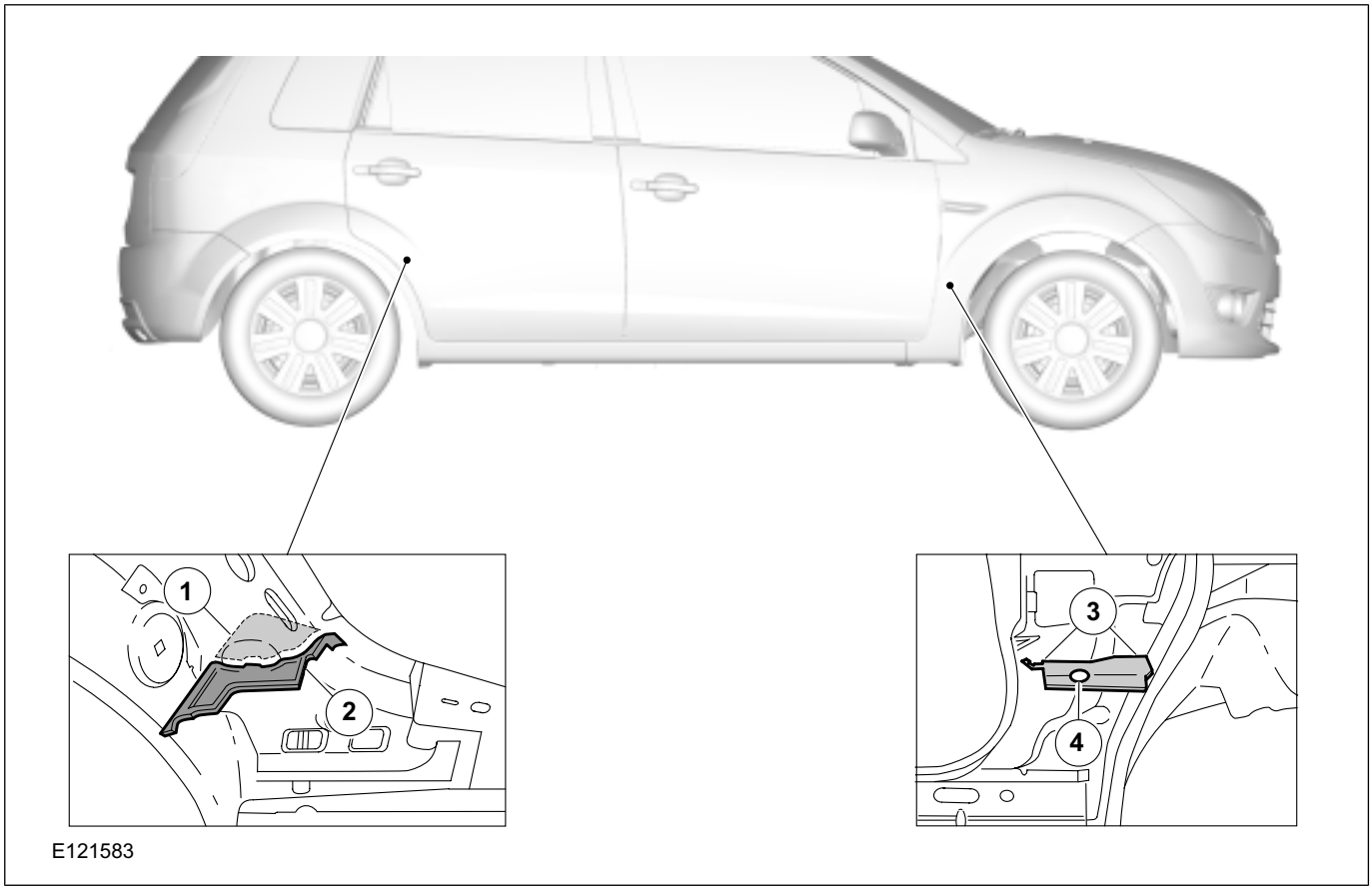
In order to prevent air conduction of noise to the vehicle interior, three NVH elements are installed on each side of the vehicle, clipped to the vehicle bodywork. When carrying out repair work, either the original NVH elements must be put back in position or new ones installed. On vehicles with a

DESCRIPTION AND OPERATION

sliding roof, the opening must be left in the A-pillar NVH element for the water drain hose.

NOTE: Gases harmful to health will be released if the insulation material is heated too much. Make sure that the insulation material installed in production is not damaged by cutting or sanding tools when cutting out bodywork parts.

NVH measures



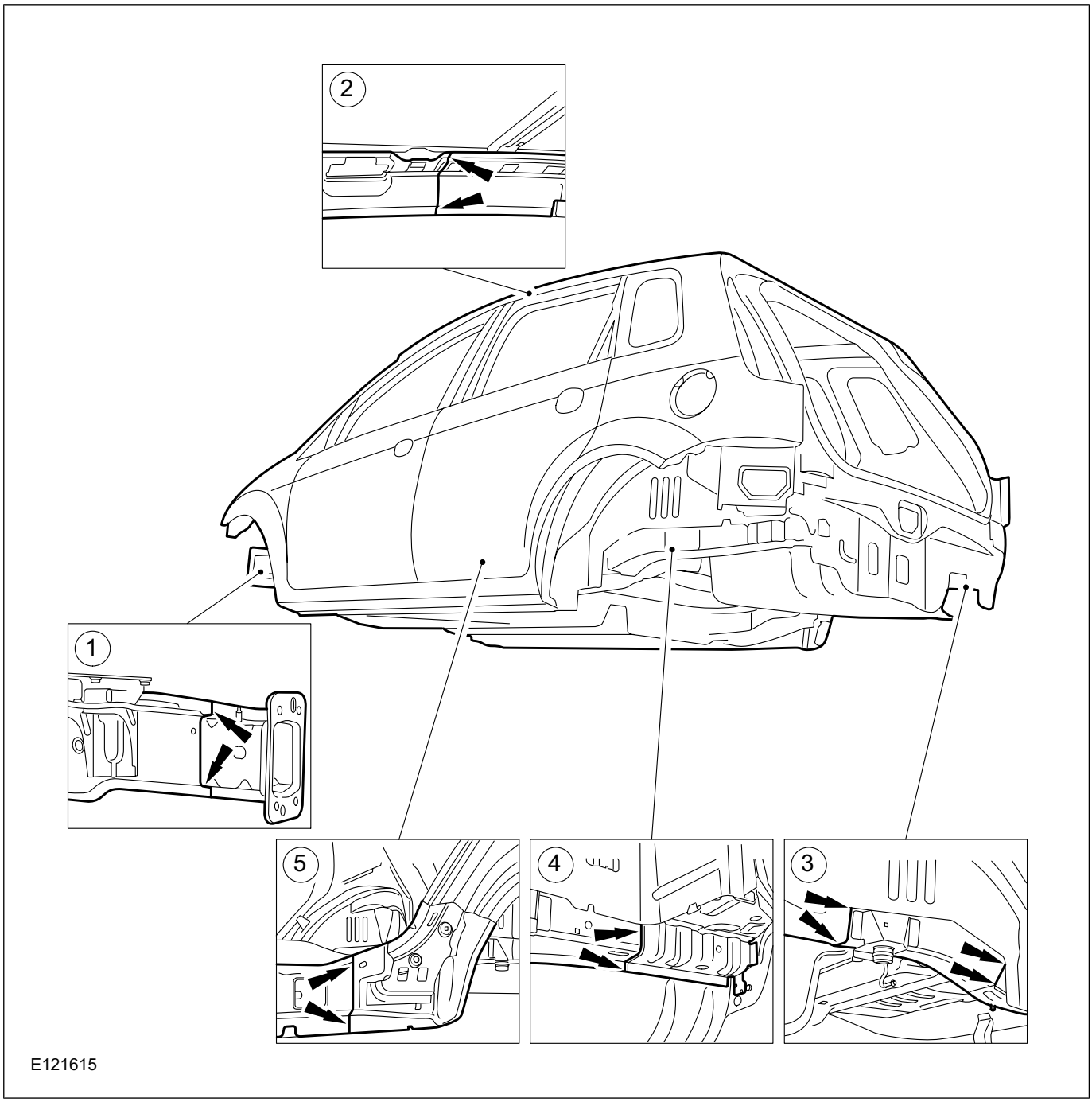
Item	Description
1	C-pillar inner NVH element
2	C-pillar outer NVH element
3	A-pillar NVH element
4	Opening for sliding roof water drain hose

Tailored blanks

By employing a combination of materials with different thicknesses and properties, tailored blanks make it possible to produce an exact match to the required strength and rigidity in different areas within one bodywork component. The number of steel panels can be decreased by installing tailored blanks and so the weight of the bodywork can be reduced.

DESCRIPTION AND OPERATION

Tailored blanks with laser welds



Item	Description
1	Front side member
2	Roof frame
3	Rear right-hand side member
4	Rear left-hand side member
5	Rocker panel reinforcement

High-strength steel parts

Reinforced high-strength steel parts are used on all Fiesta models.

NOTE: The working methods given in Part I of the Body Repair Manual (501-25A) must be observed in all repair work.

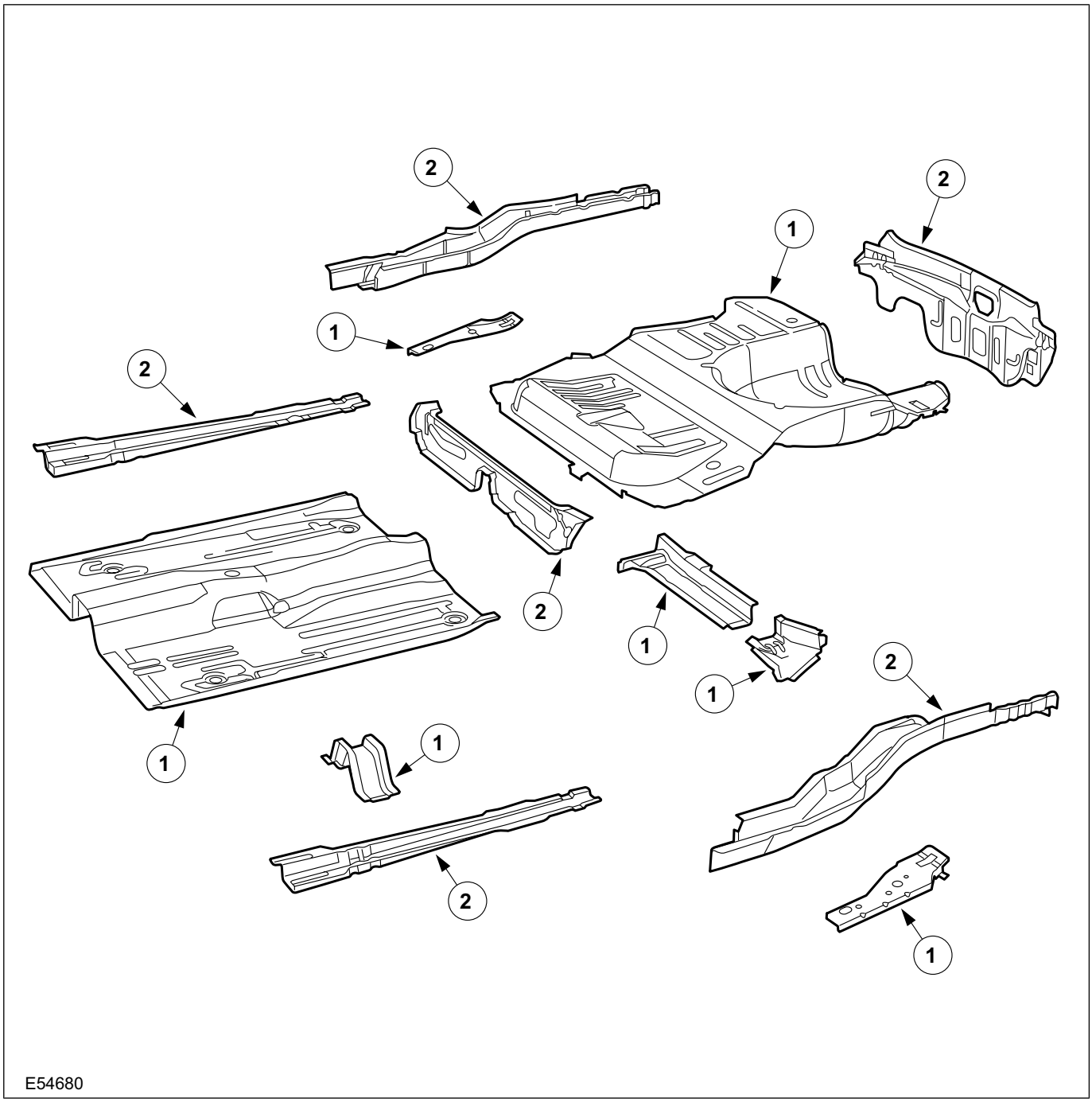
DESCRIPTION AND OPERATION

Overview of parts, front end

Item	Description
1	Galvanised steel panels
2	High strength and galvanised steel panels
3	High-strength low alloy steel

DESCRIPTION AND OPERATION

Overview of parts, floor pan



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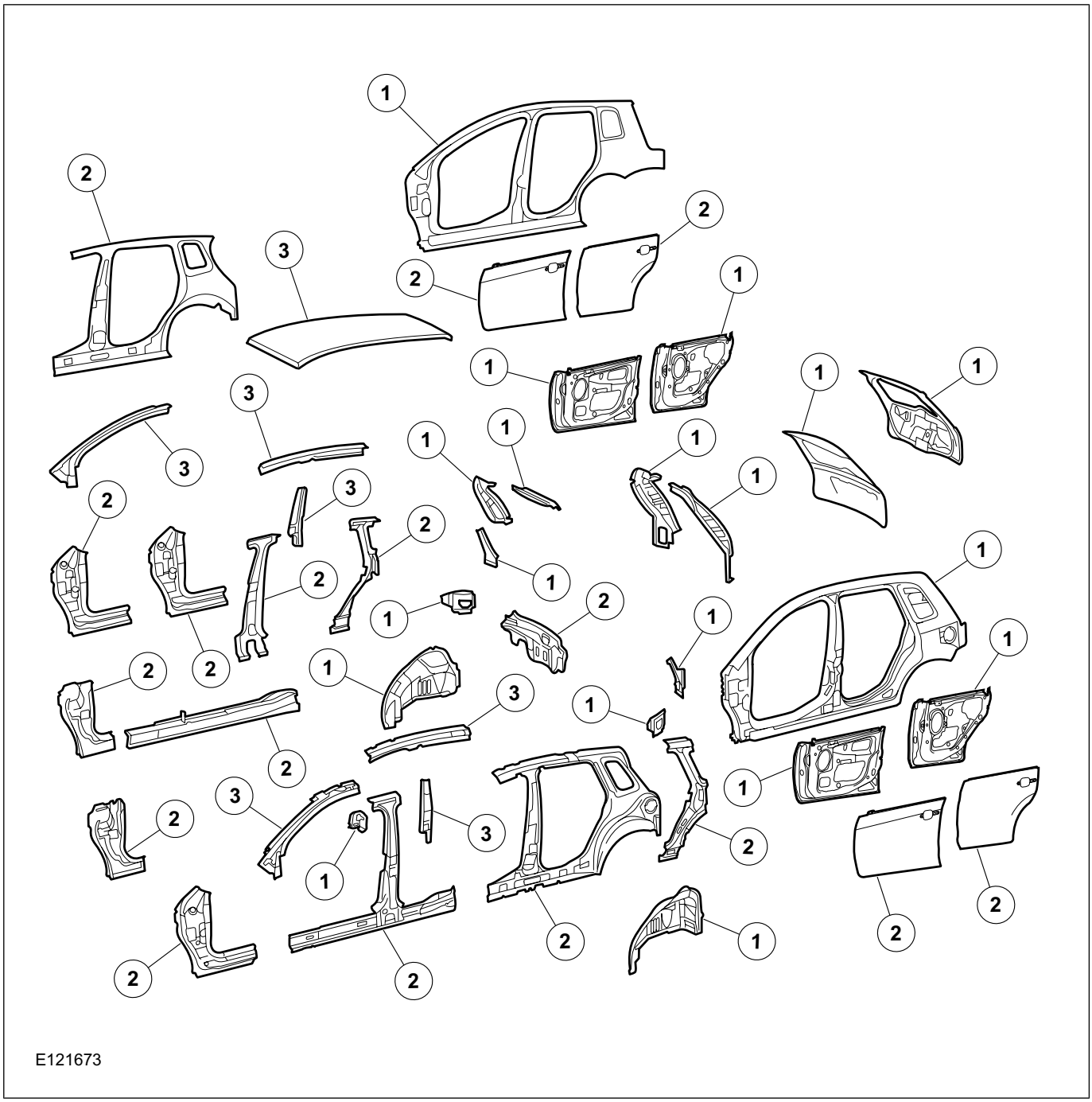
Item	Description
1	Galvanised steel panels
2	High strength and galvanised steel panels

DESCRIPTION AND OPERATION

Overview of parts, side view



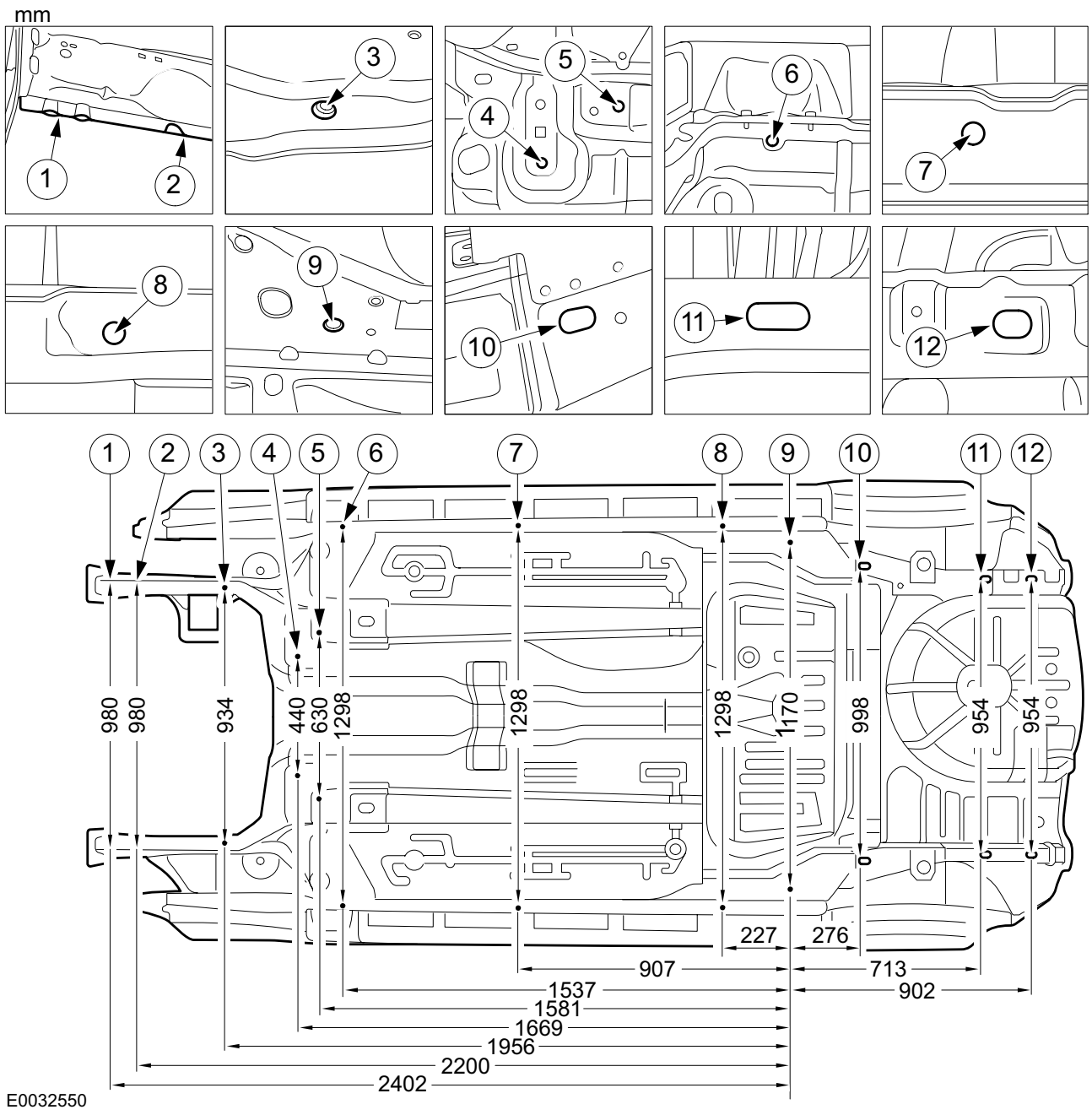
Item	Description
1	Galvanised steel panels
2	High strength and galvanised steel panels
3	High-strength steel parts

GENERAL PROCEDURES

Underbody Tolerance Check

1. Body frame dimensions

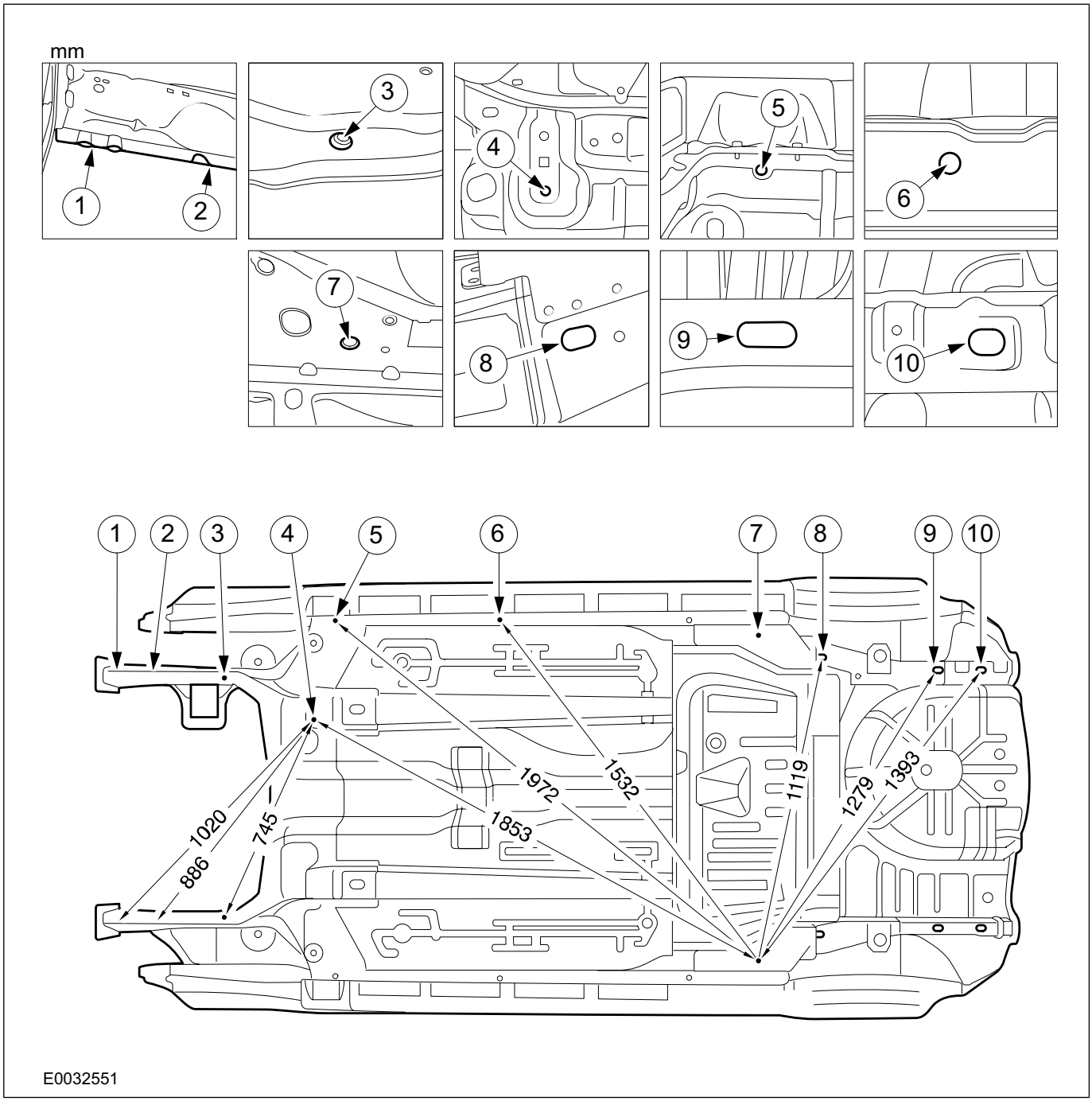
- A tolerance of ± 3 mm applies to all measurements given. All detailed illustrations correspond to the left-hand side of the vehicle.
- All measurements have been taken from production data and are the length of the straight line between the measurement points. All measurements can therefore be made using a symmetrically adjusted measuring gauge.
- The measurement points were measured with assemblies removed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (as seen from the driver's seat).



GENERAL PROCEDURES

2. Body frame dimensions

- A tolerance of ± 3 mm applies to all measurements given. All detailed illustrations correspond to the left-hand side of the vehicle.
- All measurements have been taken from production data and are the length of the straight line between the measurement points. All measurements can therefore be made using a symmetrically adjusted measuring gauge.
- The measurement points were measured with assemblies removed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (as seen from the driver's seat).



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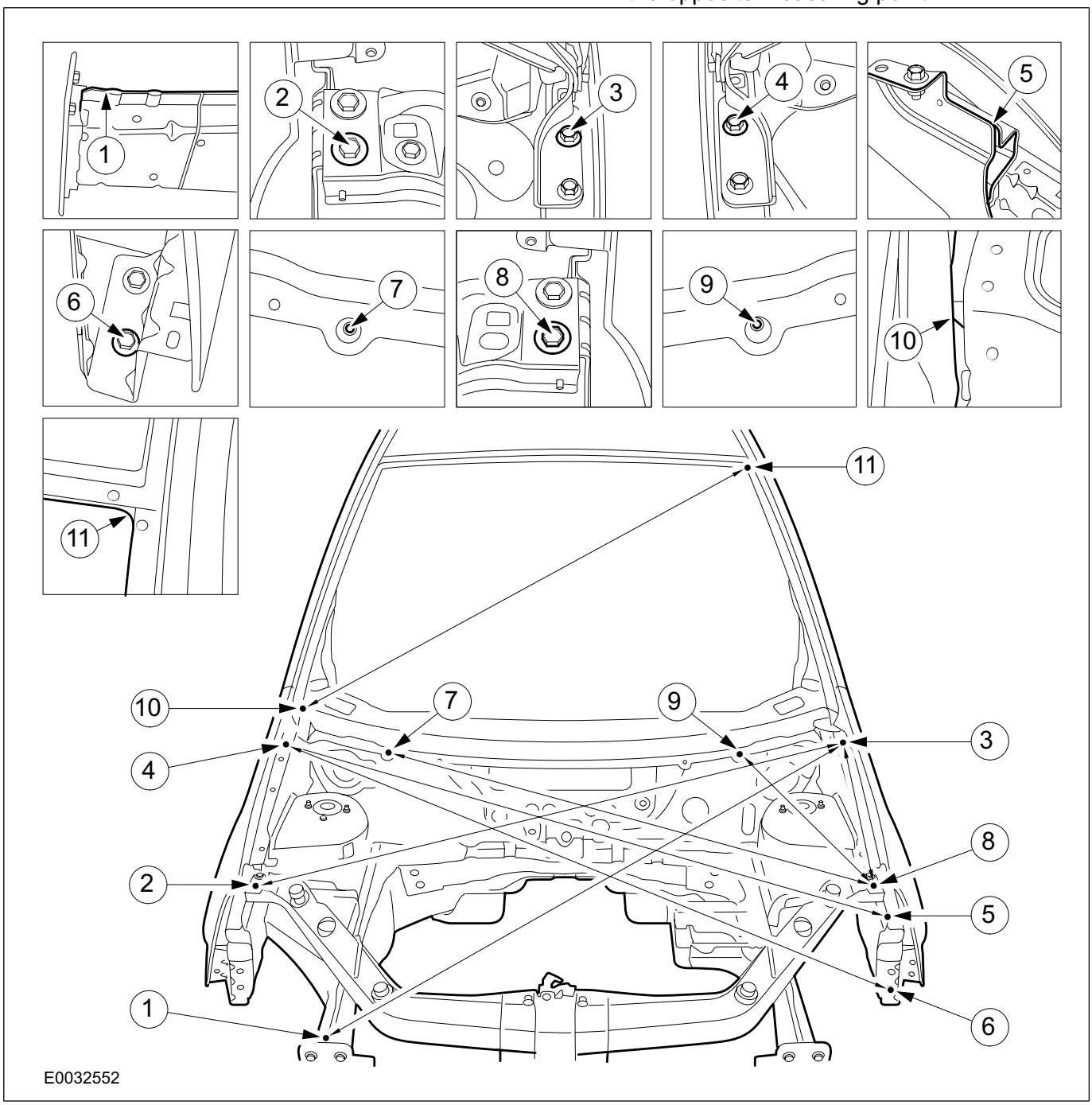
GENERAL PROCEDURES

Frame Tolerance Check

1. Body dimensions, vehicle front

- All dimensions with tolerance ± 3 mm. All dimensions were determined from the centre of the hole or panel edge using a symmetrically adjusted measuring gauge.
- 1 -3 = 1,378 mm; 2 -3 = 1,416 mm; 4 -5 = 1,462 mm; 4 -6 = 1,524 mm; 7 -8 = 1,157 mm; 8 -9 = 473 mm; 10 -11 = 1,433 mm.
- Measuring point 11 is measured in the curve and corresponds to the greatest distance to the opposite measuring point.



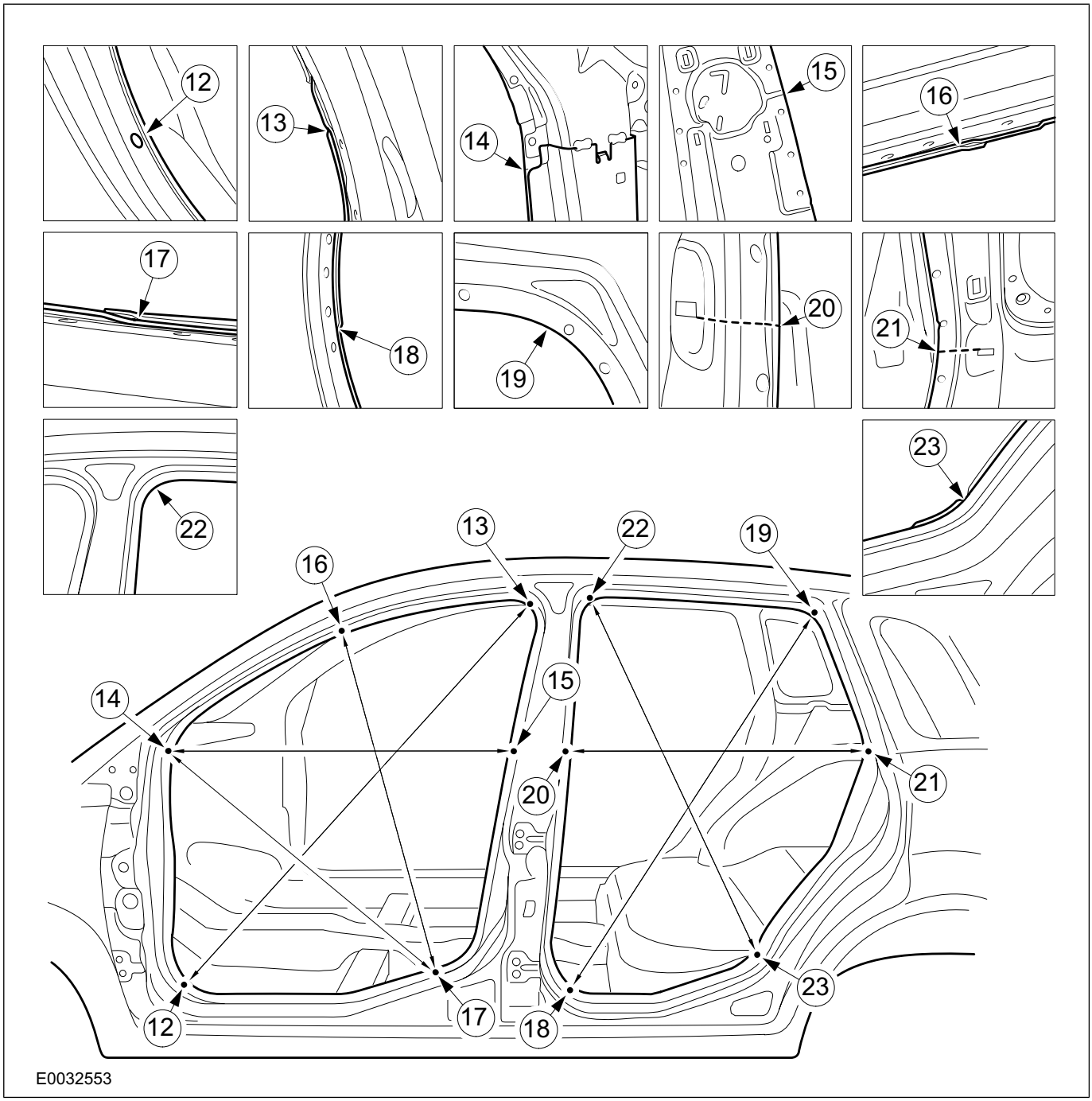
2. Body dimensions, side view (5-door version)

- All dimensions with tolerance ± 3 mm. All dimensions were determined from the centre of the hole or panel edge using a symmetrically adjusted measuring gauge.
- 12 - 13 = 1,290 mm; 14 - 15 = 840 mm; 14 - 17 = 824 mm; 16 - 17 = 876 mm; 18 - 19 =

GENERAL PROCEDURES

1,105 mm; 20 - 21 = 720 mm; 22 - 23 = 964 mm.

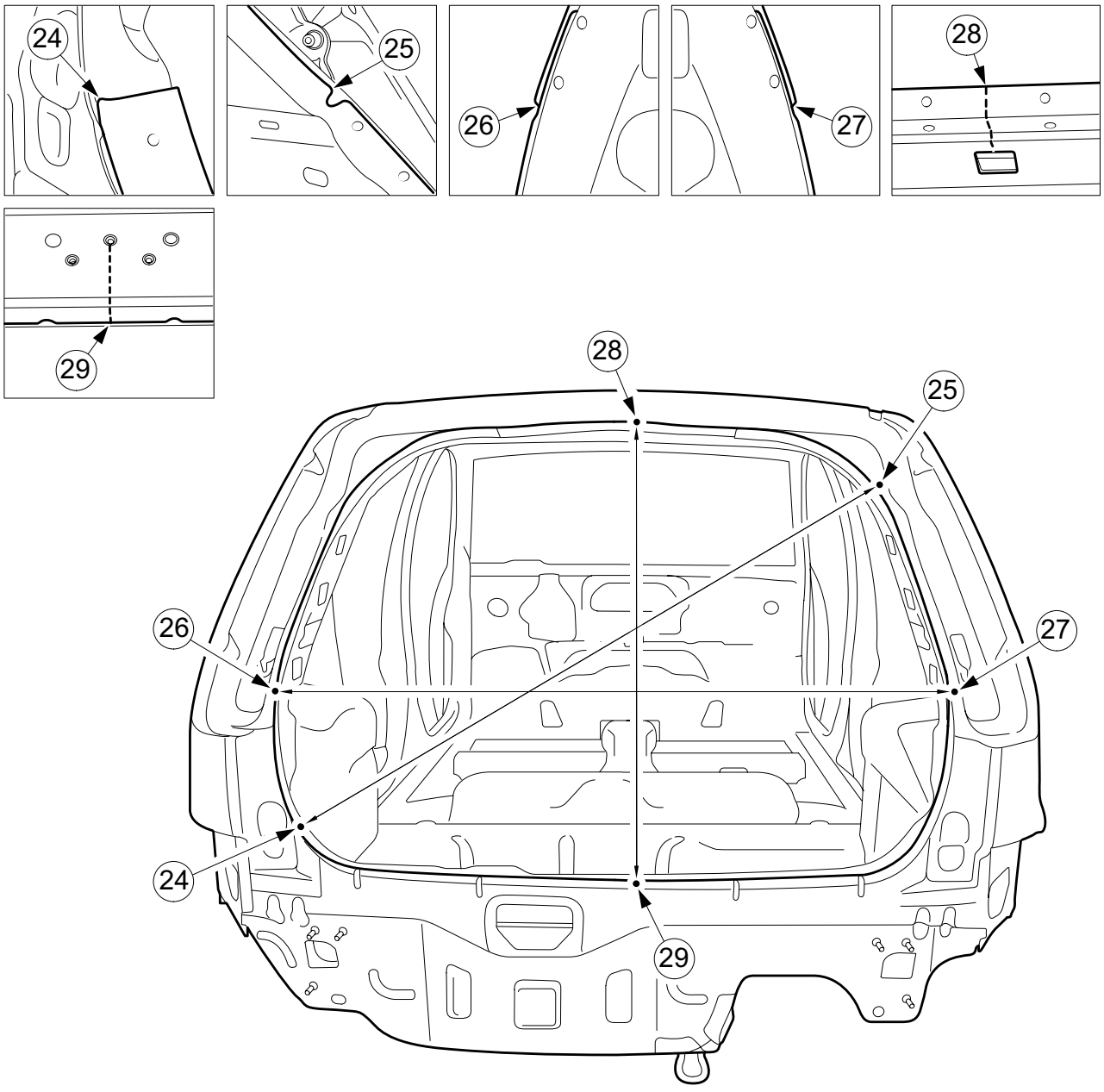
- Measuring points 12, 19 and 22 are measured in the curve and correspond to the largest distance to the opposite measuring point.



3. Body dimensions, rear view (5-door version)

- All dimensions with tolerance ± 3 mm. All dimensions were determined from the centre of the hole or panel edge using a symmetrically adjusted measuring gauge.
- 24 -25 = 1,139 mm; 26 -27 = 1,086 mm; 28 -29 = 818 mm.

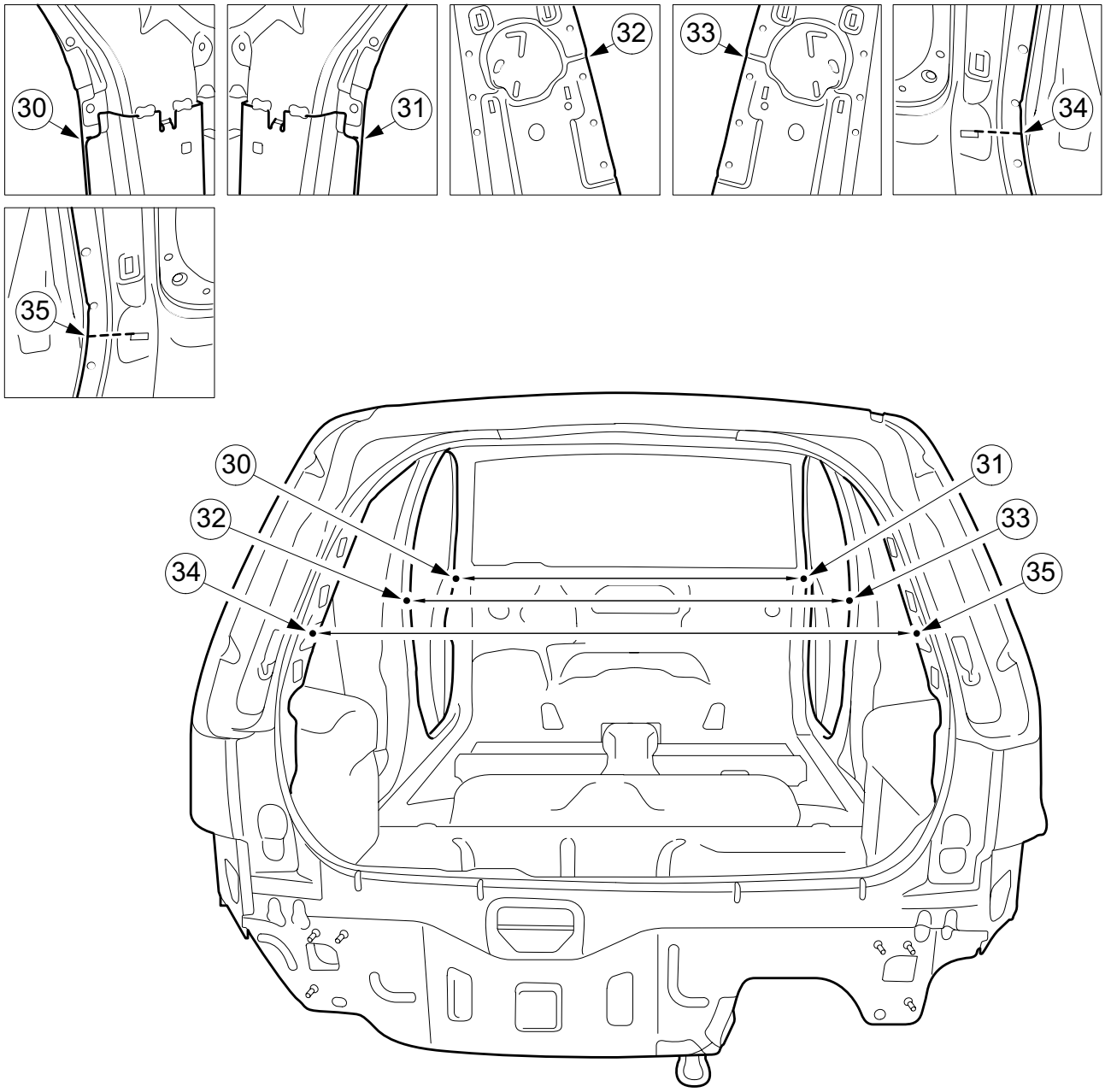
GENERAL PROCEDURES



4. Body dimensions, interior (5-door version)

- All dimensions with tolerance ± 3 mm. All dimensions were determined from the centre of the hole or panel edge using a symmetrically adjusted measuring gauge.
- 30 -31 = 1,349 mm; 32 -33 = 1,343 mm; 34 -35 = 1,332 mm.

GENERAL PROCEDURES



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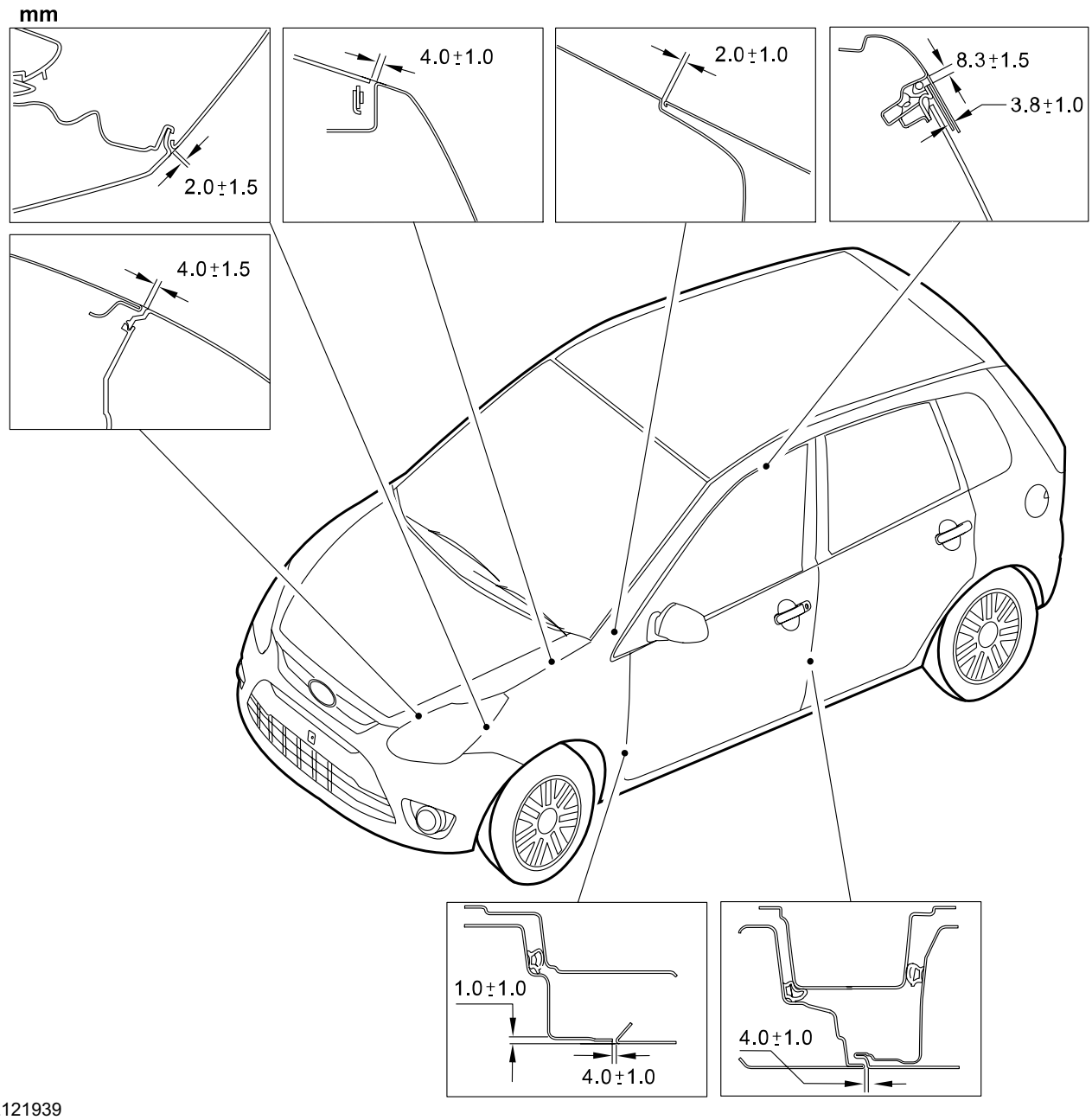
GENERAL PROCEDURES

Body Tolerance Check

1. Body gap dimensions

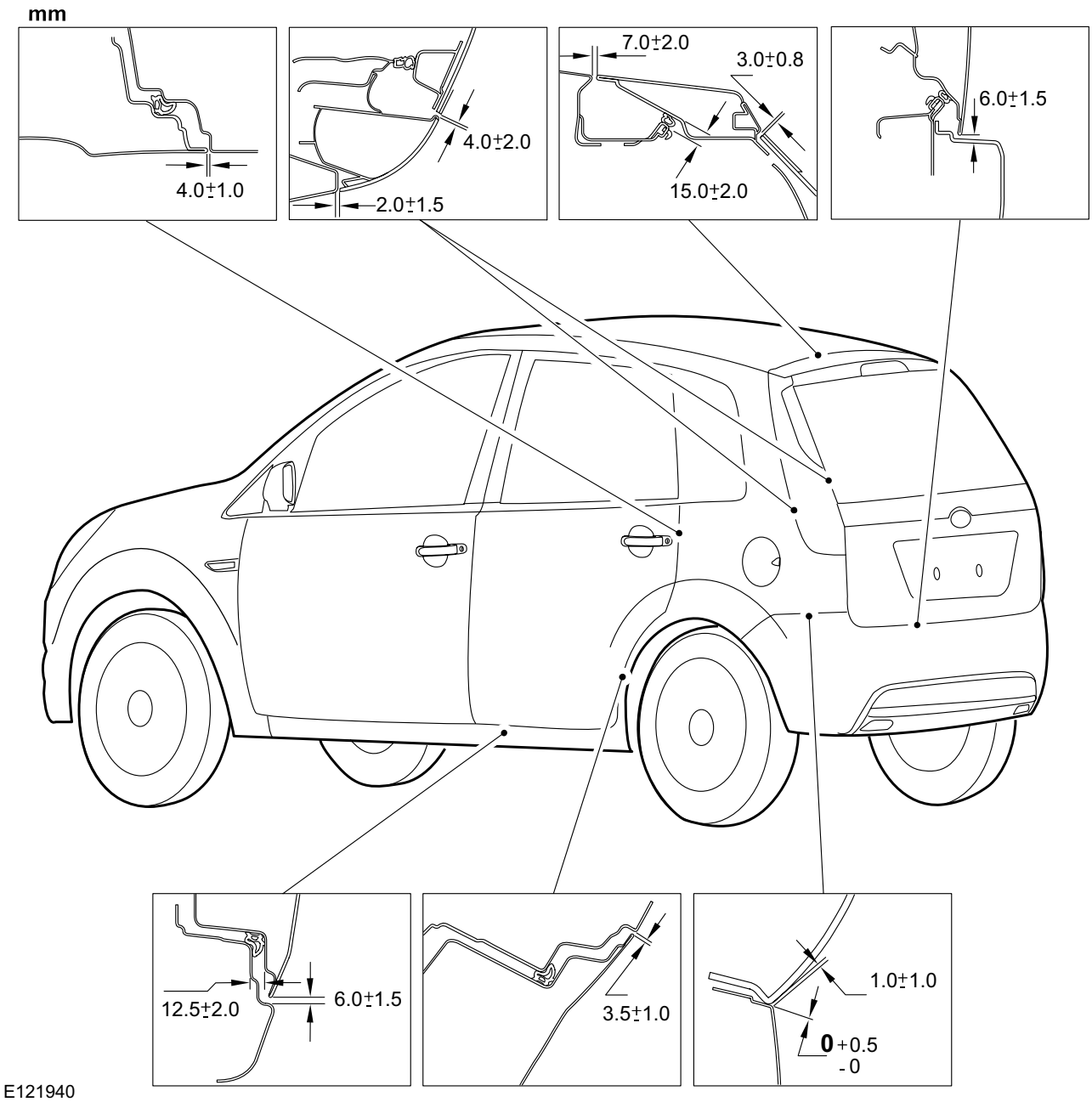
- The gap dimension given must be the same along the whole length of the gap.



2. Body gap dimensions

- The gap dimension given must be the same along the whole length of the gap.

GENERAL PROCEDURES



SECTION 501-27 Front End Sheet Metal Repairs

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

REMOVAL AND INSTALLATION

REMOVAL AND INSTALLATION

Fender Apron Panel Reinforcement(44 277 4)

Materials	
Name	**Specification**
Apron panel reinforcement	

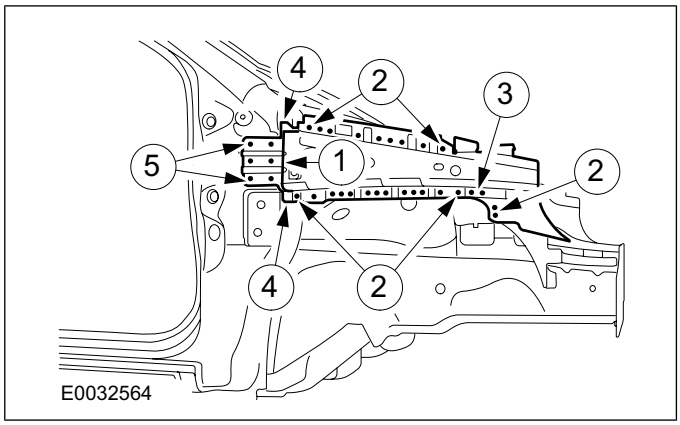
Removal

1. General Notes.

- The hood, windshield, doors and fenders are already removed before repair work starts.
- Necessary removal work: water trap cover and wheelhouse cover.

2. Apron panel reinforcement

1. Preliminary separating cut.
2. Mill out the spot welds.
3. Mill out the spot welds (two panel thicknesses).
4. Grind out the weld seam
5. Grind out the spot welds.



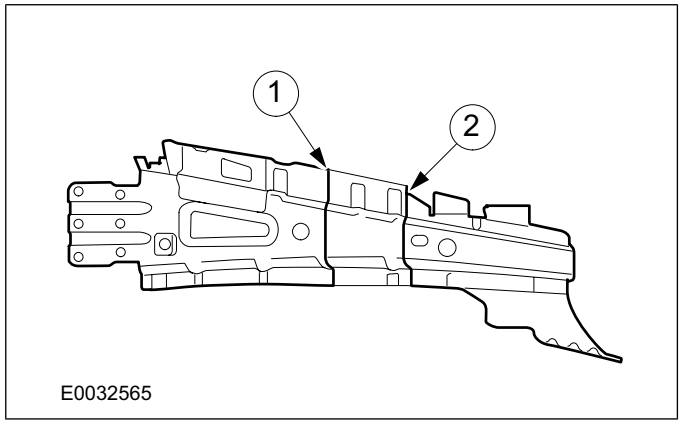
E0032564

Installation

NOTE: Partial replacement of the apron panel is possible, depending on the damage. The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Cut lines for partial replacement

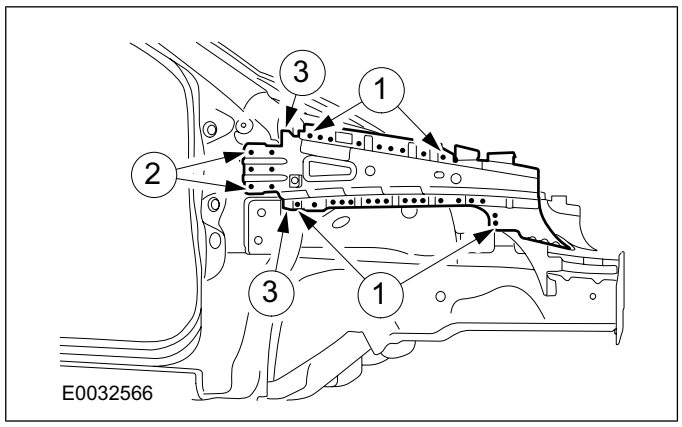
1. Rear cut line.
2. Front cut line.



E0032565

2. Apron panel reinforcement

1. Resistance spot weld
2. Puddle welding
3. Continuous MIG weld seam.



E0032566

REMOVAL AND INSTALLATION

Front Side Member Extension

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Side member front extension	
Bulkhead reinforcement	

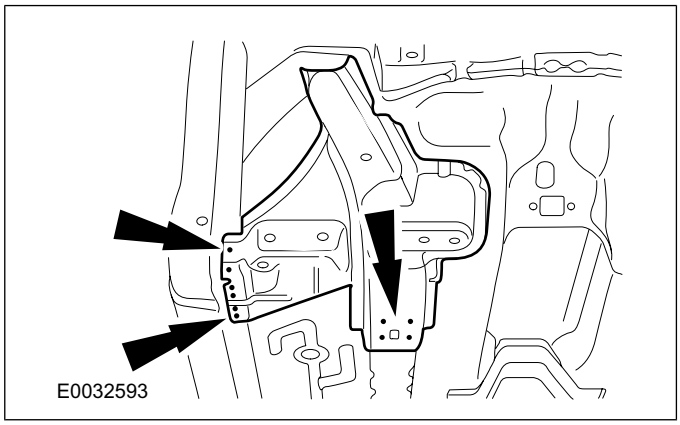
Removal

1. General Notes.

- The front side member with apron panel and apron panel reinforcement are already removed before the repair work starts.
- Necessary removal work: Facia crash padding and seats.
- Fold back the carpets and move the wiring back away from the working area.

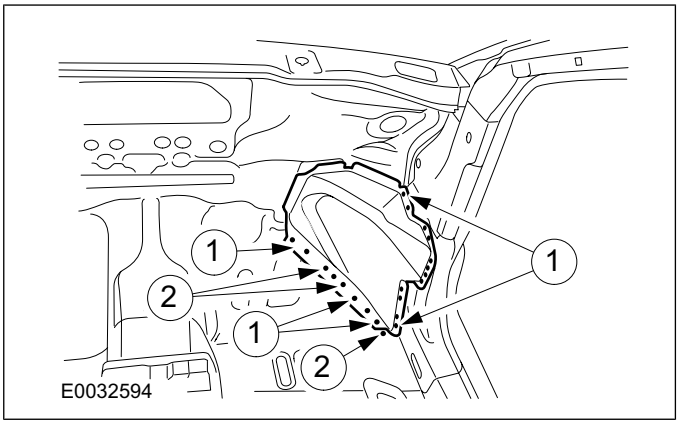
2. Side member

- Mill out the spot welds.



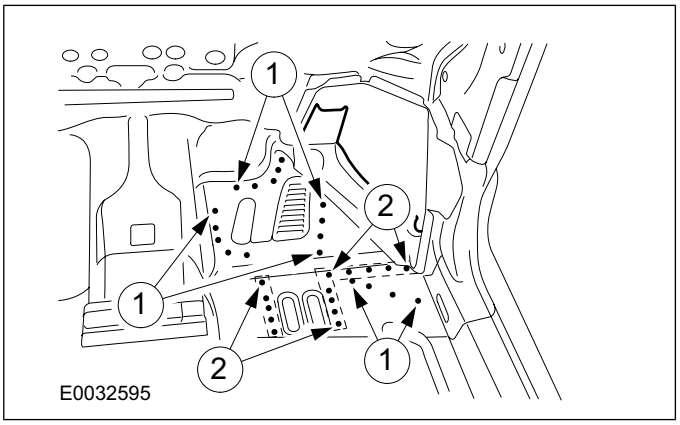
3. Bulkhead reinforcement

1. Mill out the spot welds.
2. Mill out the spot welds (two panel thicknesses).



4. Bulkhead reinforcement

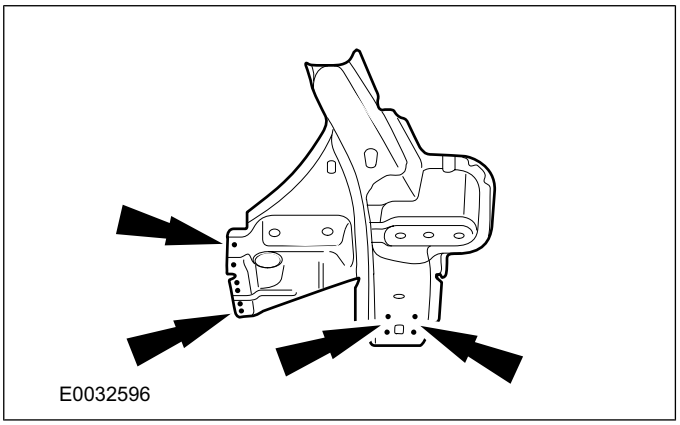
1. Mill out the spot welds.
2. Mill out the spot welds (two panel thicknesses).



Installation

1. Side member

- Drill holes for puddle welding (10 mm diameter).

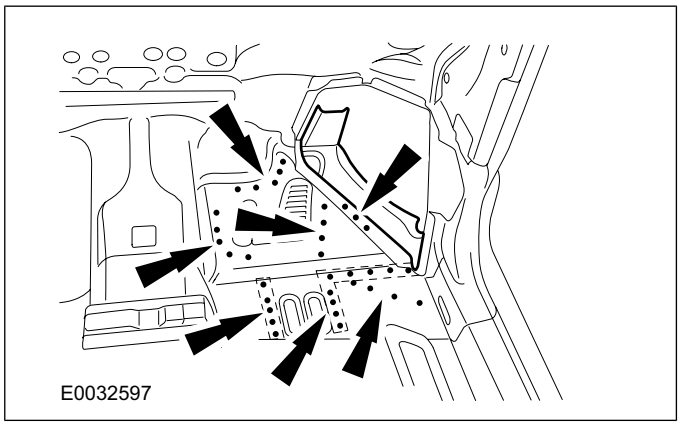


REMOVAL AND INSTALLATION

NOTE: : before welding, secure the side member using the measurement or alignment angle system.

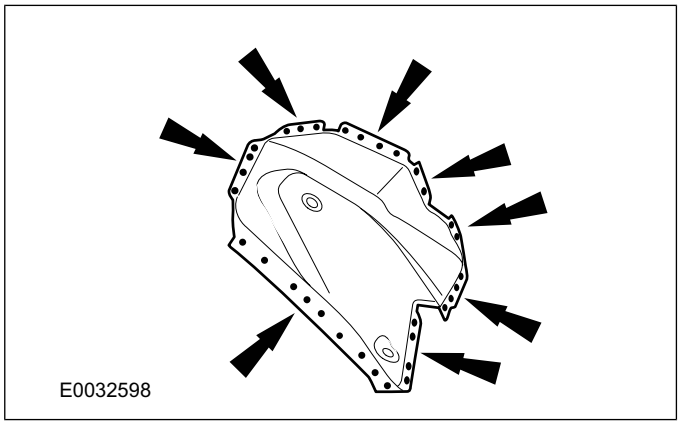
2. Side member

- Puddle welding



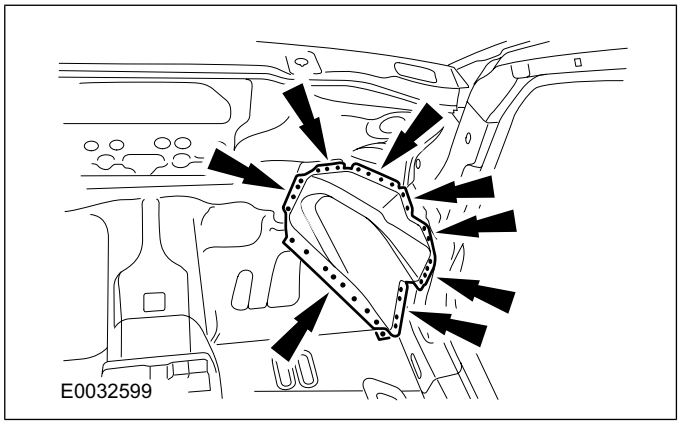
3. Bulkhead reinforcement

- Drill holes for puddle welding (10 mm diameter).



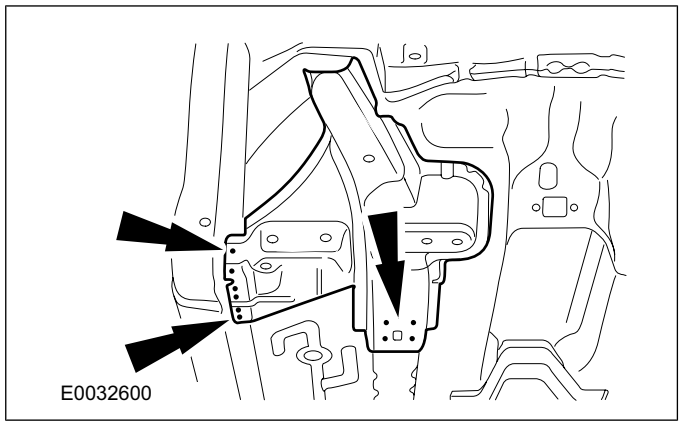
4. Bulkhead reinforcement

- Puddle welding



5. Side member

- Puddle welding



REMOVAL AND INSTALLATION

Front Side Member and Fender Apron Panel LH

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Side member with apron panel	
Apron panel reinforcement	

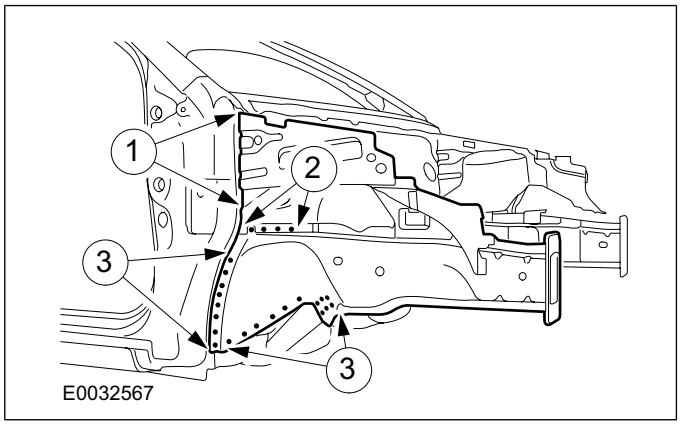
Removal

1. General Notes.

- Fenders, hood, doors and apron panel reinforcement are already removed before repair work starts.

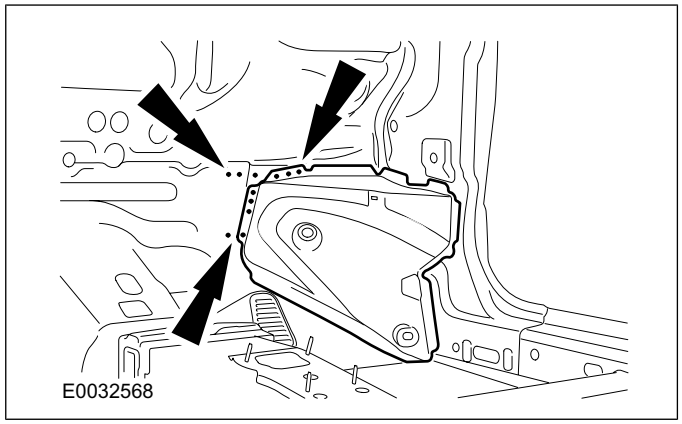
2. Side member with apron panel

1. Separating cut.
2. Mill out the spot welds (two panel thicknesses).
3. Mill out the spot welds.



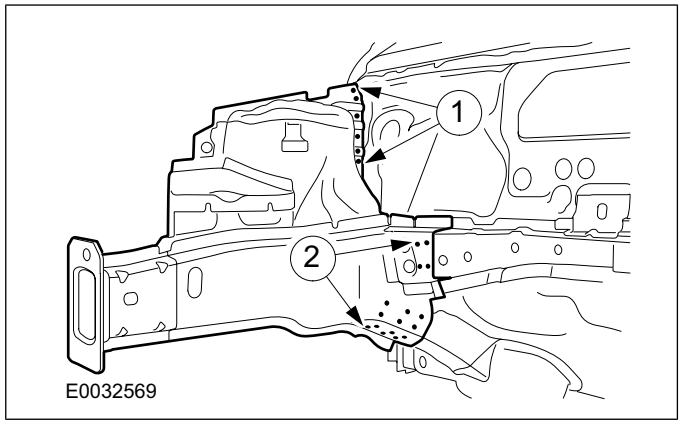
3. Bulkhead reinforcement

- Mill out the spot welds (two panel thicknesses).



4. Side member with apron panel

1. Mill out the spot welds.
2. Grind out the spot welds.



Installation

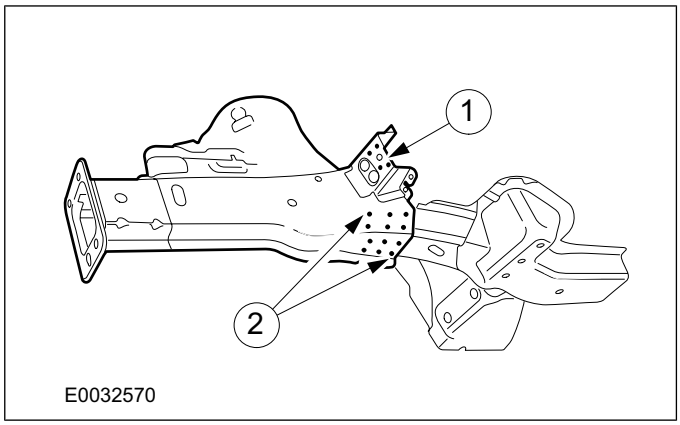
NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Side member with apron panel

1. Drill holes for puddle welding.

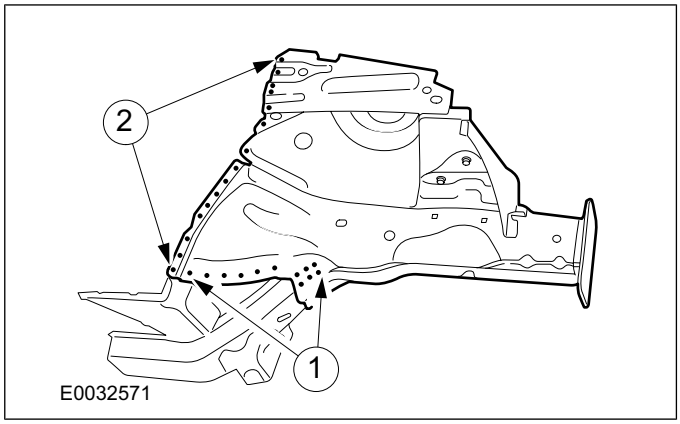
REMOVAL AND INSTALLATION

2. Mill out spot welds (diameter: 10 mm)



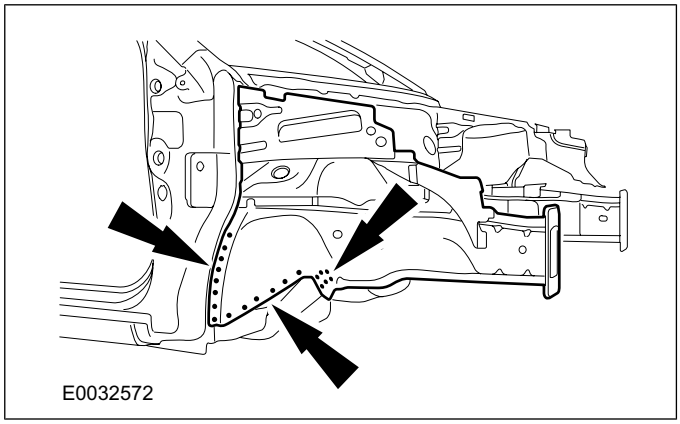
2. Side member with apron panel

1. Mill out spot welds (diameter: 10 mm).
2. Drill holes for puddle welding.



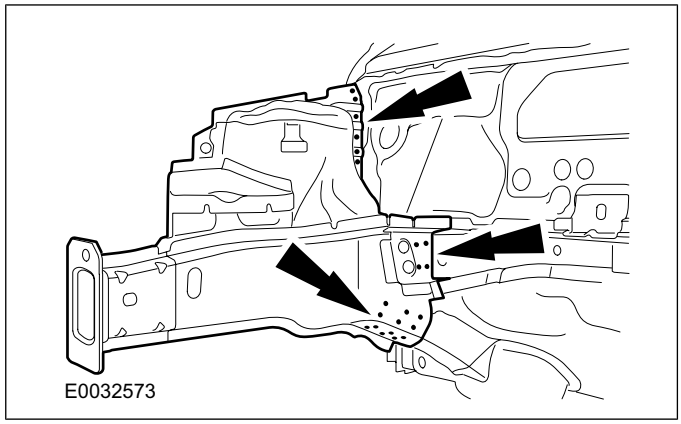
3. Side member with apron panel

- Puddle welding



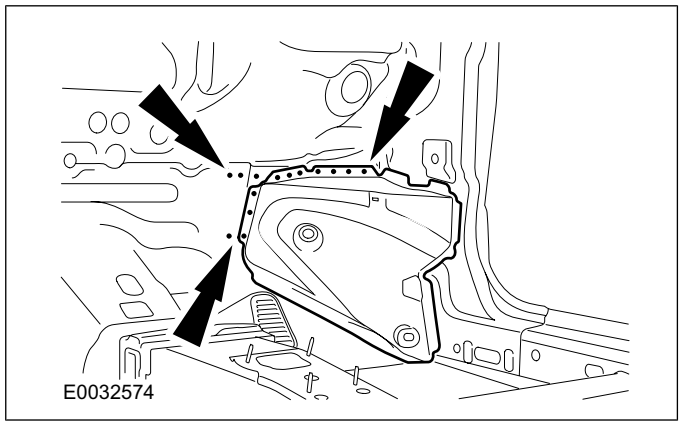
4. Side member with apron panel

- Puddle welding



5. Bulkhead reinforcement

- Puddle welding



REMOVAL AND INSTALLATION

Front Side Member Section

General Equipment

Measurement or alignment angle system

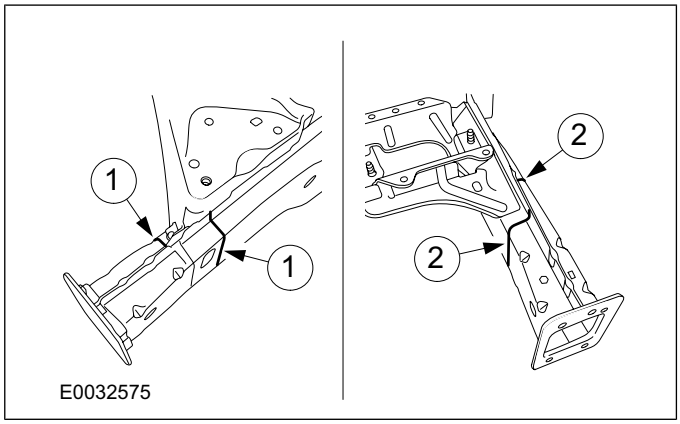
Materials	
Name	**Specification**
Outer side member	
Inner side member	
Crossmember retaining flange	

Removal

1. General Notes.

1. Right-hand side cut line.
2. Left-hand side cut line.

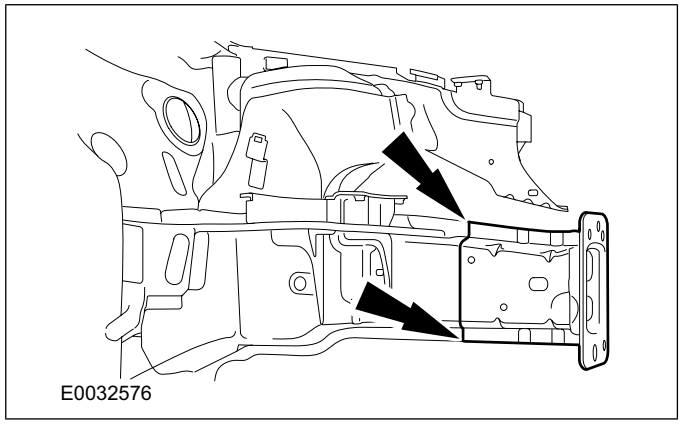
- The fine cut lines are not the same on the right-hand and left-hand sides.
- Hood lock panel, front crash element, hood, and fender are already removed before repair work starts.



NOTE: Separate the side member completely on the inside along the fine cut line.

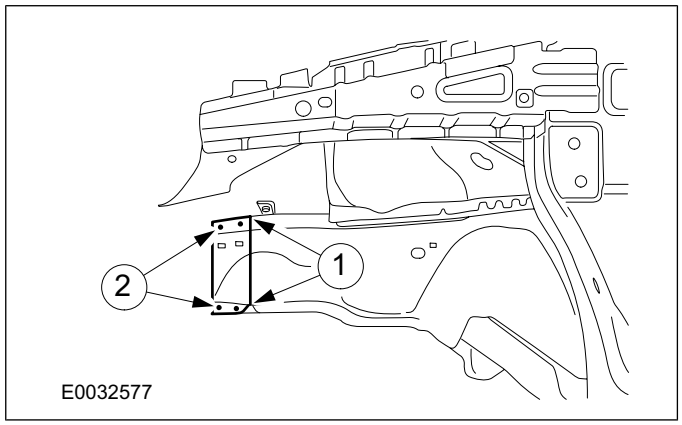
2. Inner side member

- Separating cut.



3. Outer side member

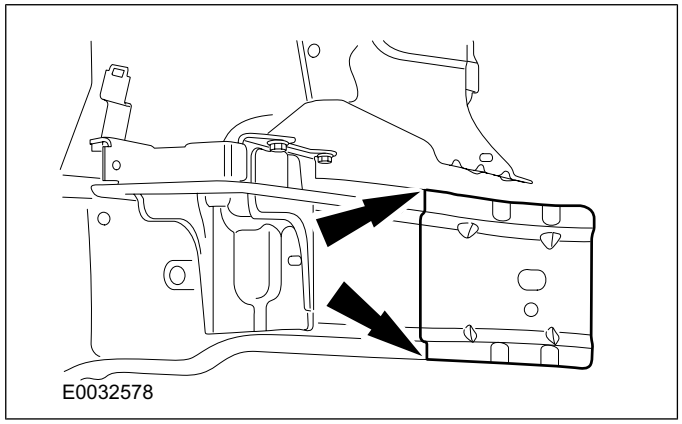
1. Separating cut.
2. Mill out the spot welds.



Installation

1. Inner side member

- Continuous MIG weld seam.

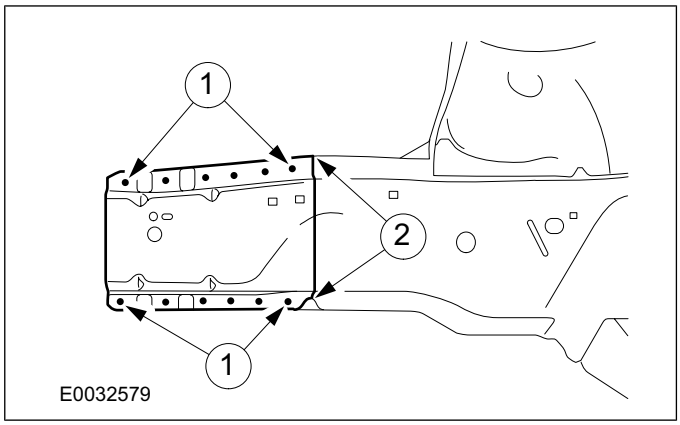


2. Outer side member

1. Resistance spot weld

REMOVAL AND INSTALLATION

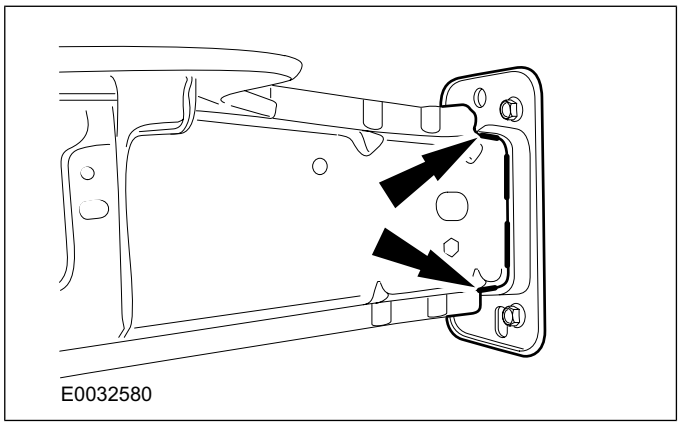
2. Continuous MIG weld seam.



NOTE: : Before welding, secure the retaining flange for the cross member using the measurement or alignment angle system and the installed hood closing panel.

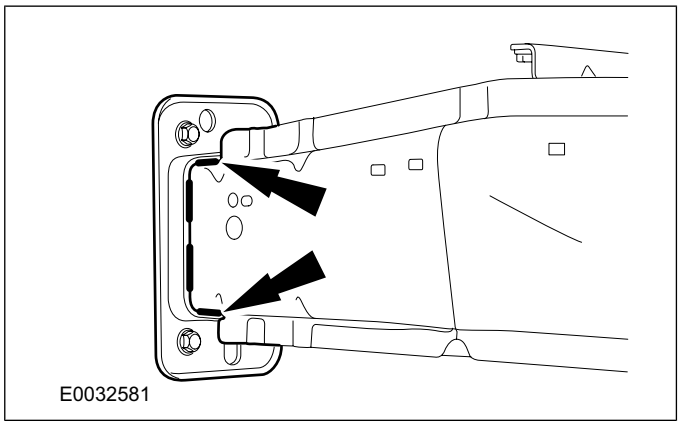
3. Inner crossmember retaining flange

- Intermittent MIG weld seam.



4. Outer crossmember retaining flange

- Intermittent MIG weld seam.



SECTION 501-28 Roof Sheet Metal Repairs

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Lubricants, sealants and adhesives

	Part number	Specification
PU glass adhesive (150 ml)	1 102 109	WSK-M11 P57-A1

REMOVAL AND INSTALLATION

Roof Panel

Materials	
Name	**Specification**
Roof	

Removal

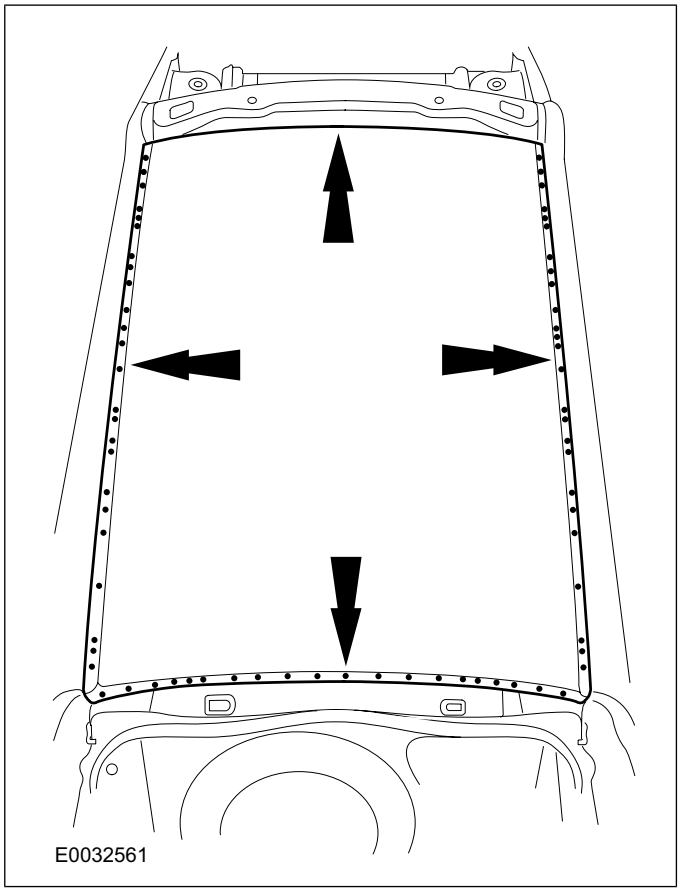
1. General Notes.

- Necessary removal work: windshield, tailgate, headliner and interior trim.

2. NOTE: Heat the bonded areas on the roof panel before removal.

Roof

- Mill out the spot welds.

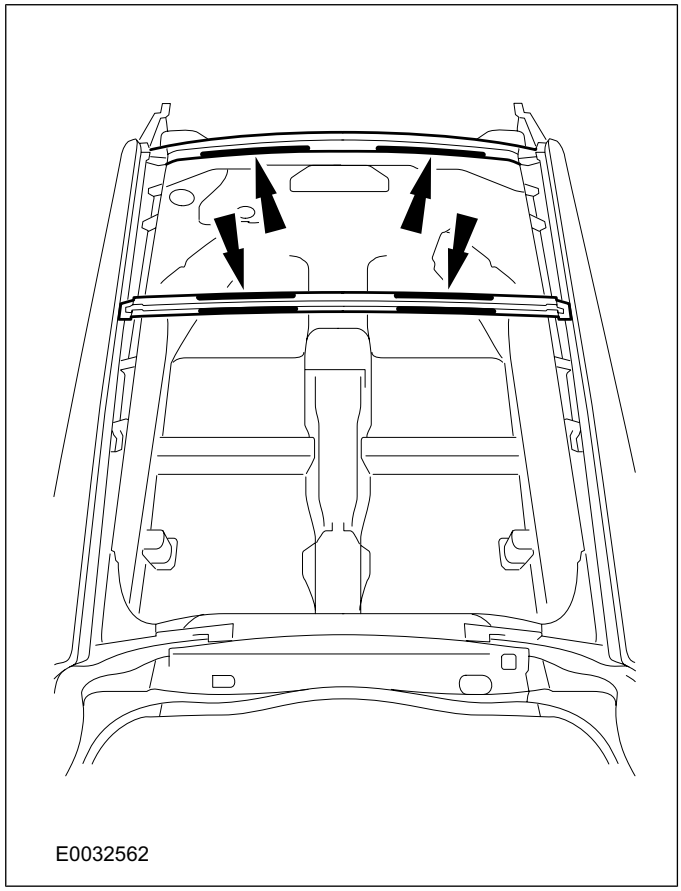


Installation

NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Roof

- Apply PU glass adhesive.

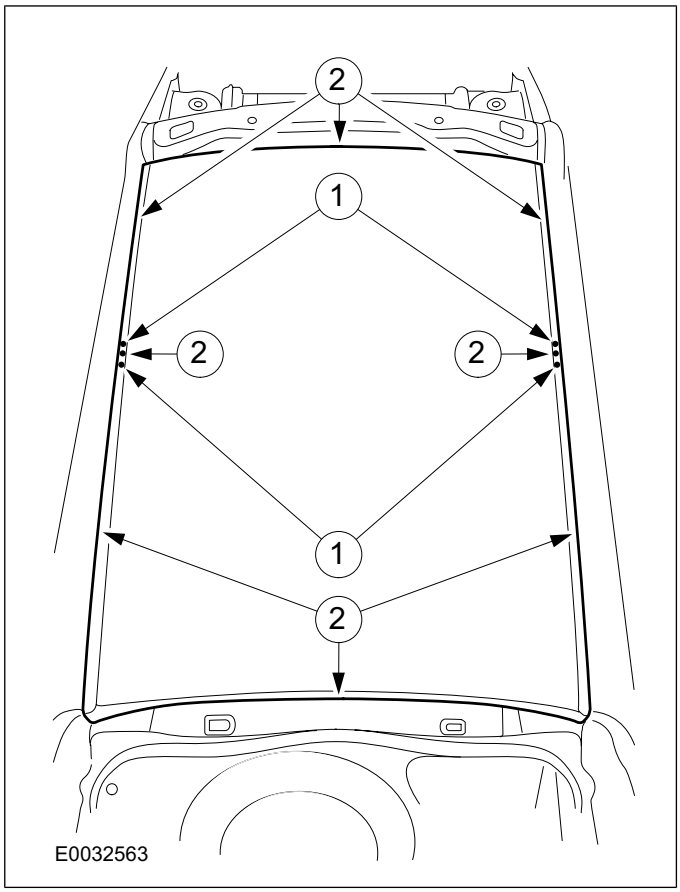


2. Roof

1. Offer up the roof and drill holes for puddle welding. Then puddle weld.

REMOVAL AND INSTALLATION

2. Resistance spot weld



SECTION 501-29 Side Panel Sheet Metal Repairs

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Lubricants, sealants and adhesives

	Part number	Specification
PU glass adhesive (150 ml)	1 102 109	WSK-M11 P57-A1
Metal adhesive kit, 2-component	1 203 241	WSK-M4 G200 A/B
Clinched flange sealant	1 136 479	WSK-M4 G245-B

REMOVAL AND INSTALLATION

A-Pillar Outer Panel Section and Reinforcement

General Equipment

Beam compasses

Materials	
Name	**Specification**
A-pillar outer panel	
A-pillar reinforcement	
A-pillar inner panel	
Bulkhead reinforcement	

Removal

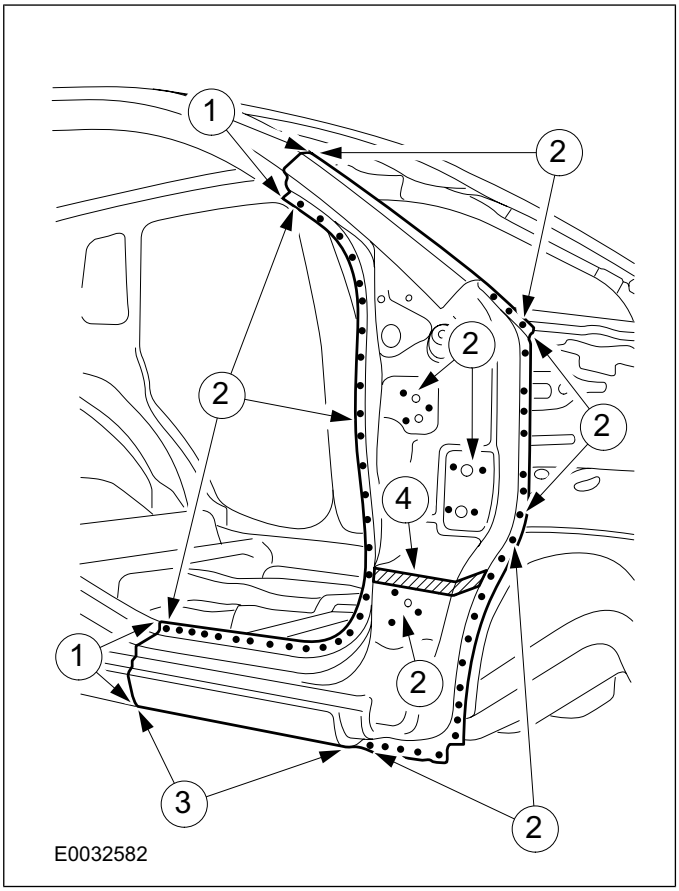
1. General Notes.

- The apron panel reinforcement and inner reinforcement of the A-pillar are already removed before the repair starts.
- Necessary removal work: door, hood, windshield, facia crash padding, A-pillar trim and rocker panel trim.

NOTE: If the inner and outer A-pillar reinforcements are being completely replaced, drill out the spot welds on the A-pillar outer panel by two panel thicknesses.

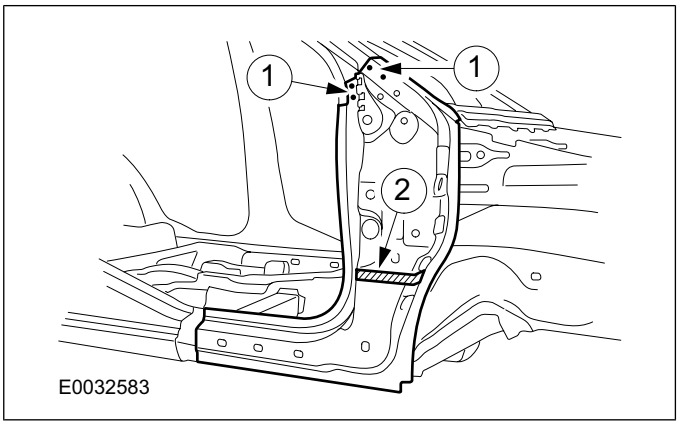
2. A-pillar outer panel

1. Separating cut.
2. Mill out the spot welds.
3. Grind out the spot welds.
4. Warm the area (about 170° C) and release the NVH elements.



3. A-pillar inner reinforcement

1. Mill out the spot welds.
2. Warm the area (about 170° C) and release the NVH elements.

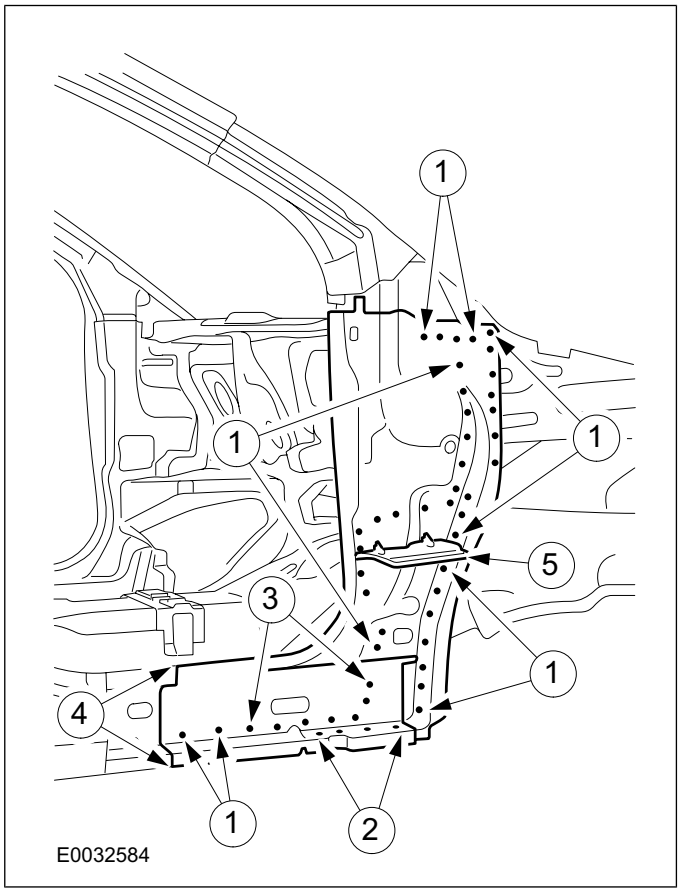


4. A-pillar inner reinforcement with rocker panel reinforcement

1. Mill out the spot welds.
2. Grind out the spot welds.

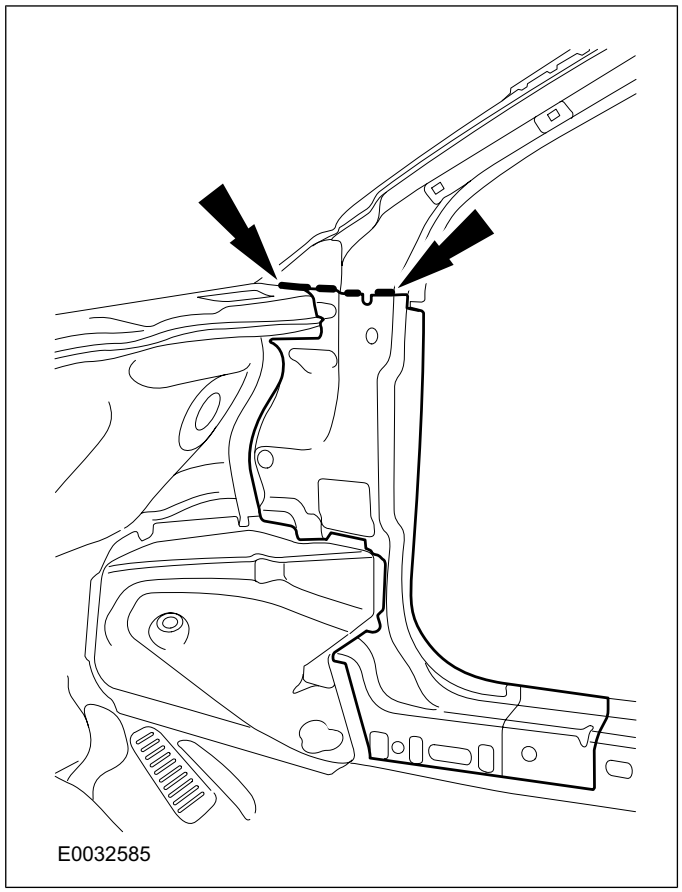
REMOVAL AND INSTALLATION

3. Mill out the spot welds (two panel thicknesses).
4. Separating cut.
5. Remove the NVH element.



5. A-pillar inner reinforcement with rocker panel reinforcement

- Grind out the weld seams.

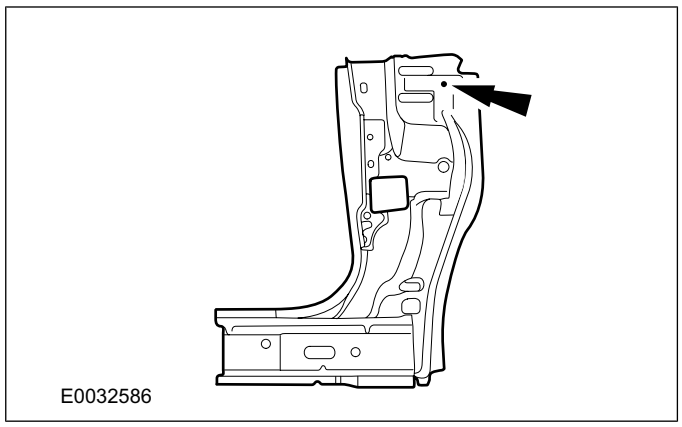


Installation

NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Inner A-pillar with rocker panel reinforcement

- Drill a hole for puddle welding (diameter: 10 mm).

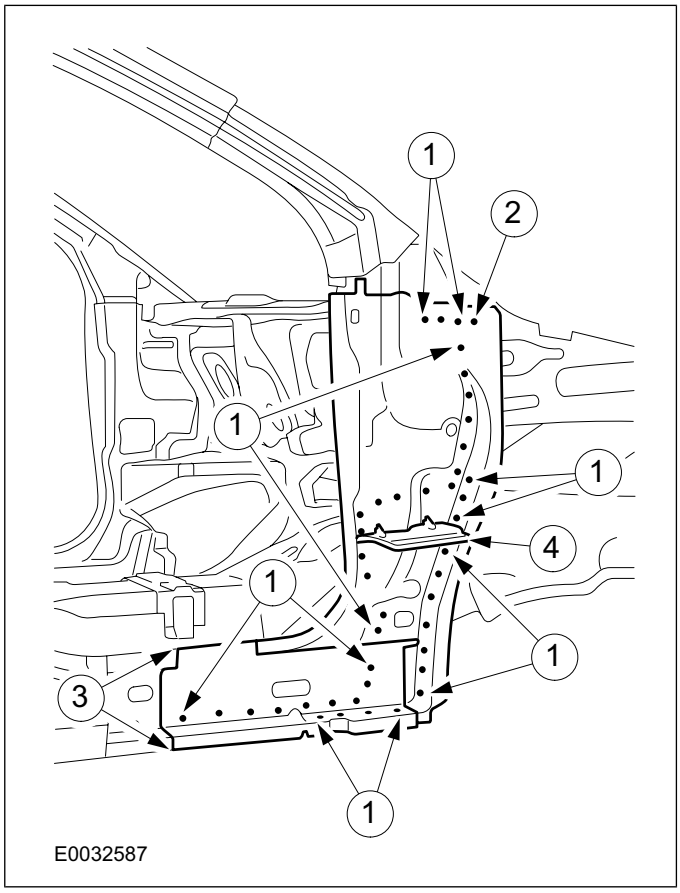


2. Inner A-pillar with rocker panel reinforcement

1. Resistance spot weld
2. Puddle welding

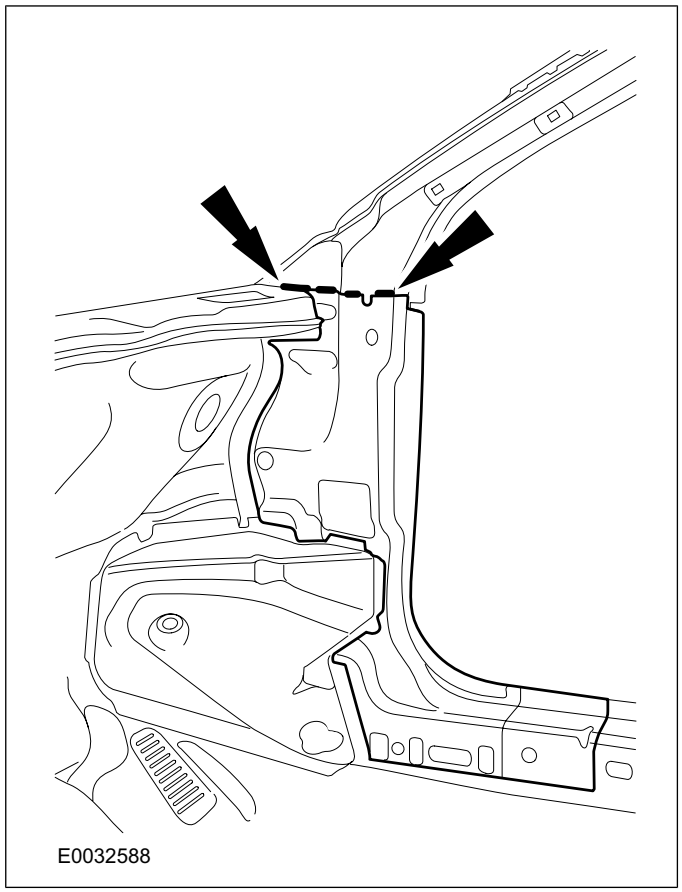
REMOVAL AND INSTALLATION

3. Continuous MIG weld seam.
4. Apply PU glass adhesive to the NVH element and install it.



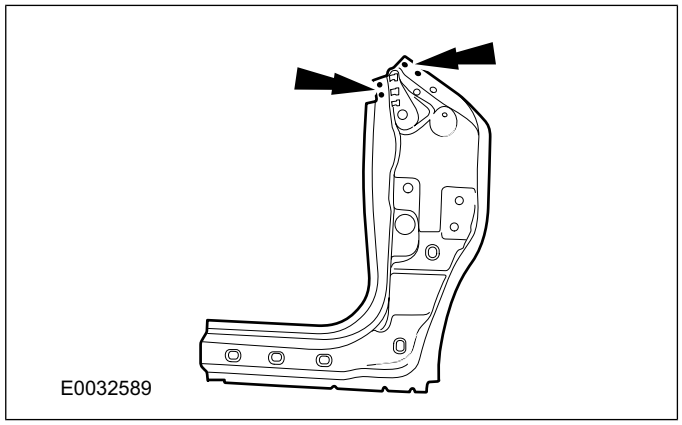
3. Inner A-pillar with rocker panel reinforcement

- Intermittent MIG weld seam.



4. A-pillar inner reinforcement

- Drill holes for puddle welding (diameter: 10 mm).

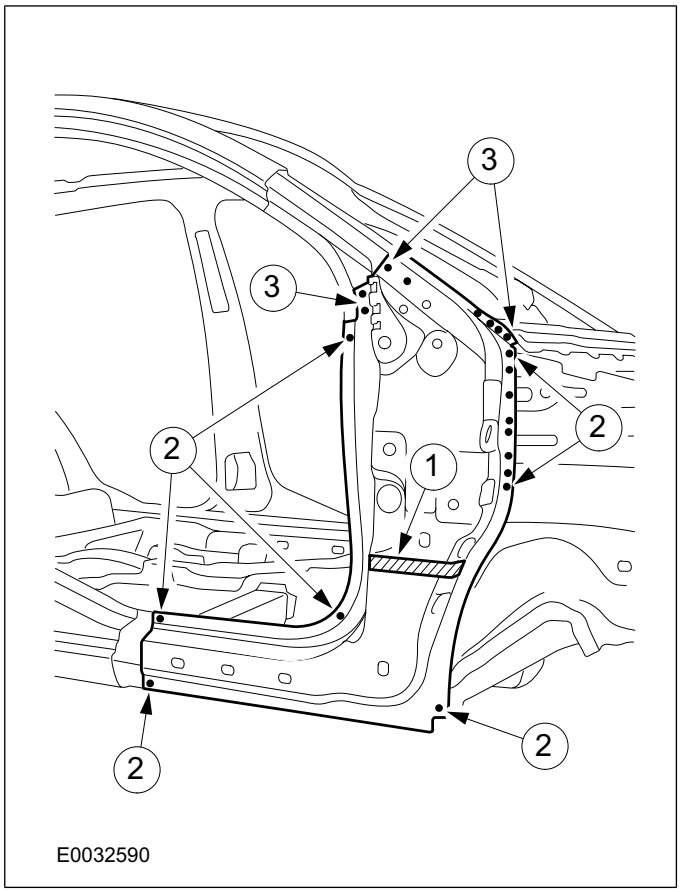


5. A-pillar inner reinforcement

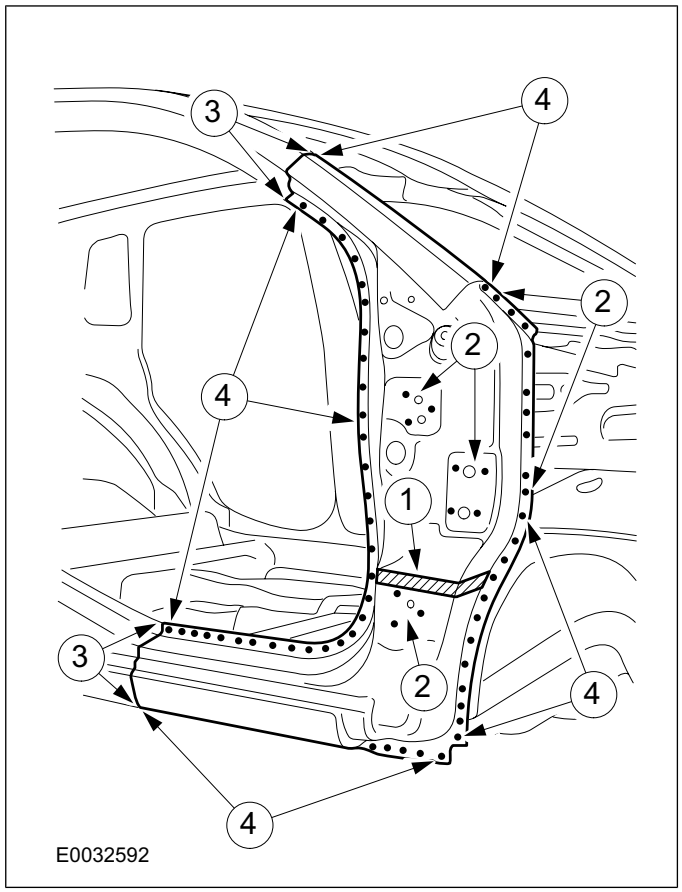
1. Apply PU glass adhesive to the NVH element.
2. Puddle welding

REMOVAL AND INSTALLATION

3. Resistance spot weld

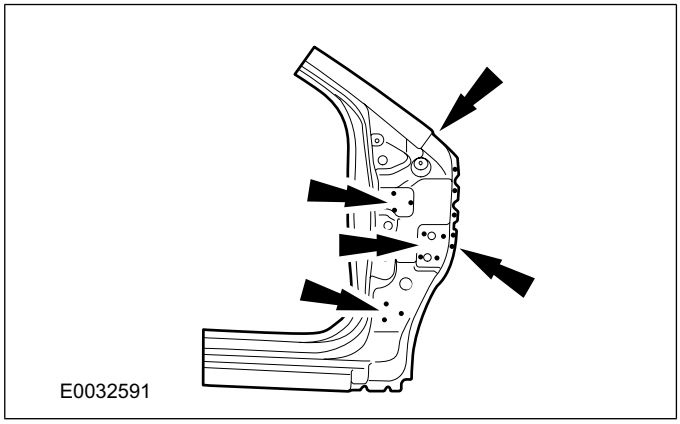


4. Continuous MIG weld seam.



6. A-pillar outer panel

1. Separating cut.
2. Drill holes for puddle welding (diameter: 10 mm).



7. A-pillar outer panel

1. Apply PU glass adhesive to the NVH element.
2. Resistance spot weld
3. Puddle welding

REMOVAL AND INSTALLATION

B-Pillar and Reinforcement — 5-Door

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
B-pillar outer panel	
B-Pillar reinforcement	
B-pillar inner panel	

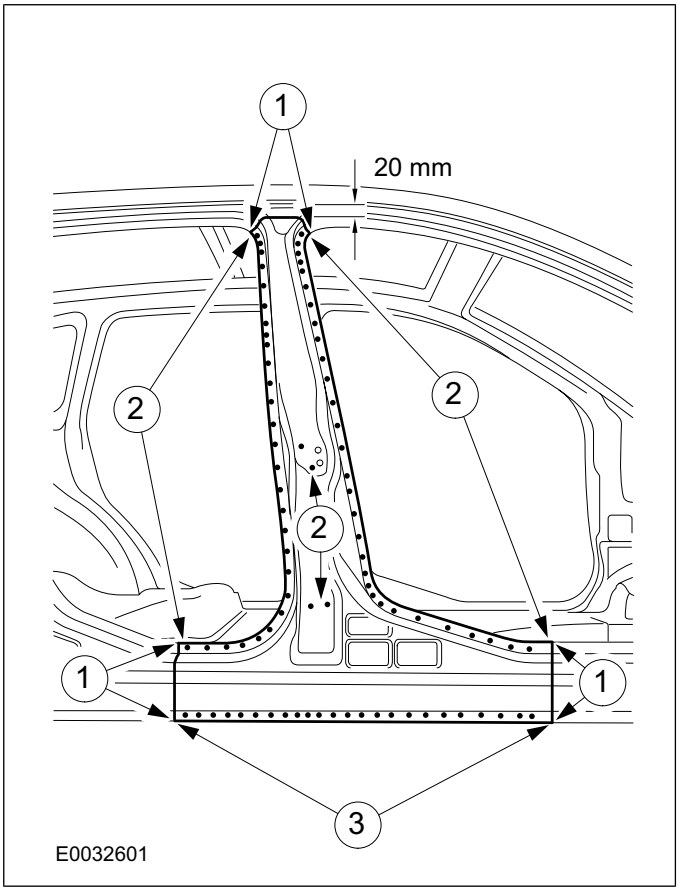
Removal

1. General Notes.

- The front door, rear door and rear door hinges are already removed before the repair starts.
- Necessary removal work: seat and rocker panel trim.
- Fold back the carpets and move the wiring harness back away from the working area.
- It is not possible to perform a partial replacement in the upper area of the B-pillar reinforcement because of the reinforcements which are inside.
- When the outer and inner reinforcements are being completely replaced, the spot welds in the region of the door seal must be drilled out as far as the inner panel.
- Make the front cut line on the rocker panel far enough forward to allow access to the B-pillar inner panel (see weld flange).

2. B-pillar outer panel

1. Separating cut.
2. Mill out the spot welds.
3. Grind out the spot welds.

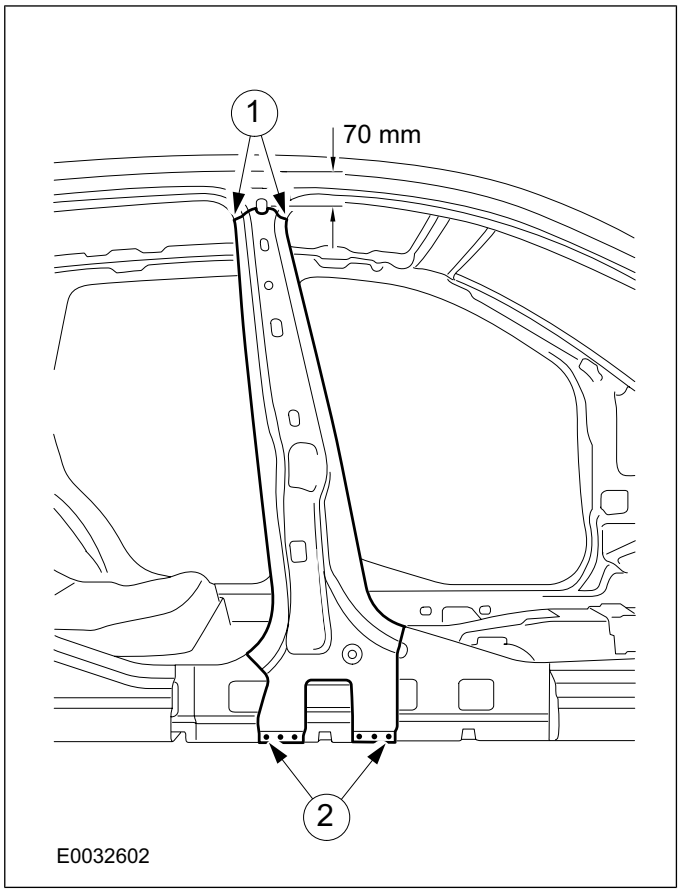


3. B-Pillar reinforcement

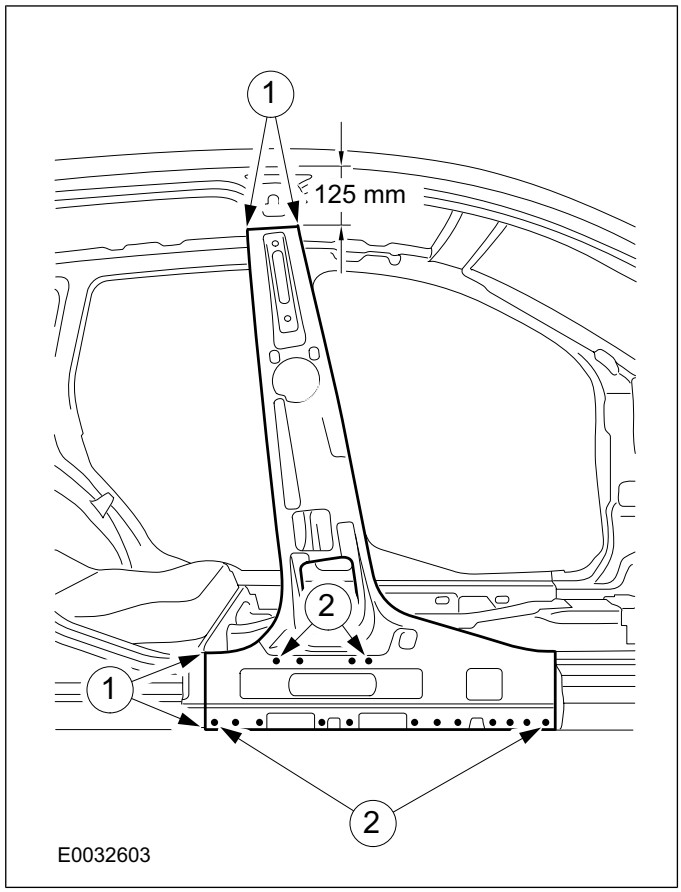
1. Separating cut.

REMOVAL AND INSTALLATION

2. Mill out the spot welds.



2. Mill out the spot welds.



4. B-pillar inner panel

1. Separating cut.

Installation

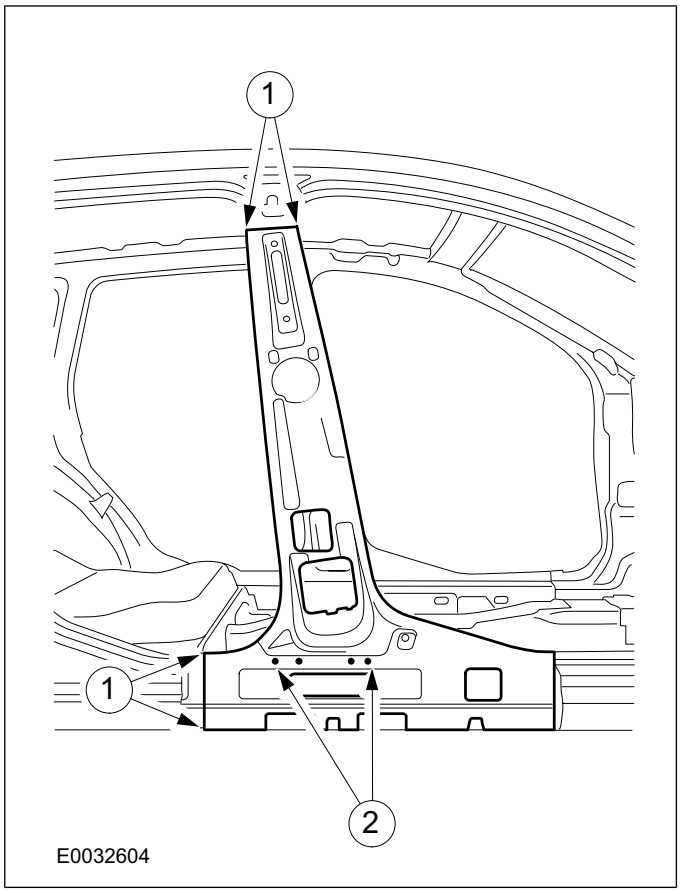
NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. B-pillar inner panel

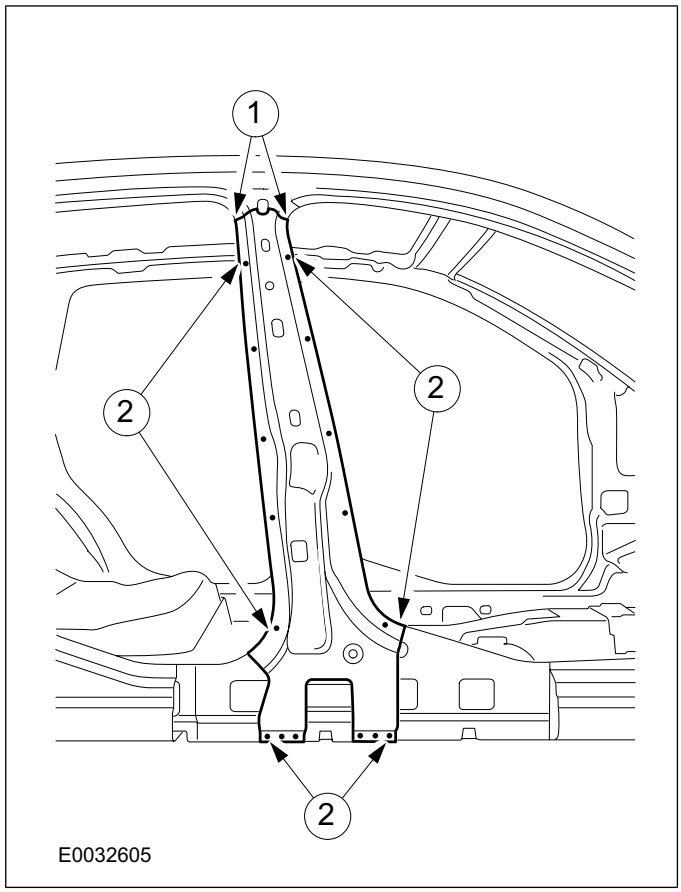
1. Continuous MIG weld seam.

REMOVAL AND INSTALLATION

2. Resistance spot weld



2. Resistance spot weld



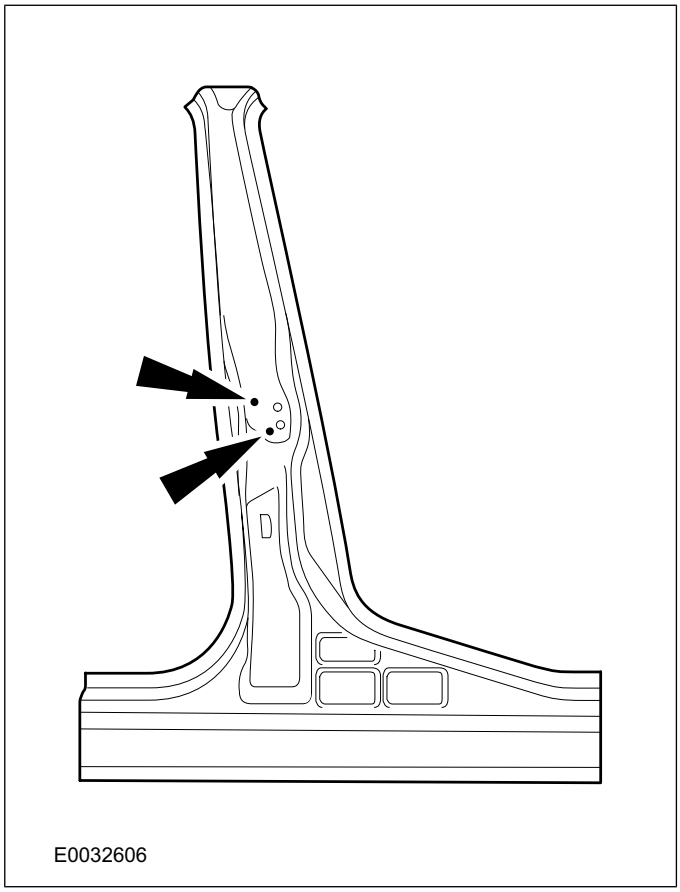
2. B-Pillar reinforcement

1. Continuous MIG weld seam.

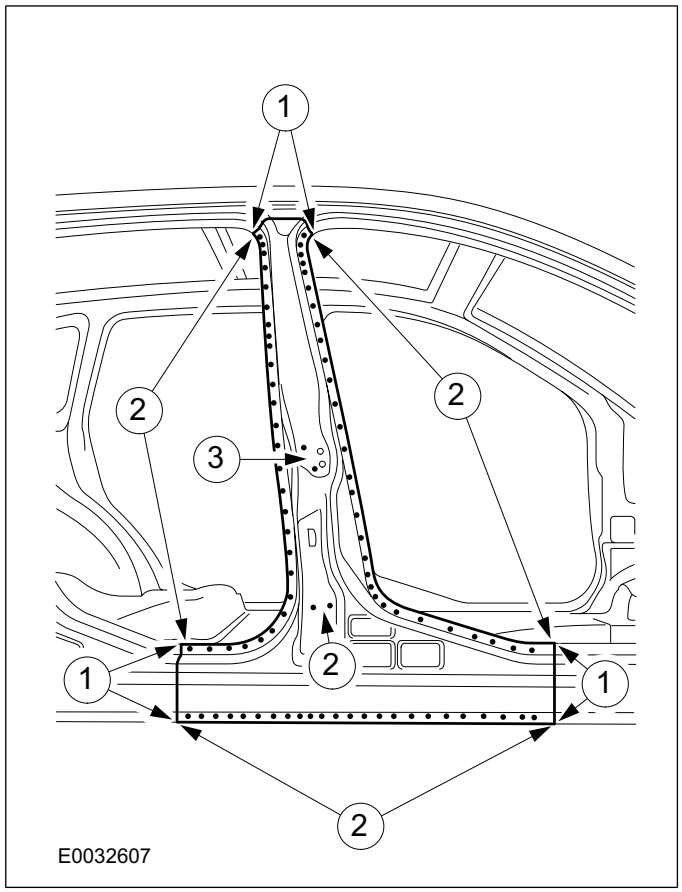
3. B-pillar outer panel

REMOVAL AND INSTALLATION

- Drill holes for puddle welding (8 mm diameter).



3. Puddle welding



4. B-pillar outer panel

1. Continuous MIG weld seam.
2. Resistance spot weld

REMOVAL AND INSTALLATION

Rocker Panel

General Equipment

Measuring stick

Materials	
Name	**Specification**
Rocker panel	

Removal

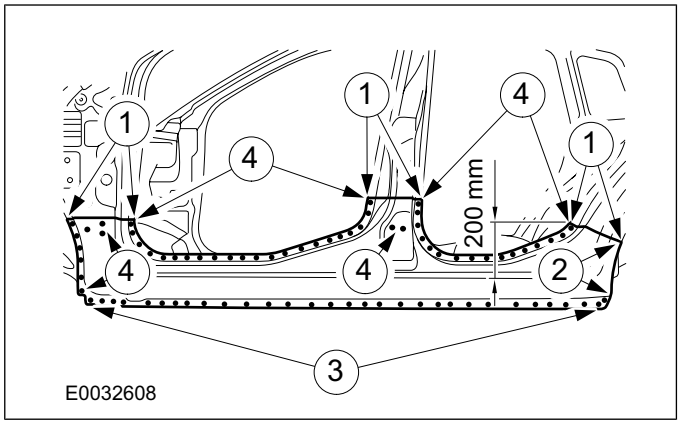
1. General Notes

- The fenders, doors and door hinges are already removed before repair work starts.
- Required disassembly operations: Rocker panel trim, front and rear seats.
- Fold back the carpets and move the wiring harness out of the working area.

2. NOTE: Make the cut location on the C-pillar a maximum of 200 mm above the edge of the rocker panel, to prevent damage to the underlying NVH element.

Rocker panel

1. Cut points.
2. Grind out the wheel arch joint.
3. Grind out the spot welds.
4. Mill out the spot welds.



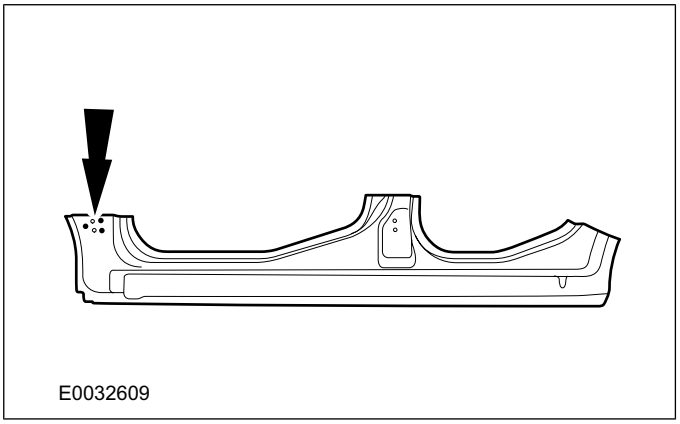
E0032608

Installation

NOTE: Before resistance spot welding of body panels with a total panel thickness of 3 mm and greater, the welding equipment instructions contained in chapter 501-25A must be followed.

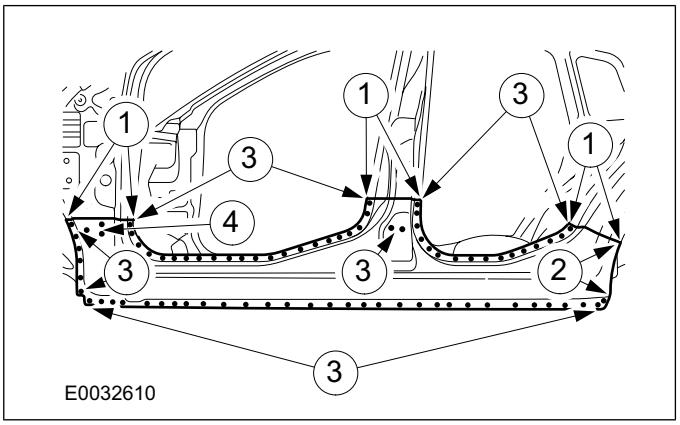
1. Rocker panel

- Drill holes for puddle welding.


E0032609

2. Rocker panel

1. Continuous MIG weld seam.
2. Apply 2-component metal adhesive just before installing the new part and then clinch the wheel arch flange.
3. Resistance spot weld.
4. Puddle welding.



E0032610

REMOVAL AND INSTALLATION

Rocker Panel Inner Reinforcement

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Rocker panel inner reinforcement	

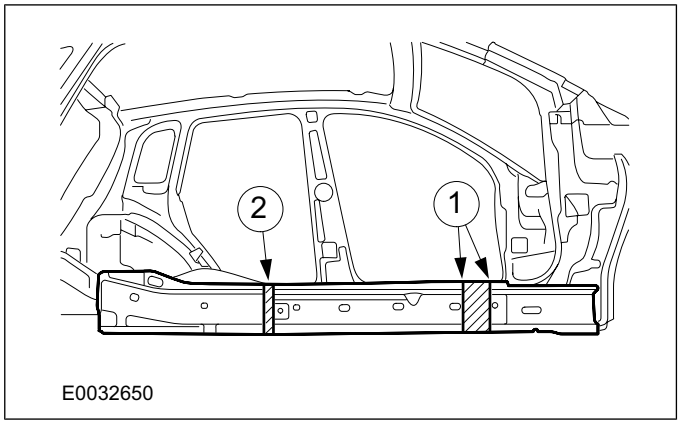
Removal

1. General Instructions

- The A-pillar outer panel, A-pillar reinforcement, B-pillar with reinforcement, side panel, wheel house with reinforcement and inner side panel are already removed before the repair starts.
- Sectional replacement is possible, depending on the damage.

2. Rocker panel inner reinforcement

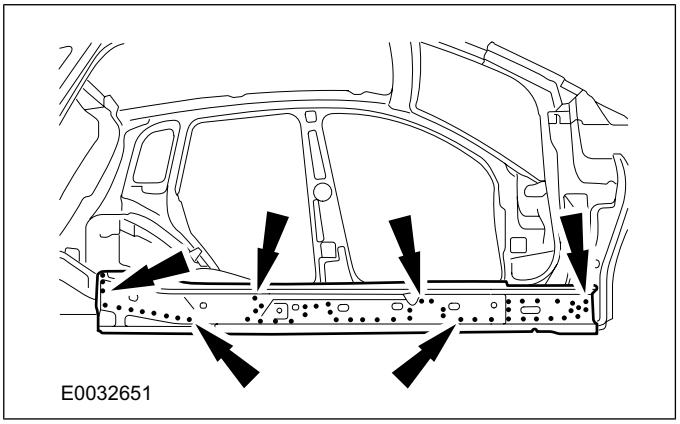
1. Front separation area (only for sectional replacement).
2. Rear separation area (only for sectional replacement).



E0032650

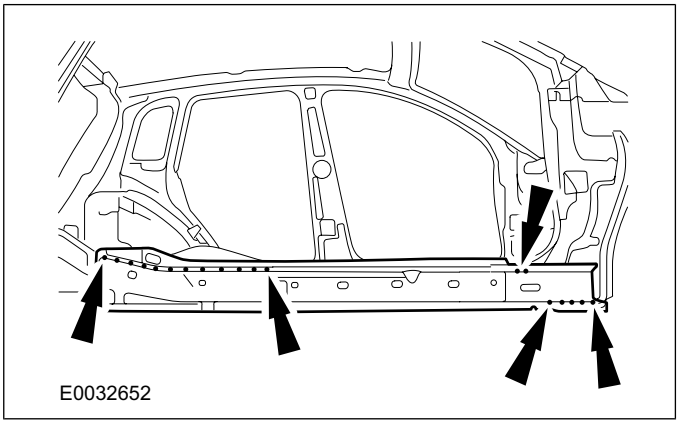
3. Rocker panel inner reinforcement

- Mill out the spot welds.


E0032651

4. Rocker panel inner reinforcement

- Grind out the spot welds.

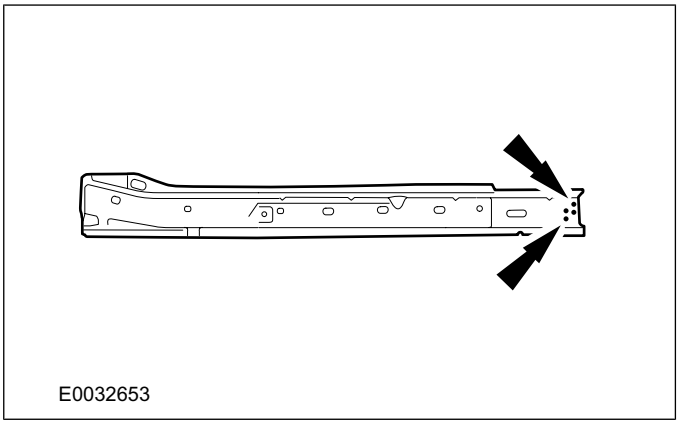

E0032652

Installation

NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Rocker panel inner reinforcement

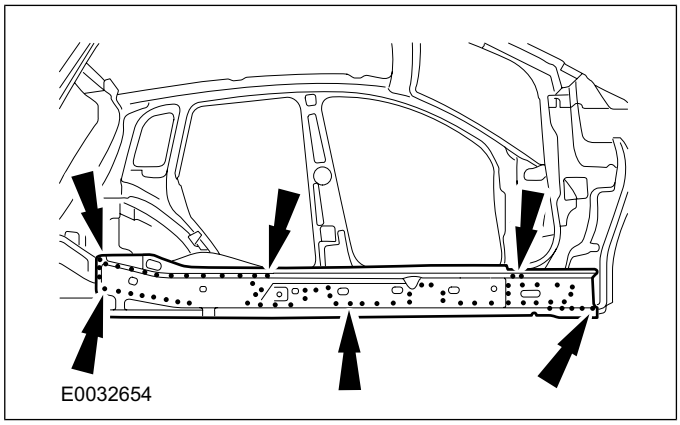
- Drill holes for puddle welding.


E0032653

REMOVAL AND INSTALLATION

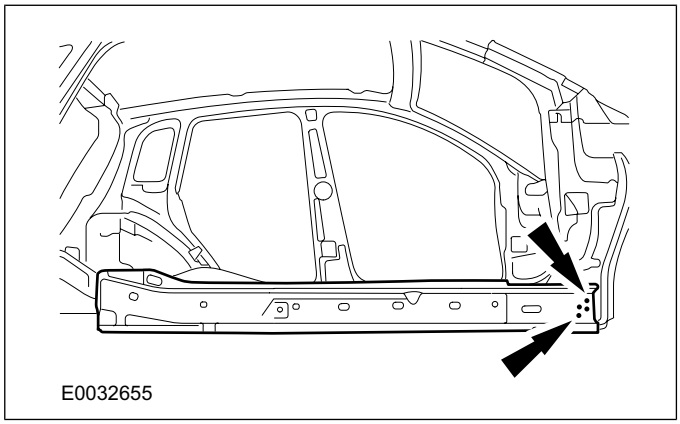
2. Rocker panel inner reinforcement

- Resistance spot welding.



3. Rocker panel inner reinforcement

- Puddle weld.



REMOVAL AND INSTALLATION

Front Door Skin Panel

Removal

1. Replacement parts.

- Door skin panel.

2. General Notes.

1. Items to be removed before repair:
   - Door.
   - Front door trim panel,

     For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
   - Exterior mirror,

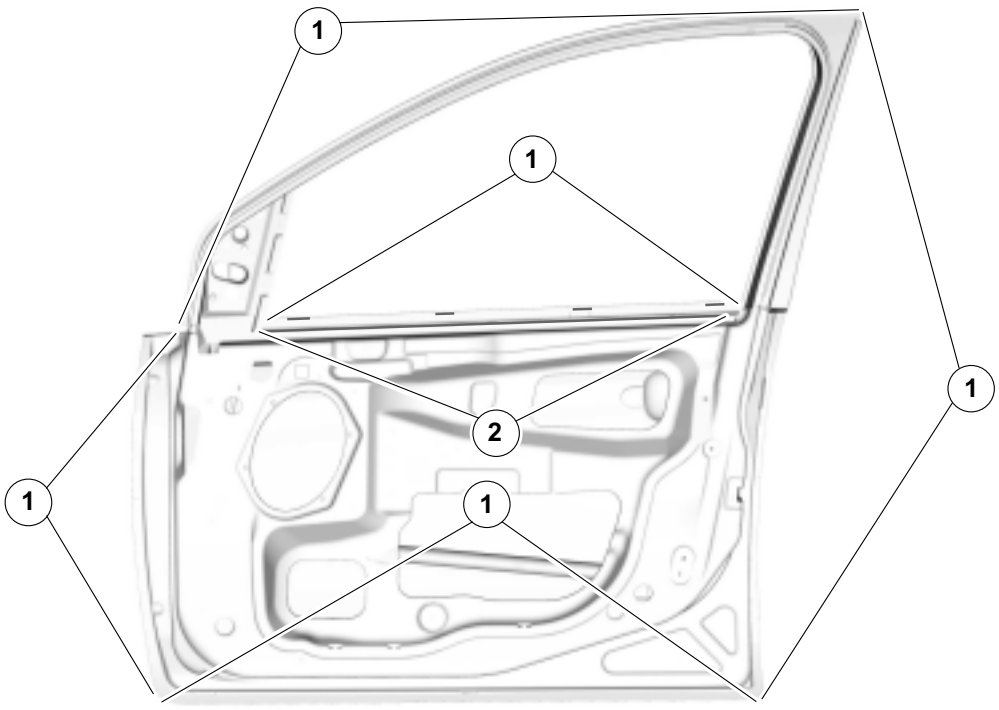
     For additional information, refer to: Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation).
   - Front door window glass,

     For additional information, refer to: Front Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).
   - Front door latch.

3. NOTE: Before opening the door skin panel flange, remove the clinched flange protection using a plaited wire brush.

Door skin panel.

1. Open the clinched flange's.
2. Detach the adhesive bond.



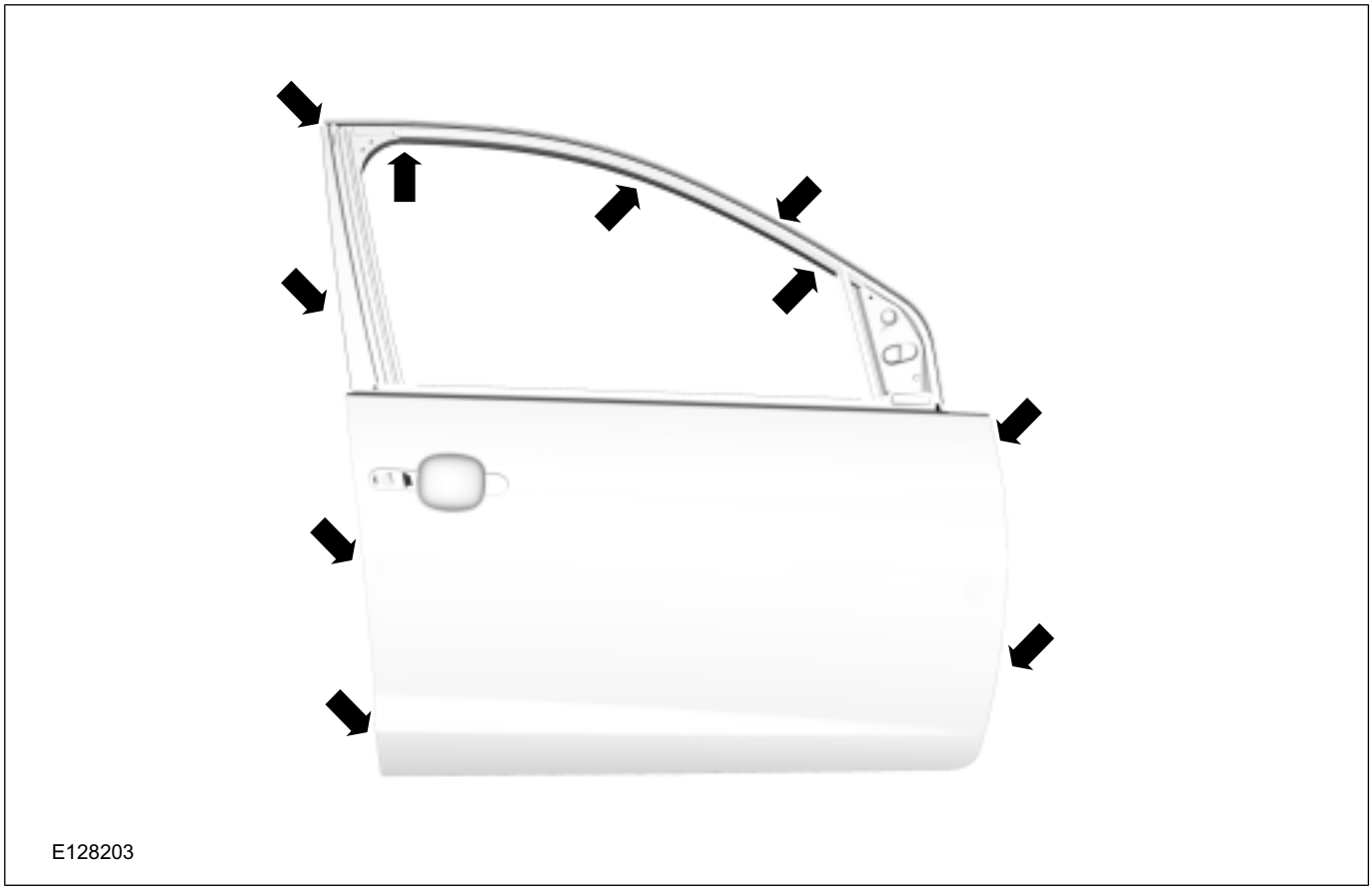
E128202

Installation

1. Door skin panel preparation.

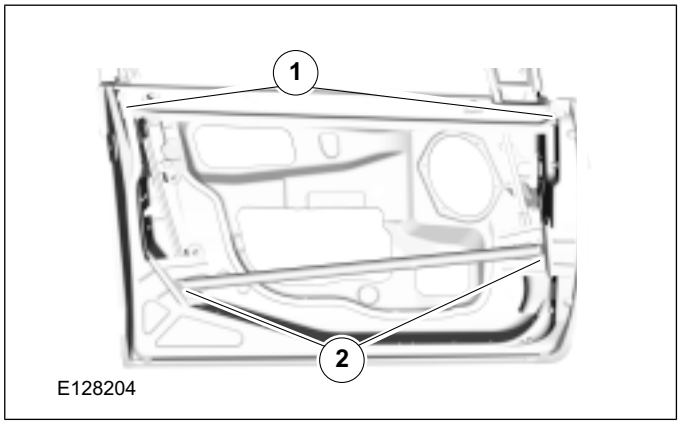
- Apply two-component metal adhesive in the clinch flange areas.

REMOVAL AND INSTALLATION



2. Door frame panel preparation.

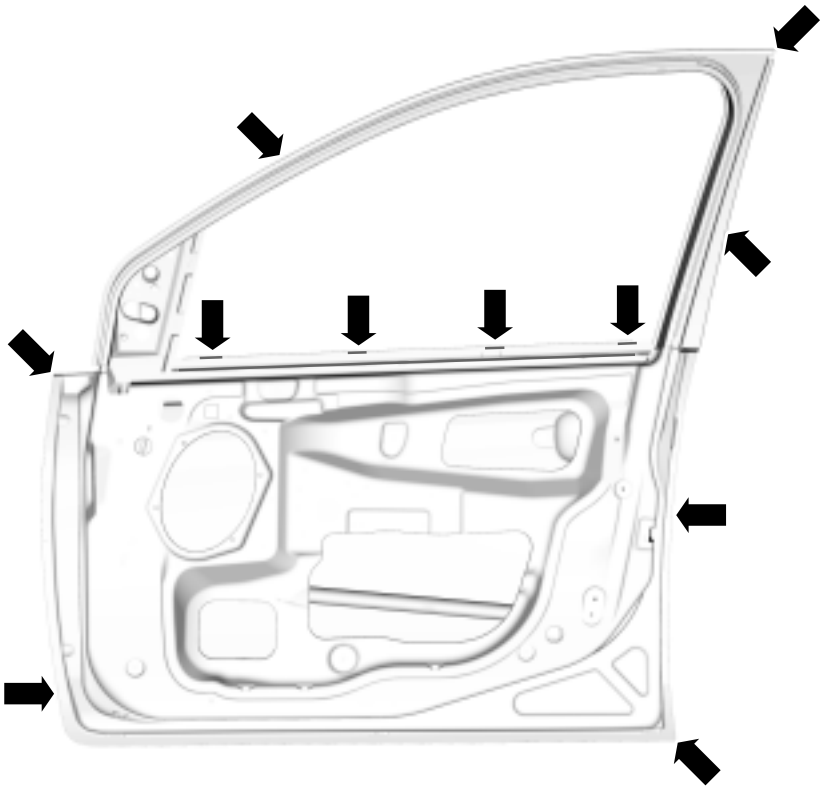
1. Apply two-component metal adhesive.
2. Apply anti-flutter material.



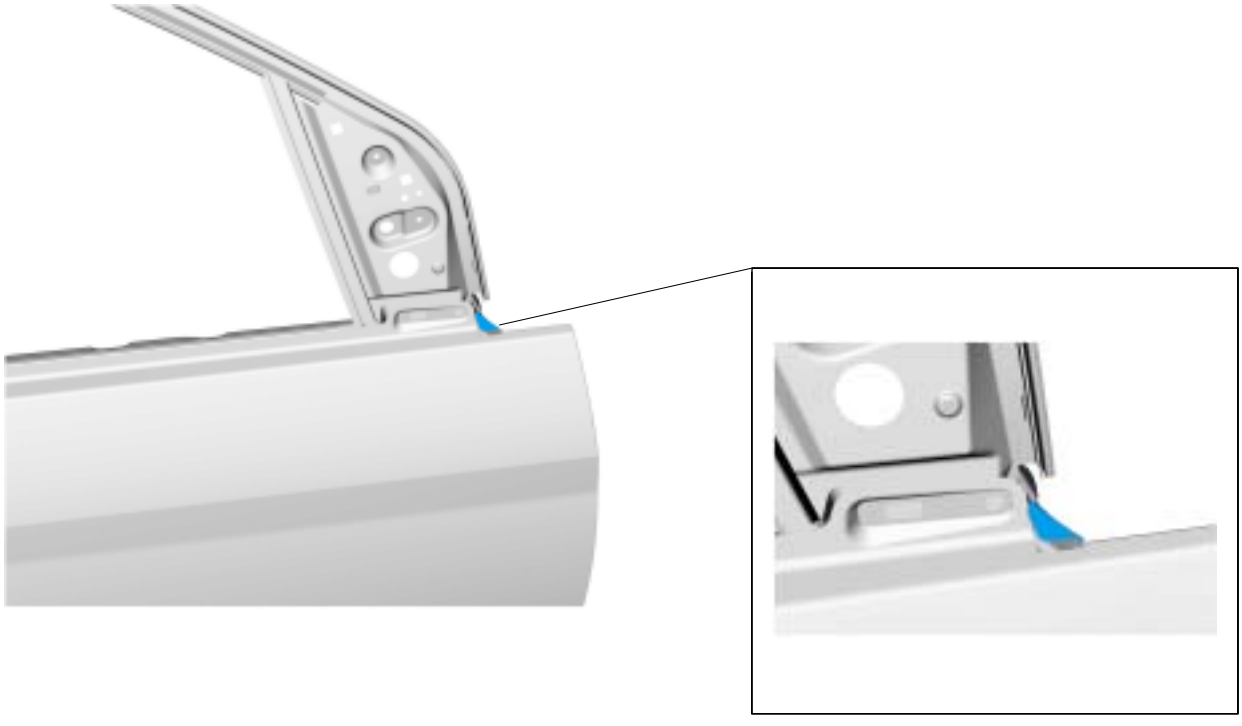
3. Door skin panel.

- Clinch the flange's and apply clinched flange protection.

REMOVAL AND INSTALLATION



E128201



E128205

NOTE: Fix tape to avoid rust and corrosion.

SECTION 501-30 Rear End Sheet Metal Repairs

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

Lubricants, sealants and adhesives

	Part number	Specification
PU glass adhesive (150 ml)	1 102 109	WSK-M11 P57-A1
Metal adhesive kit, 2-component	1 203 241	WSK-M4 G200 A/B

REMOVAL AND INSTALLATION

Quarter Panel RH

Materials	
Name	**Specification**
Quarter panel	

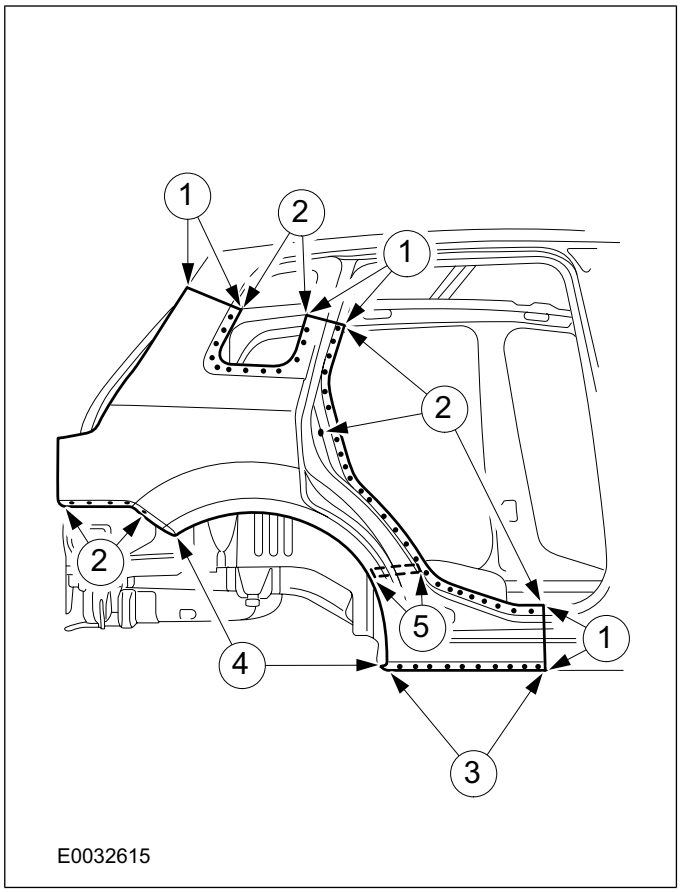
Removal

1. General Notes

- The door and tailgate are already removed before repair work starts.
- Required disassembly operations: Bumper, rear lamp, weatherstrip, inner trims and side window.
- Depending on the extent of the damage, the forced air extraction gusset should also be replaced.

2. Quarter panel

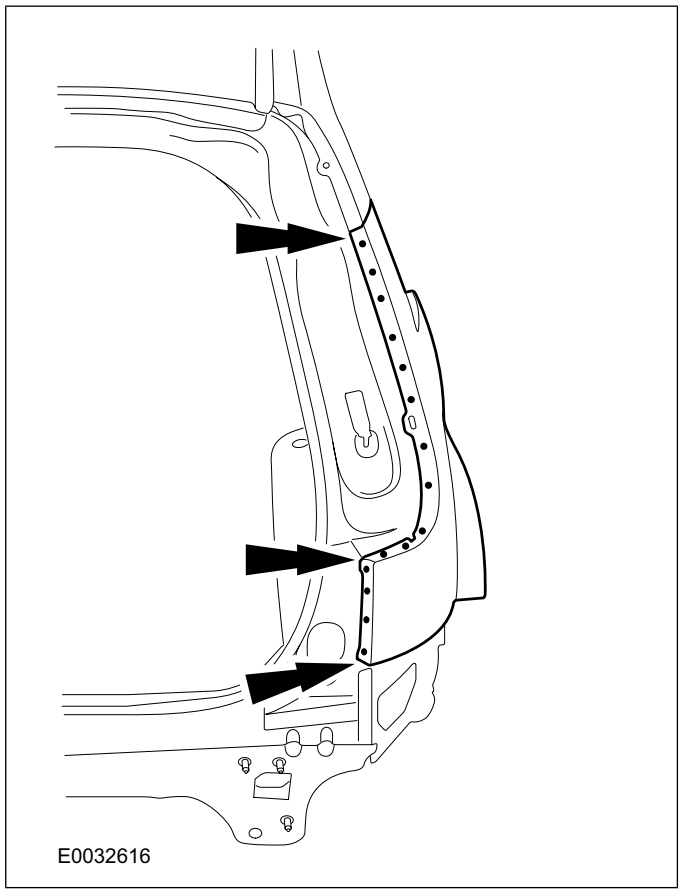
1. Cut points.
2. Mill out the spot welds.
3. Grind out the spot welds.
4. Grind down one panel thickness at the wheel arch edge.
5. Heat the area (approx. 170° C) and release the NVH elements.



E0032615

3. Quarter panel

- Mill out the spot welds.

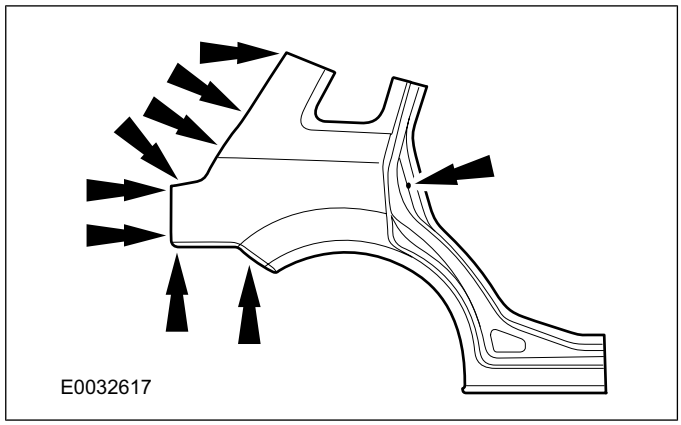

E0032616

Installation

NOTE: Before resistance spot welding of body panels with a total panel thickness of 3 mm and greater, the welding equipment instructions contained in chapter 501-25A must be followed.

1. Quarter panel

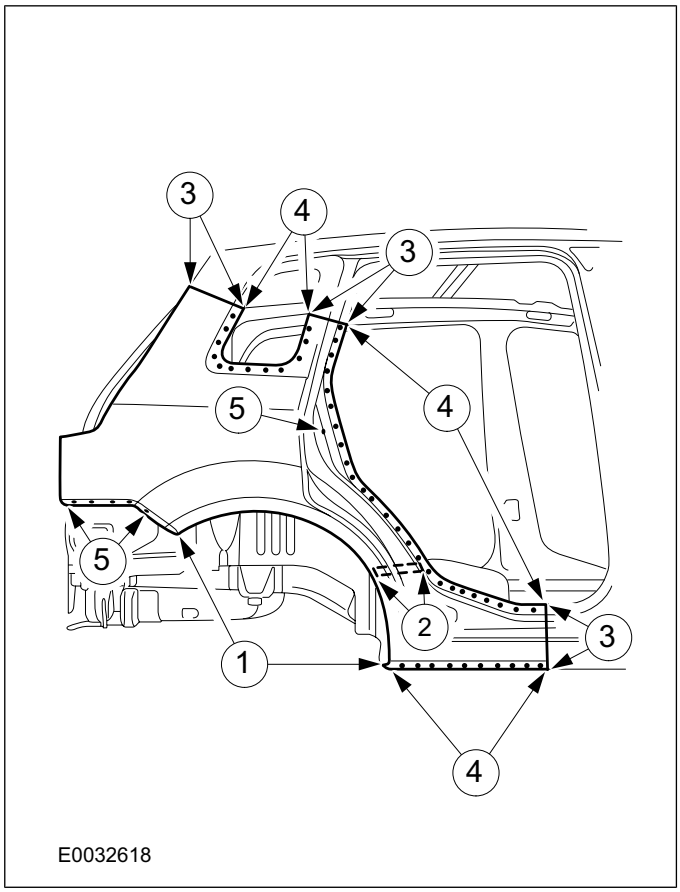
- Drill holes for puddle welding.


E0032617

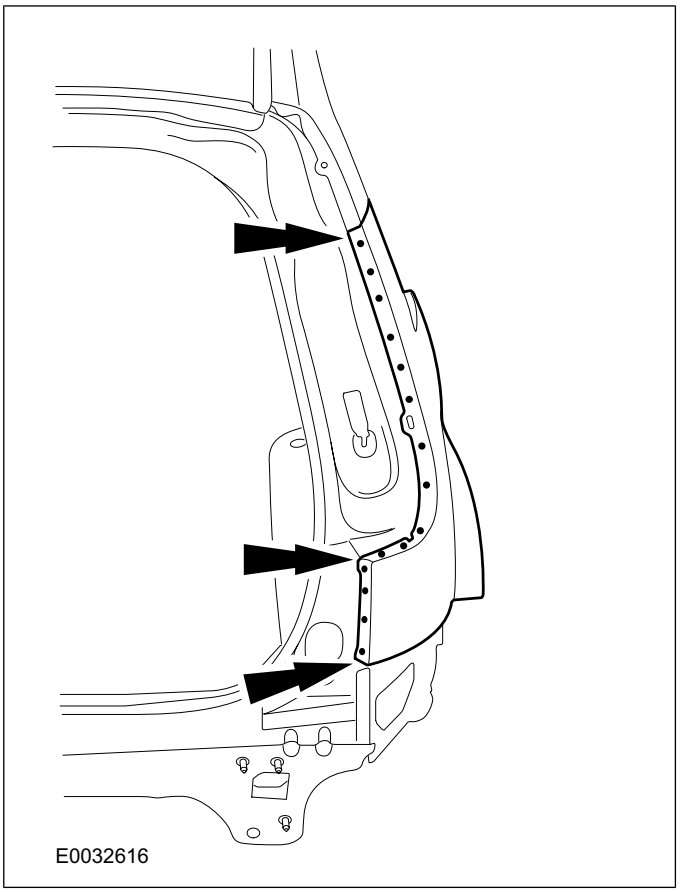
REMOVAL AND INSTALLATION

2. Quarter panel

1. Apply 2-component metal adhesive to the clinched flange and clinch the wheel arch flange.
2. Apply PU glass adhesive to the NVH element.
3. Continuous MIG weld seam.
4. Resistance spot weld.
5. Puddle welding.



- Puddle welding.



3. Quarter panel

REMOVAL AND INSTALLATION

Inner Quarter Panel and Wheelhouse

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Inner quarter panel with wheelhouse	
Wheelhouse reinforcement	
NVH element	

Removal

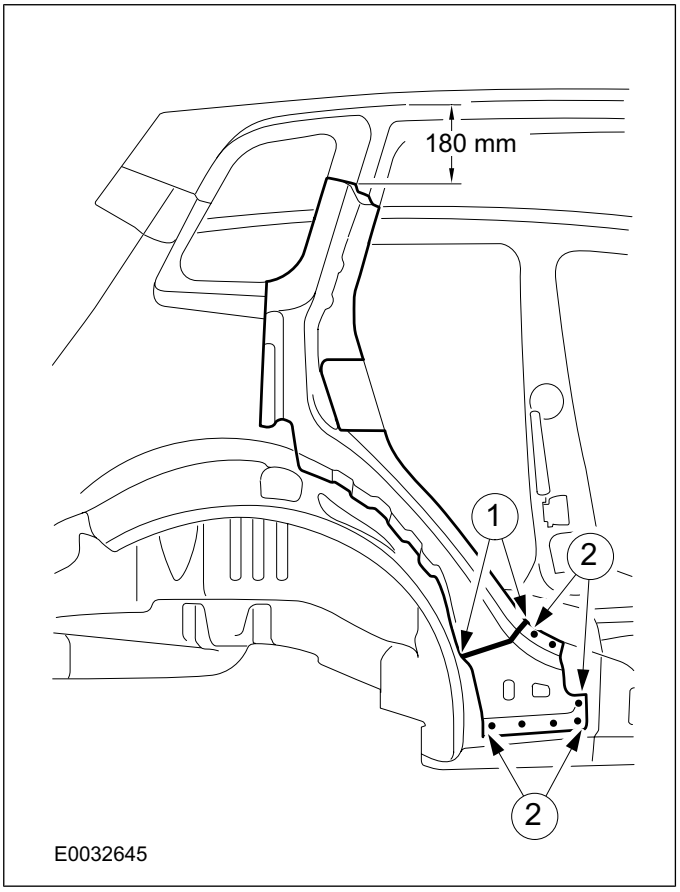
1. General notes

- Quarter panel, back panel, lamp mounting panel and water drain panel are already removed before the start of repairs.
- Necessary removal work: side panel trim.
- Reposition the carpeting and the wiring away from the working area.

NOTE: When separating the side panel, do not exceed the maximum displacement of the cut line in relation to the roof edge.

2. Inner quarter panel reinforcement

1. Separating cut.
2. Mill out the spot welds.

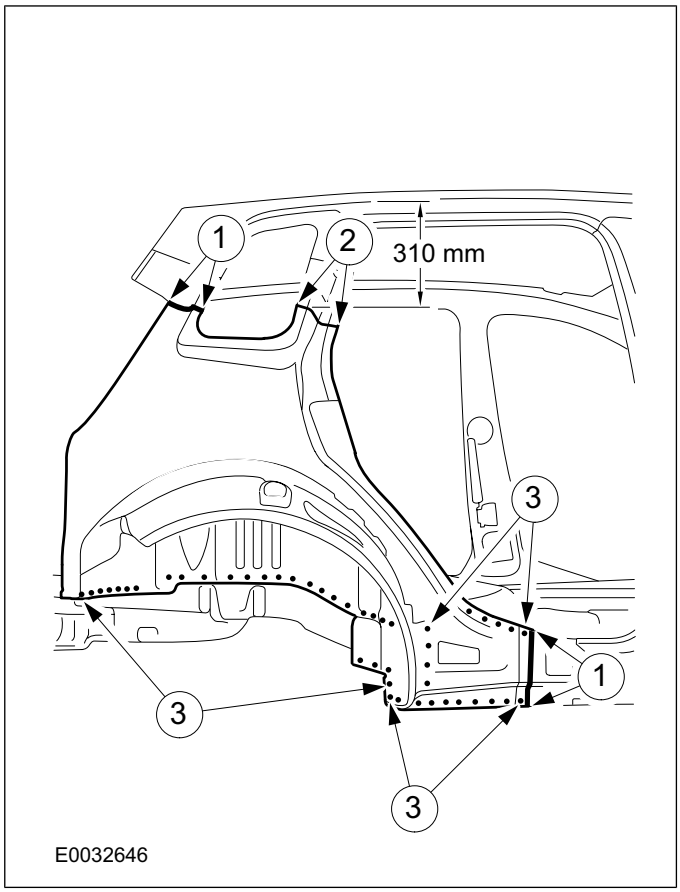


3. Inner side panel with reinforcement

1. Separating cut.
2. Cut location (two panel thicknesses).

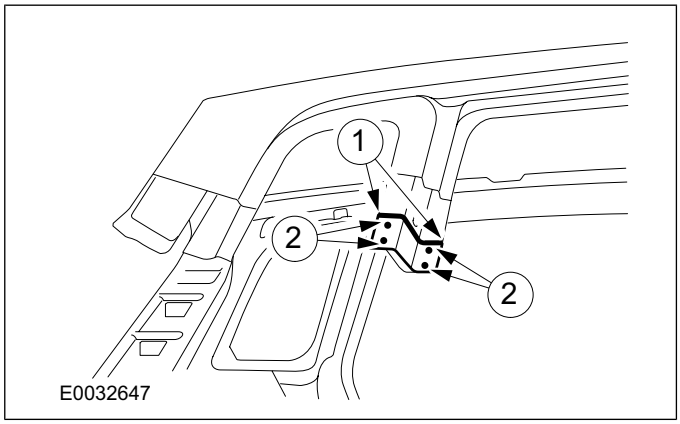
REMOVAL AND INSTALLATION

3. Mill out the spot welds.



4. Inner quarter panel reinforcement

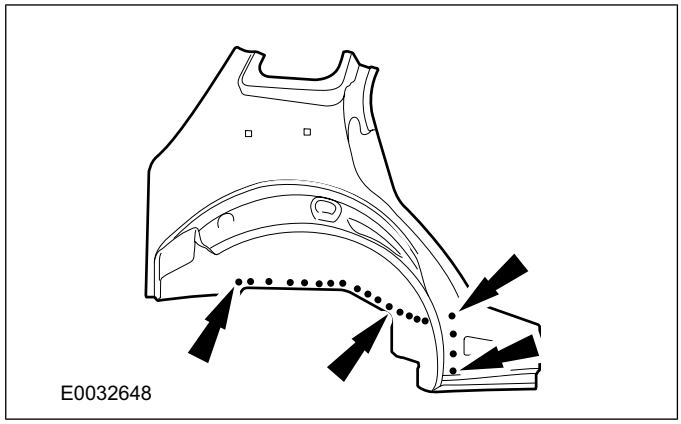
1. Separating cut.
2. Mill out the spot welds.



Installation

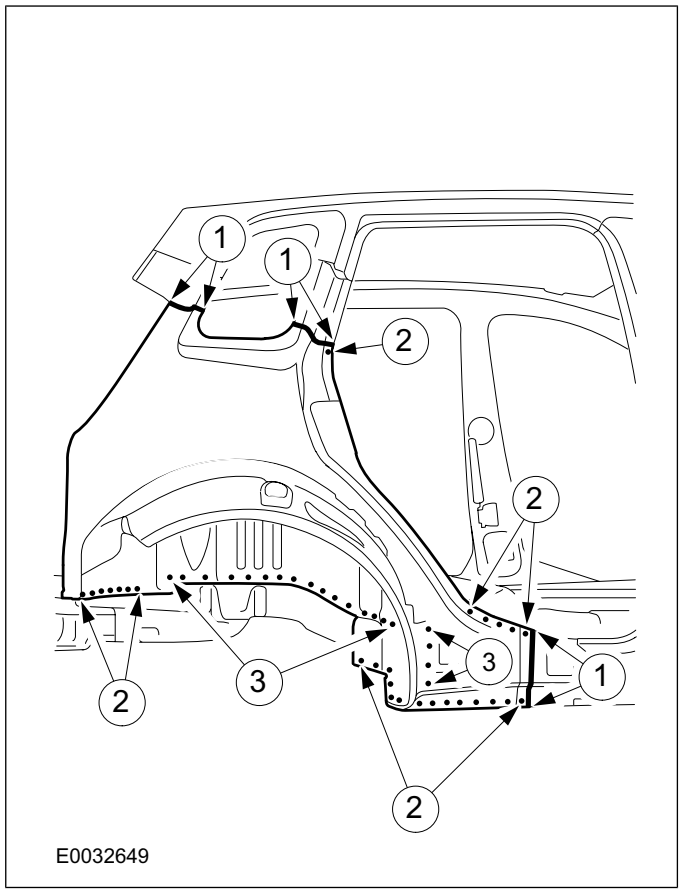
1. Inner quarter panel

1. Drill holes for puddle welding.



2. Inner quarter panel

1. Continuous MIG weld seam.
2. Resistance spot welding.
3. Puddle weld.

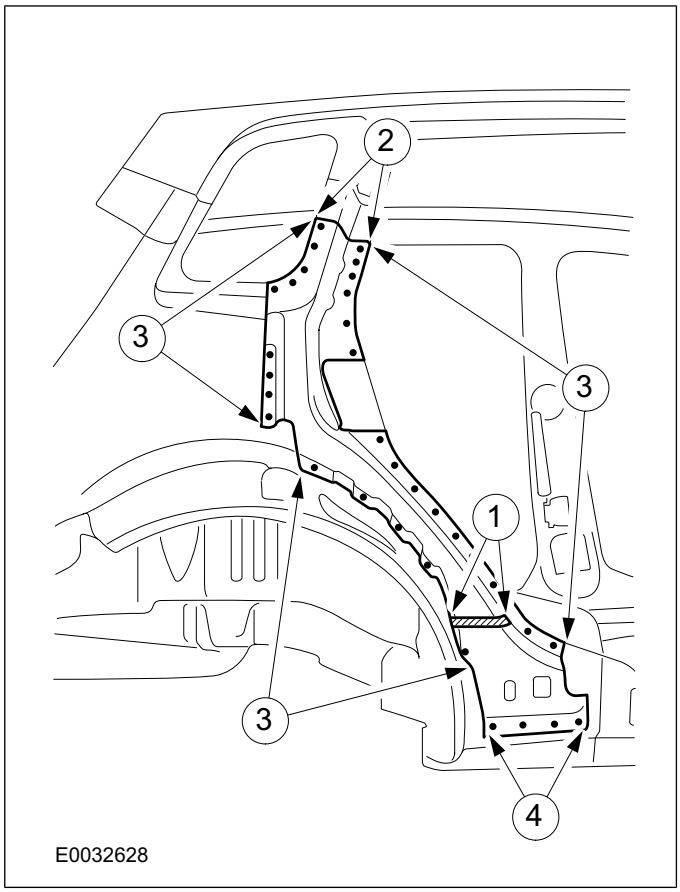


3. Inner quarter panel reinforcement

1. Apply PU glass adhesive to the NVH element.
2. Continuous MIG weld seam.
3. Resistance spot welding.

REMOVAL AND INSTALLATION

4. Puddle weld.



REMOVAL AND INSTALLATION

Water Drain Panel Reinforcement

Materials	
Name	**Specification**
Water drain panel reinforcement	

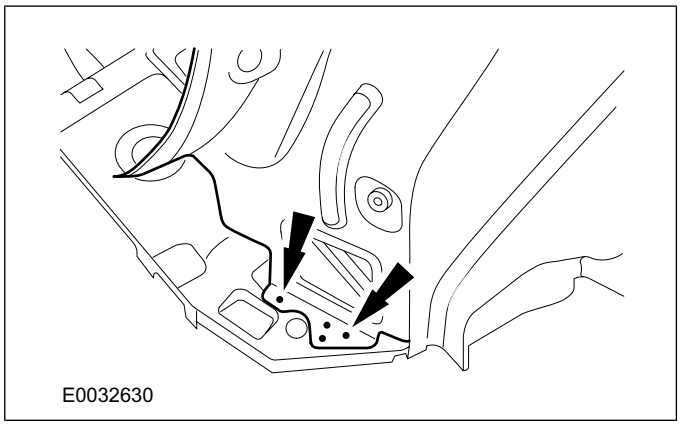
Removal

1. General Notes.

- Side panel and lamp mounting panel and back panel with reinforcement are already removed before the start of repairs.
- The cut may vary depending on damage.

2. Water drain panel reinforcement

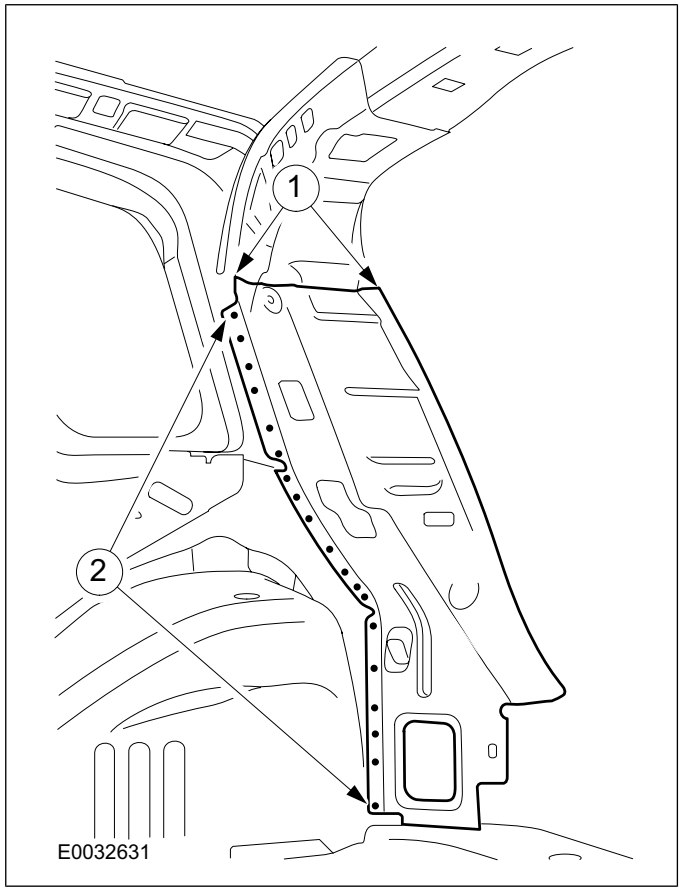
- Mill out the spot welds.



3. Water drain panel reinforcement

1. Separating cut.

2. Mill out the spot welds.



Installation

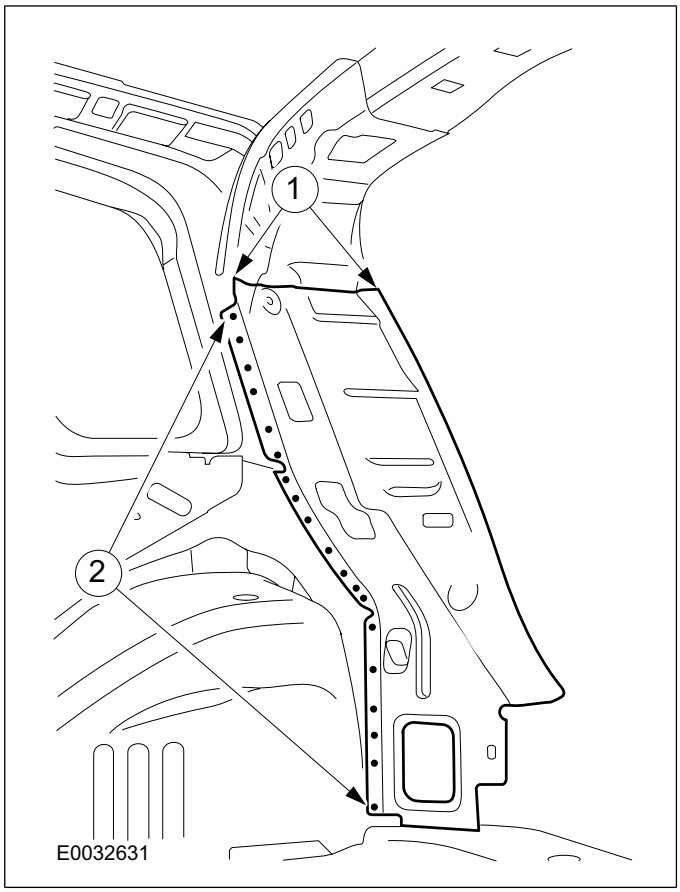
NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Water drain panel reinforcement

1. Continuous MIG weld seam.

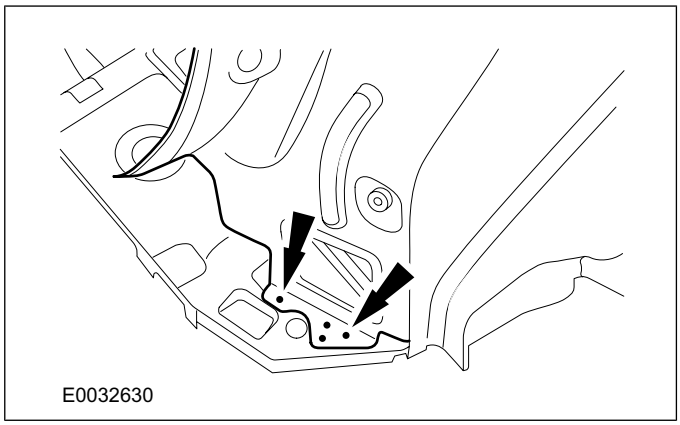
REMOVAL AND INSTALLATION

2. Resistance spot weld



2. Water drain panel reinforcement

- Resistance spot weld



REMOVAL AND INSTALLATION

Back Panel

Materials	
Name	**Specification**
Back panel	

Removal

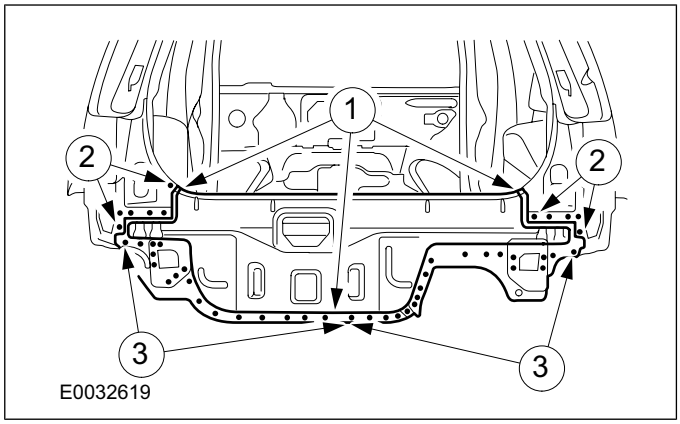
1. General Instructions

- Necessary removal work: rear panel trim.

2. NOTE: Do not damage the weld flanges remaining on the bodywork.

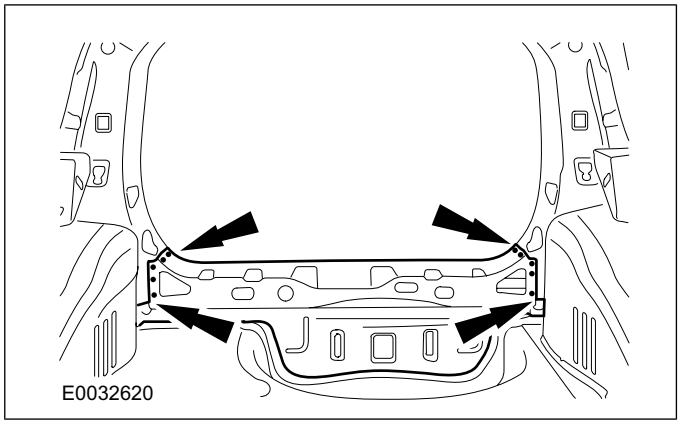
Back panel

1. Preliminary separating cut.
2. Grind out the spot welds.
3. Mill out the spot welds.

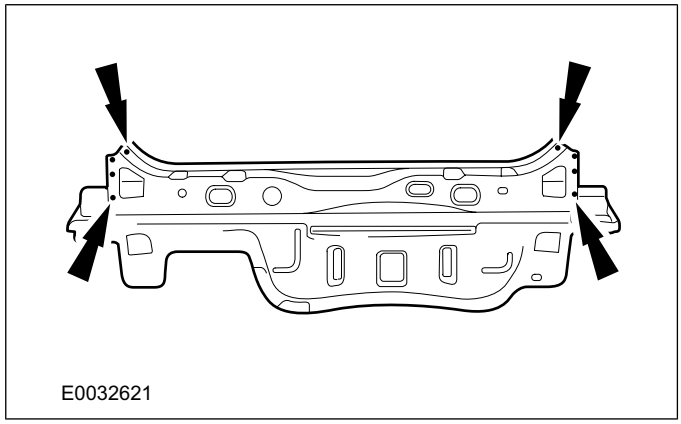


3. Back panel

- Mill out the spot welds.

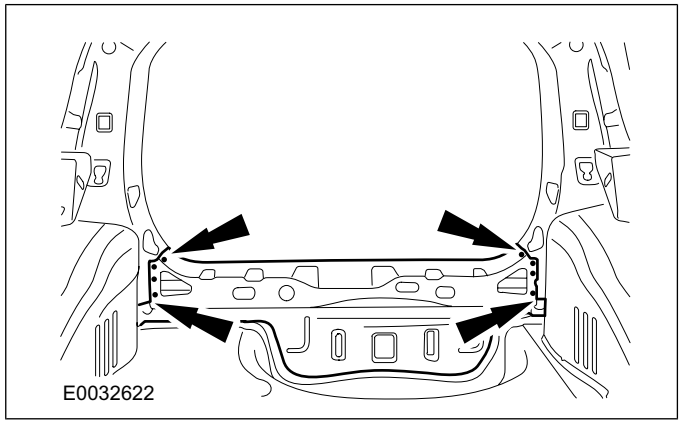


- Drill holes for puddle welding.



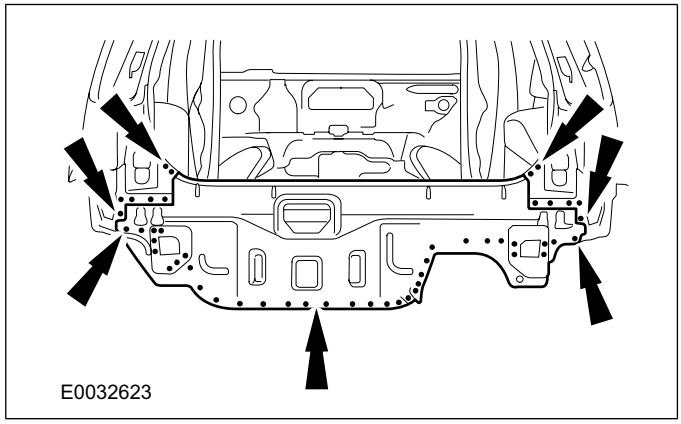
2. Back panel

- Puddle weld.



3. Back panel

- Resistance spot welding.



Installation

1. Back panel

REMOVAL AND INSTALLATION

Rear Floor Panel

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Luggage compartment floor panel	
Spare wheel retainer	

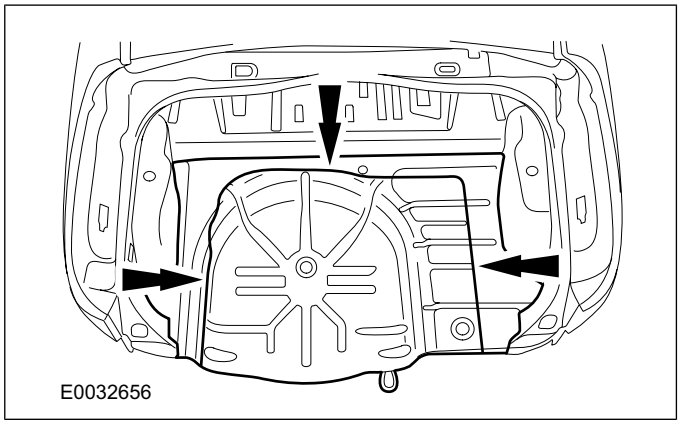
Removal

1. General Instructions

- The tailgate and rear panel with gussets are already removed before the start of repairs.
- Necessary removal work: rear seat, luggage compartment carpet, side panel trim left and right.

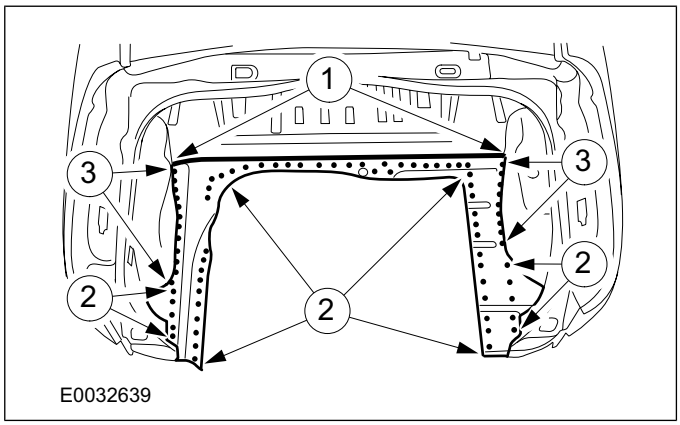
2. Luggage compartment floor panel

1. Preliminary separating cut.



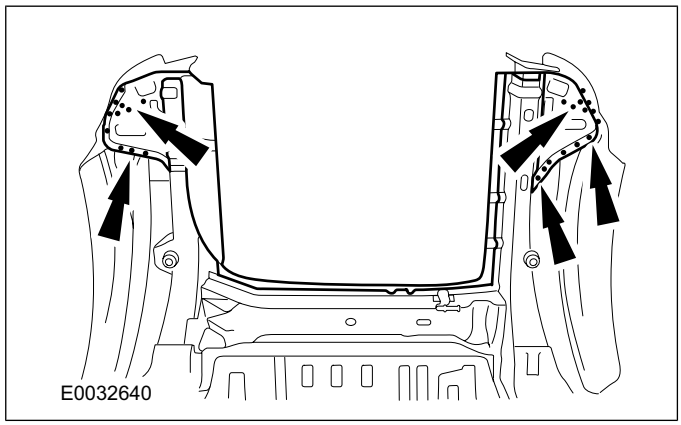
3. Luggage compartment floor panel

1. Exact separating cut.
2. Mill out the spot welds.
3. Grind out the spot welds.



4. Luggage compartment floor panel

- Grind out the spot welds.

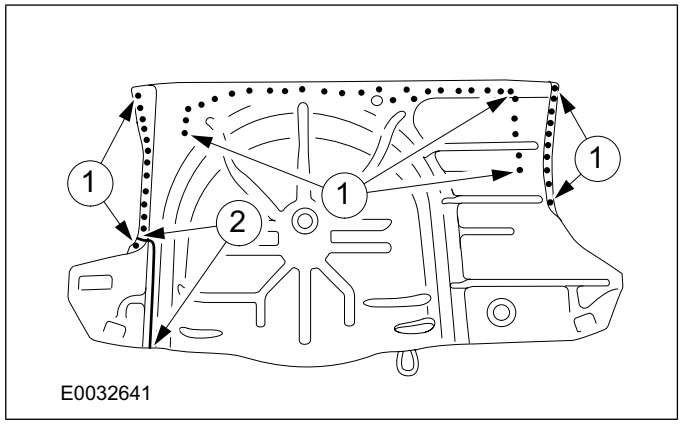


Installation

NOTE: The new part overlaps in the connection area at the front by 10 mm. To install it, because of space limitations, cut the left-hand part panel and re-install separately. The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Luggage compartment floor panel

1. Drill holes for puddle welding.
2. Exact separating cut.

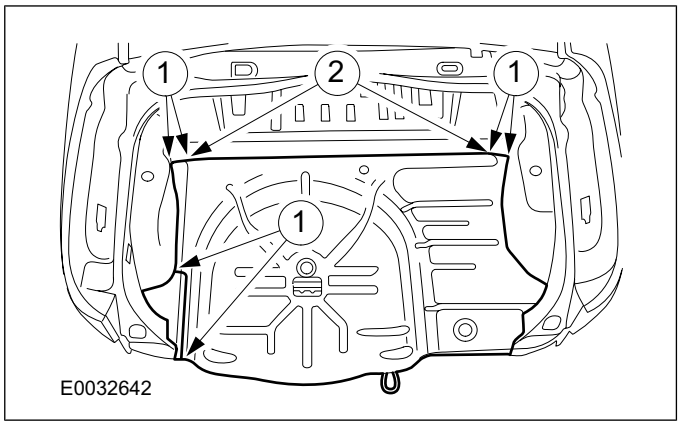


2. Luggage compartment floor panel

1. Continuous MIG weld seam.

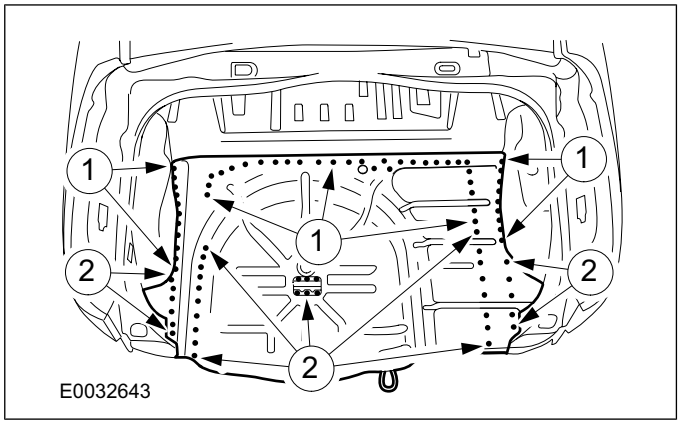
REMOVAL AND INSTALLATION

2. Intermittent MIG weld seam.



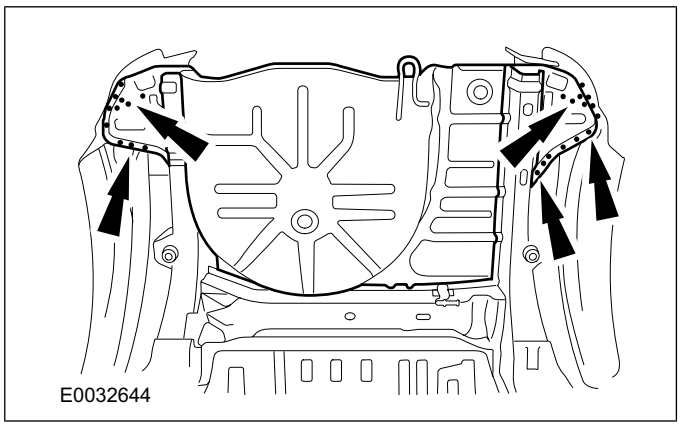
3. Luggage compartment floor panel

1. Puddle weld.
2. Resistance spot welding.



4. Luggage compartment floor panel

- Resistance spot welding.



REMOVAL AND INSTALLATION

Rear Floor Panel Section

Materials	
Name	**Specification**
Rear floor panel	

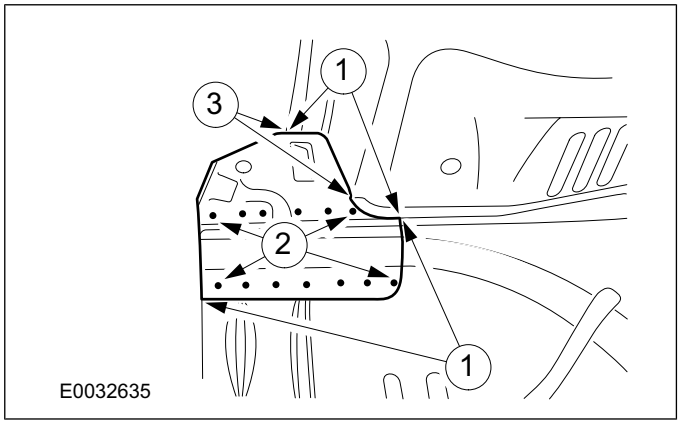
Removal

1. General Notes

- Tailgate, back panel, rear crossmember, quarter panel and lamp mounting panel reinforcement are already removed before the start of repairs.
- Required removal operations: Interior trim.
- Fold back the carpets out of the working area.

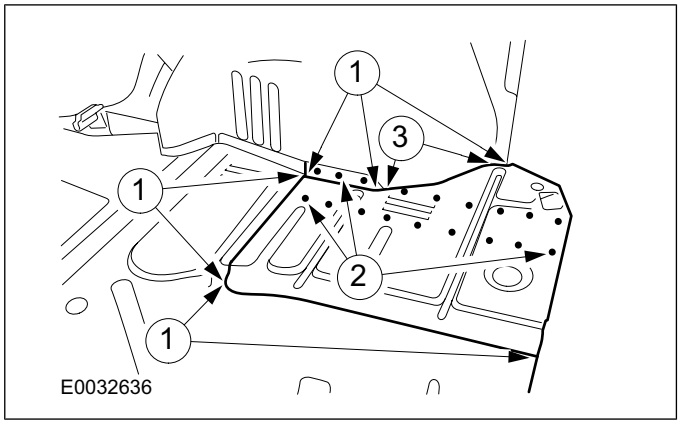
2. Left-hand rear floor panel

1. Preliminary cut location.
2. Mill out the spot welds.
3. Mill out the spot welds from below



3. Right-hand rear floor panel

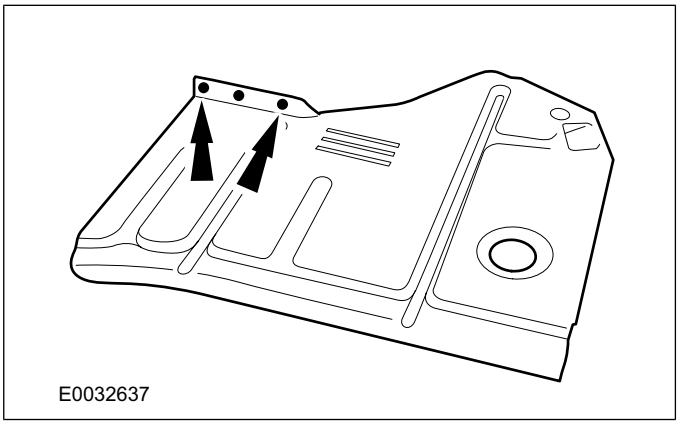
1. Preliminary cut location.
2. Mill out the spot welds.
3. Mill out the spot welds from below



Installation

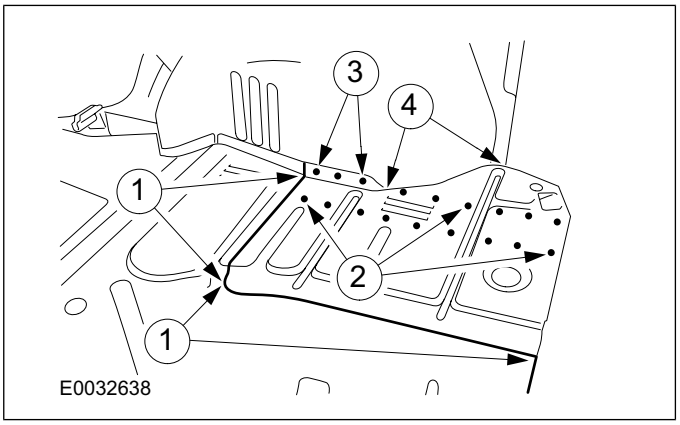
1. Right-hand rear floor panel

- Drill holes for puddle welding.



2. Rear floor panel

1. Continuous MIG weld.
2. Resistance spot weld.
3. Puddle weld.



REMOVAL AND INSTALLATION

Rear Outer Wheelhouse Half

Materials	
Name	**Specification**
Wheelhouse outer half	
Wheelhouse reinforcement	
NVH element	

Removal

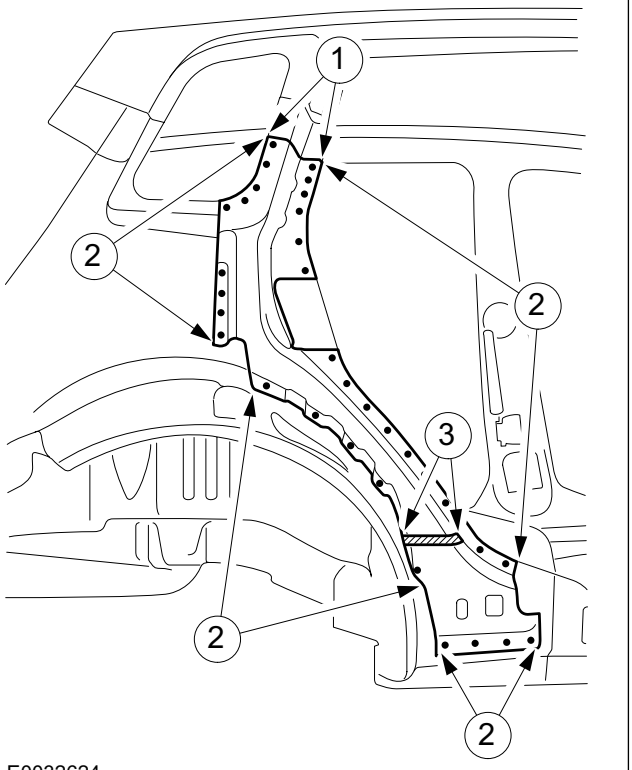
1. General Instructions

- side panel, back panel, lamp mounting panel and lamp mounting panel reinforcement are already removed before the start of repairs.

NOTE: Make the separating cut on the wheel house reinforcement offset from the wheel house outer halves.

2. Wheelhouse reinforcement

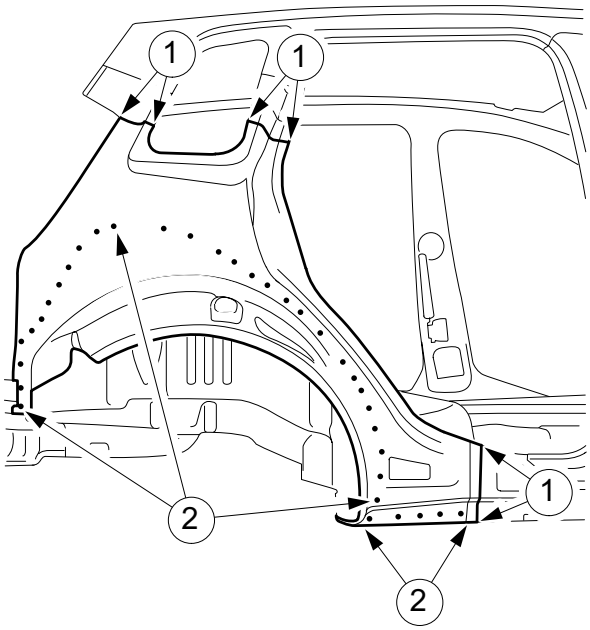
1. Separating cut.
2. Mill out the spot welds.
3. Warm the area (to about 170° C) and release the NVH elements.



E0032624

3. Wheelhouse outer half

1. Separating cut.
2. Mill out the spot welds.



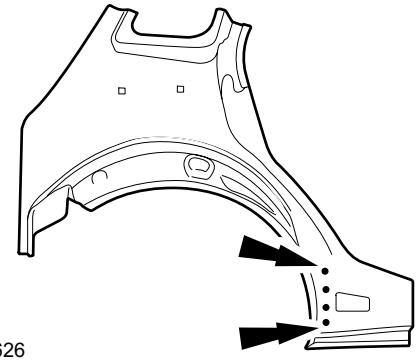
E0032625

Installation

NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

1. Wheelhouse outer half

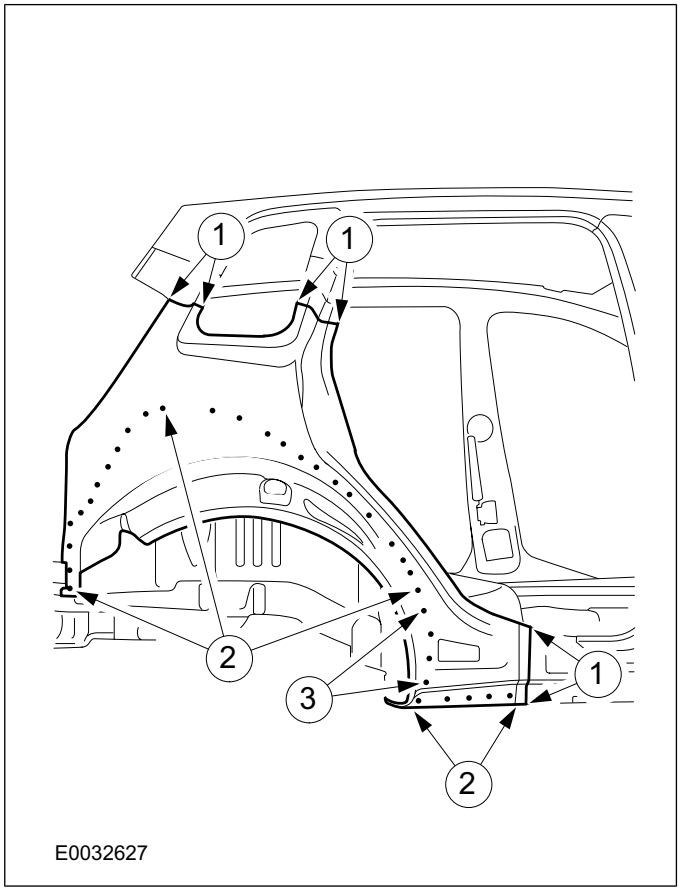
- Drill holes for puddle welding.


E0032626

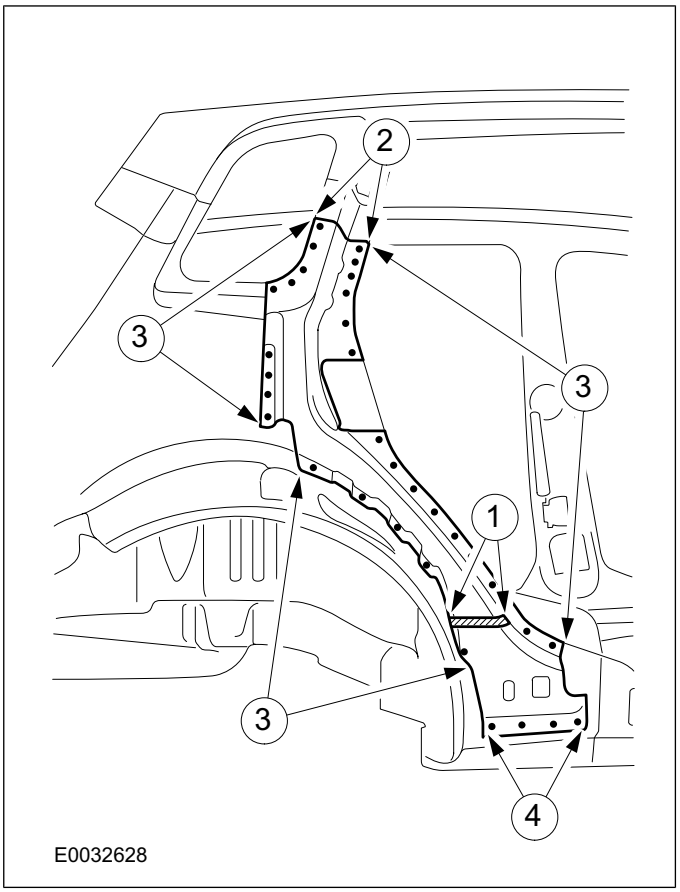
REMOVAL AND INSTALLATION

2. Wheelhouse outer half

1. Continuous MIG weld seam.
2. Resistance spot welding.
3. Puddle weld.



4. Puddle weld.



3. Wheelhouse outer half

1. Glue the NVH element in place with PU glass adhesive.
2. Continuous MIG weld seam.
3. Resistance spot welding.

REMOVAL AND INSTALLATION

Rear Side Member Section

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Rear side member	

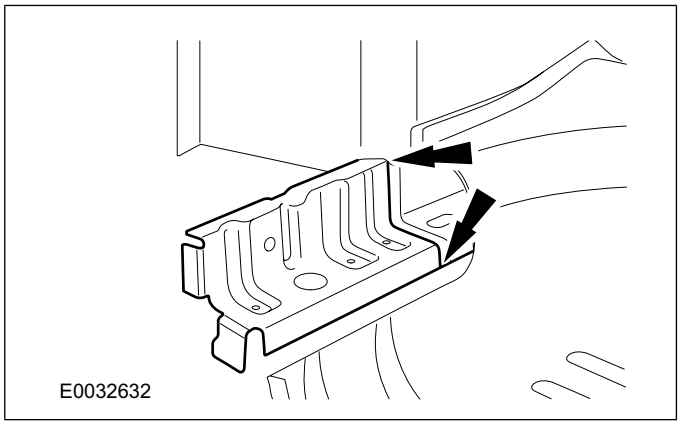
Removal

1. General Notes.

- The luggage compartment floor (part for partial replacement), back panel, forced air extraction gusset and side panel are already removed before the repair work starts.
- The separating cut may vary on the right-hand side, depending on the damage.

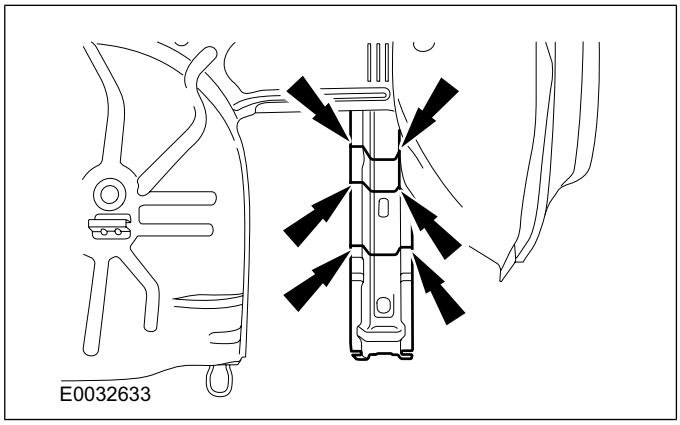
2. Left-hand side member

- Separating cut.



3. Right-hand side member

- Possible separating cuts.

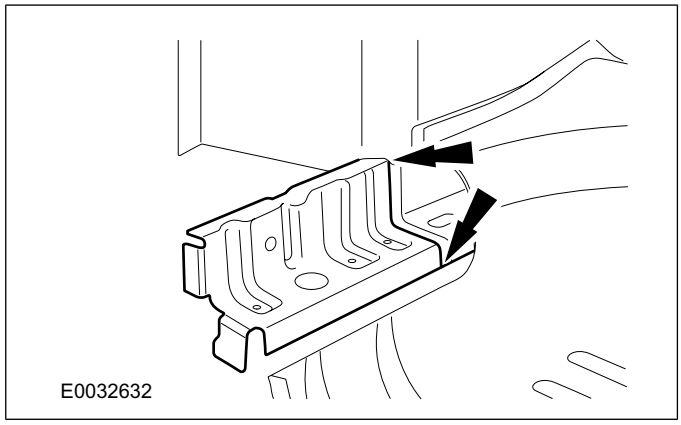


Installation

1. NOTE: The instructions concerning welding equipment given in Section 501-25A must be observed before resistance spot welding body panels with a total thickness of 3 mm and greater.

Side member

- Continuous MIG weld seam.



REMOVAL AND INSTALLATION

Quarter/Side Panel Rear Section RH

1. Replacement parts

- Quarter panel sectional part
- Luggage compartment water drain panel
- Quarter panel reinforcement extension

Removal

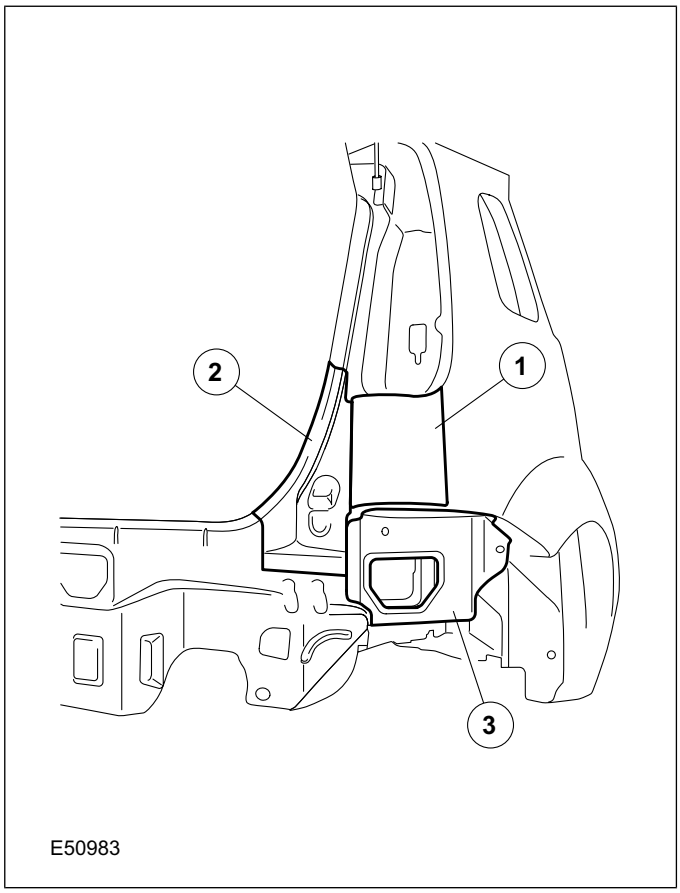
NOTE: Sectional repair of the rear right quarter panel can be performed with the back panel both installed and removed. In the operational procedure described here, the back panel has already been removed.

1. General notes

- Required removal operations: wheelhouse trim panel, rear lamp, rear bumper, quarter panel trim.
- Move the carpeting and the wiring away from the working area.

2. Overview of repair

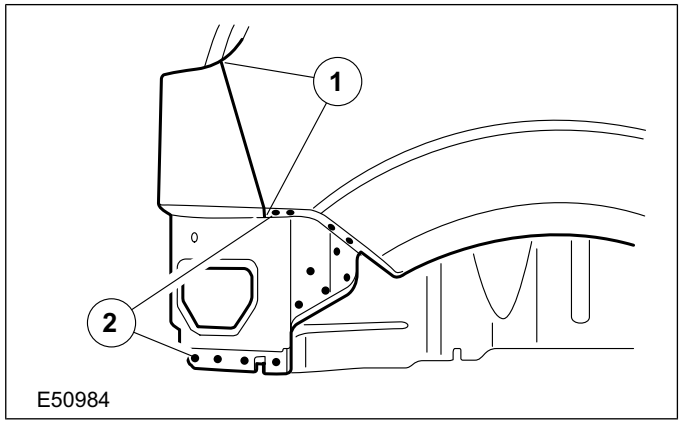
1. Quarter panel sectional repair.
2. Luggage compartment water drain panel.
3. Quarter panel reinforcement extension.



E50983

3. Quarter panel and quarter panel reinforcement extension

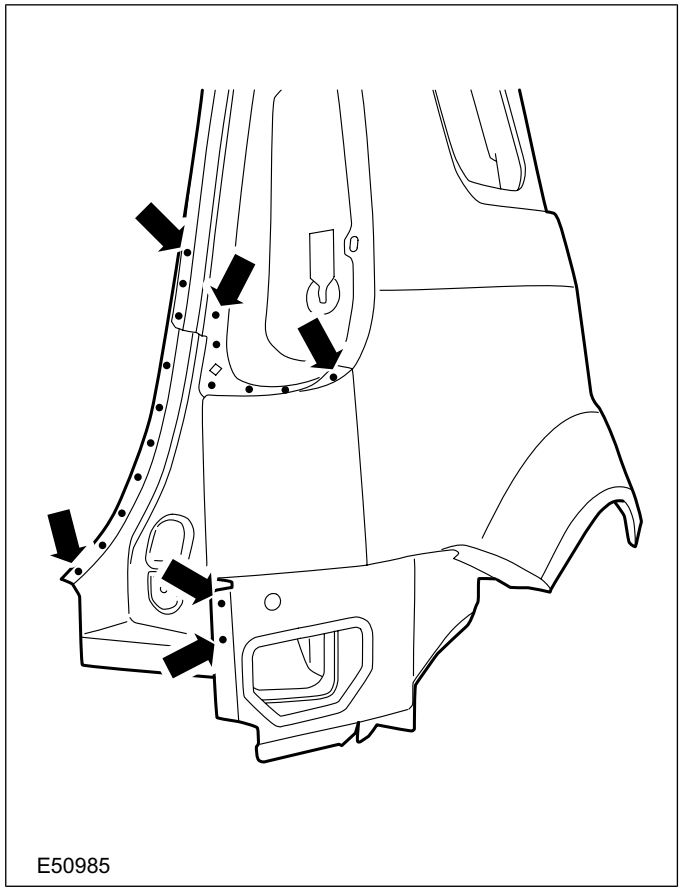
1. Cut point.
2. Mill out the spot welds.



E50984

4. Quarter panel and luggage compartment water drain panel

- Mill out the spot welds.

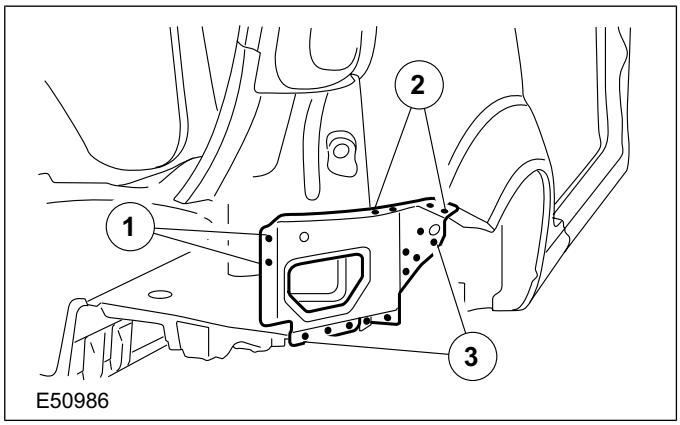

E50985

Installation

1. Quarter panel reinforcement extension

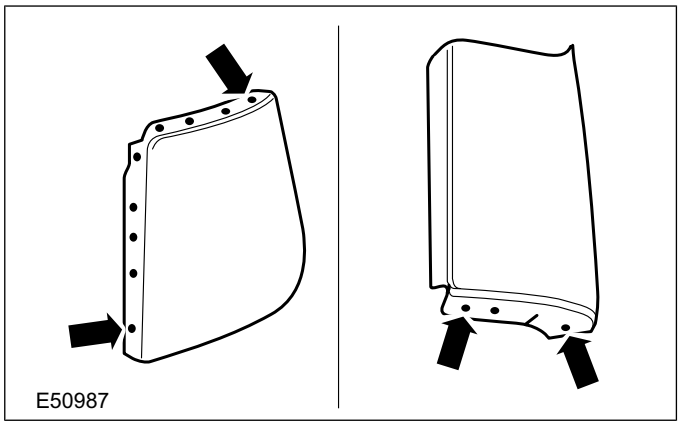
REMOVAL AND INSTALLATION

1. Drill holes for puddle welding.
2. Puddle weld.
3. Resistance spot weld.



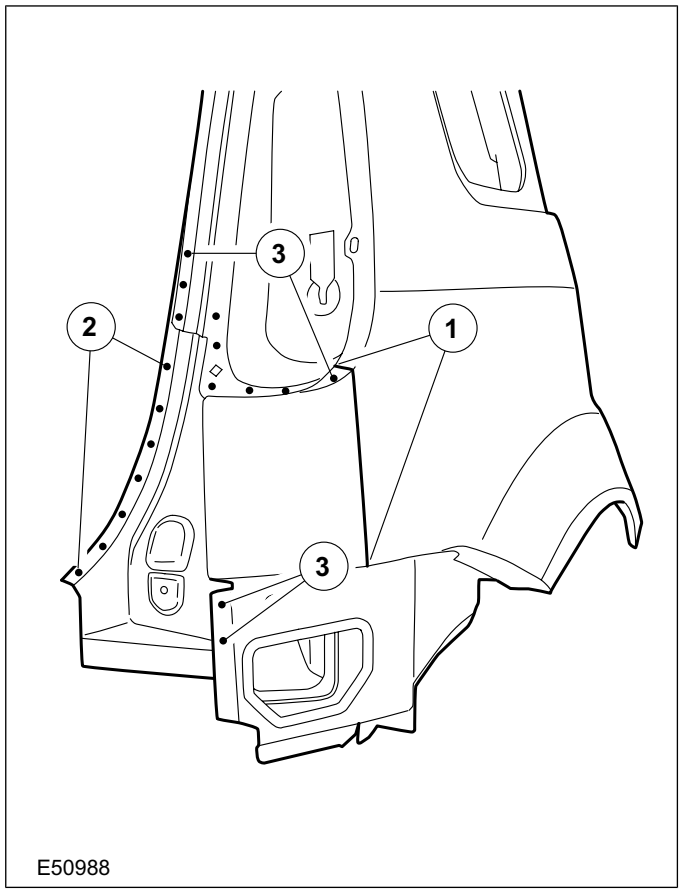
2. Quarter panel

- Drill holes for puddle welding.



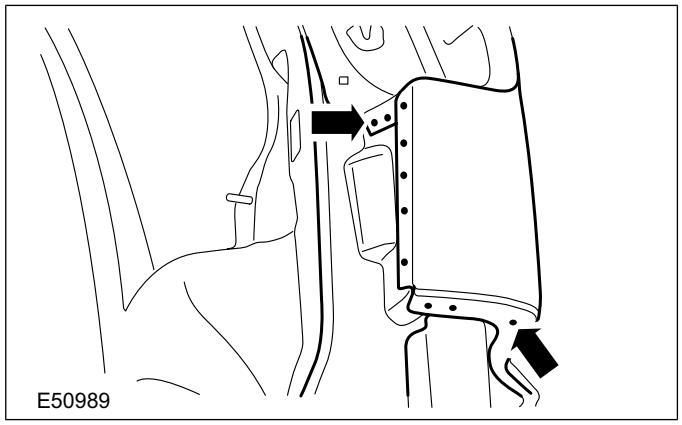
3. Quarter panel and luggage compartment water drain panel

1. Continuous MIG weld (butt weld).
2. Resistance spot weld.
3. Puddle weld.



4. Quarter panel and luggage compartment water drain panel

- Puddle weld.



SECTION 501-36 Paint - General Information

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

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SPECIFICATIONS

Description	Finis Code	Specification
Underbody protection	5 030 492	-
Anti-corrosion wax	1 219 834	WSK-M7C89-A
Profiled butyl seal	1 128 983	S-M3G4620-A
Weld primer	1 205 996	-
Clinched flange protection	1 136 479	WSK-M4G245-B
Cavity wax	5 030 081	-
Seam sealing compound	1 205 817	WSS-M4G364-A
Body sealing compound	1 143 255	-
Because the supply of paint materials to the dealer workshops has been handed over to paint suppliers, the specifications for these materials are not given in the table.		

DESCRIPTION AND OPERATION

Description and Usage of Paint Literature

Vehicle paints are subject to severe demands caused by external influences. Moisture, air-borne deposits in the form of various chemicals and UV light constantly affect a paint surface. Furthermore, mechanical damage occurs through grit, stones and sand. Bird droppings, insect residues, pollen and tree sap also attack the paint surface.

The present literature not only informs the specialist about current repair painting techniques, but also provides tips and instructions on modern and economical repair processes.

High quality bodywork paints require the use of the most modern technologies and regular updating of the technician's knowledge of painting techniques, because of the constantly new developments in paint technology.

Information about different materials is listed under Specification.

Furthermore, information on the fundamental principles of repair painting and paint materials is provided in several chapters. The safety instructions indicate the possible health hazards and other sources of danger. There are also notes about tools and materials as well as on basic painting methods.

In the model specific repair instructions, only the most important repair steps or special features are referred to. Detailed information on the generally applicable painting procedures is given in this paint manual.

Direct supply of repair paints by Ford has been discontinued. There is however an agreement with many paint manufacturers, which ensures fast and problem-free supply to the dealer undertakings.

Paint suppliers:

- DuPont
- PPG
- Sikkens
- Standox

When using painting materials, it should be taken into account that the manufacturers have exactly matched their products between each other. In order to avoid quality defects, difficulties in working and losses in corrosion protection, these may not be substituted with other products.

NOTE: The Ford Service Organization organizes basic and more in-depth training on much of the content of this paint manual. As well as the practical part of the training, a further component is the Student Information document, which offers supplementary information in the form of a brochure.

During all work it must always be ensured that personal safety and the operational capability of the vehicle are not threatened by the choice of methods, tools and components.

The information given in the diagrams in the chapter "Paint Damage" is provided by the repair paint manufacturer.

DESCRIPTION AND OPERATION

Symbols

General

Various symbols, signs, instructions and illustrations are used in this literature. Warnings and cautions have different meanings and require different ways of proceeding. Diagrammatic representations are provided with instructional signs for improved clarity. These are briefly explained below:

WARNING: This caption is used when failure to follow instructions exactly or failure to follow them at all may result in a hazard to persons or in persons being injured.

CAUTION: This caption is used when incorrectly following the test procedures or instructions or failure to follow them at all could lead to damage to the vehicle or components.

NOTE: This caption is used when attention needs to be drawn to special or extra information.

When reading this handbook, you will come across the points WARNING, CAUTION AND NOTE. These instructions are always given immediately before the corresponding job steps.

Hazardous materials designations

Many accidents occur because of ignorance. In the area of personal health protection, it is particularly important to clearly emphasize sources of danger and their effects on human organs.

Only with knowledge of hazardous material designations can it be certain that the necessary precautions are taken when handling substances which are harmful to health.

NOTE: Pay attention to the manufacturer's data on the containers and given in the Safety Data Sheet.

DESCRIPTION AND OPERATION

Hazardous material symbols

Item	Description
1	Very poisonous, T+ (extremely toxic), small quantities can be fatal.
2	Poisonous, T (toxic), causes serious damage to health
3	Corrosive, C (corrosive), destroys living tissue.
4	Harmful to health, Xn (noxious).
5	Irritant, Xi (irritant), can cause inflammation.

Item	Description
6	Explosive
7	Highly flammable, F+ (extremely flammable), already flammable at temperatures below 0° C.
8	Flammable, F (flammable), forms a flammable mixture with air.
9	Oxidizing, O (oxidizing), reacts with combustible substances.

As well as the danger symbols, there is more comprehensive manufacturer's information to be

DESCRIPTION AND OPERATION

found on the containers and in the Safety Data Sheets, and you must pay attention to this information.

Instructions on measures to be taken for personal protection.

As well as the information about sources of danger, there are mandatory instructions which draw your attention to the personal protection measures to be taken.

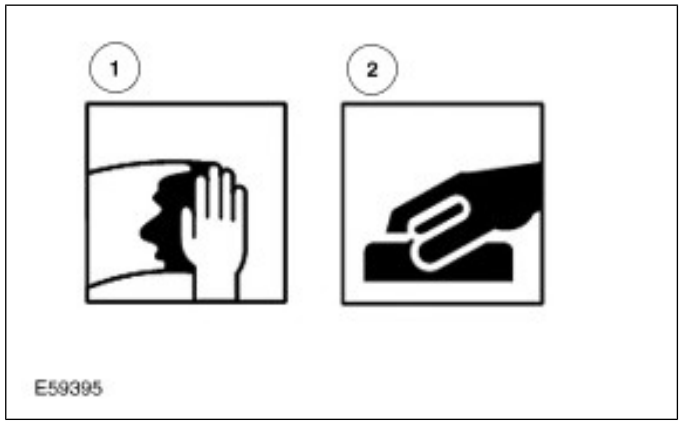
Mandatory symbol

Item	Description
1	Breathing protection must be worn
2	Eye protection must be worn
3	Ear protection must be worn
4	Protective gloves must be worn
5	Protective footwear must be worn

Icons

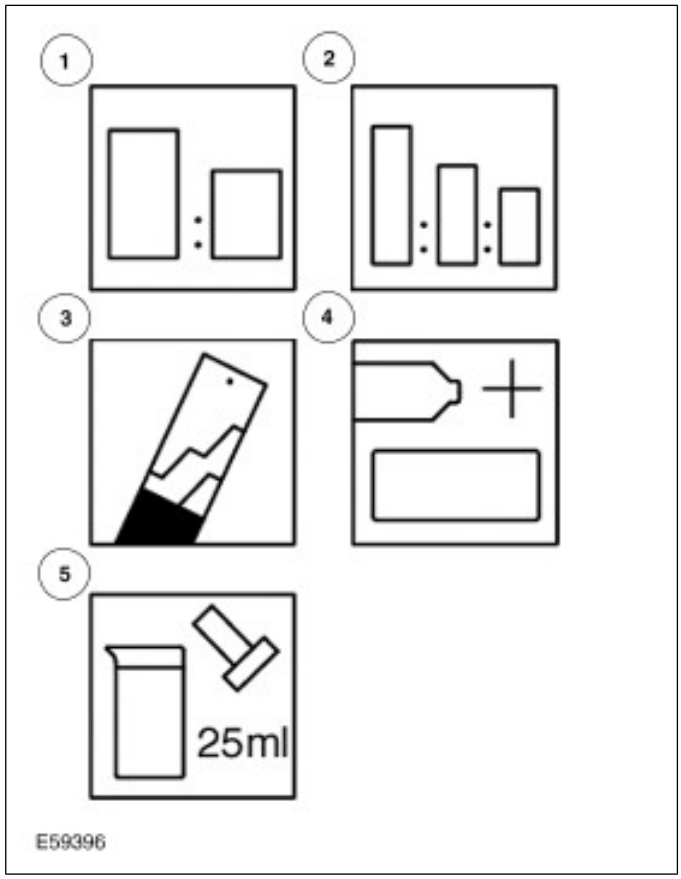
So that the necessary information for optimal handling is clear, unambiguous and can be quickly understood, the leading paint manufacturers have agreed a standard symbolic language. Language independent representations in the form of icons provide handling instructions which are supplemented with quantity or time information.

Pretreatment



Item	Description
1	Clean
2	Sand

Mix



Item	Description
1	2 component mixture
2	3 component mixture

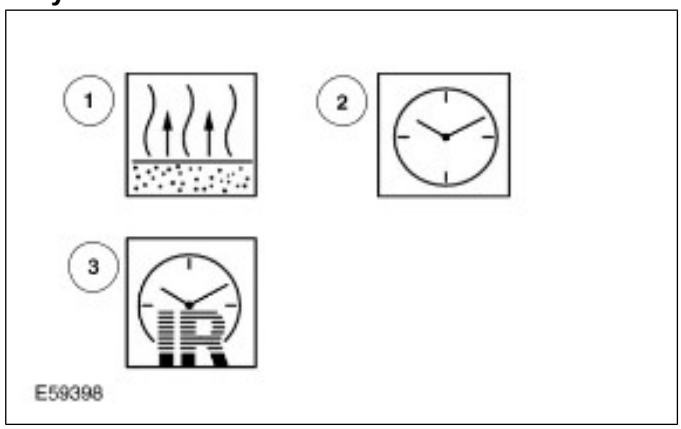
DESCRIPTION AND OPERATION

Item	Description
3	Use a measuring rod
4	Addition of hardener
5	Addition of additives

Process

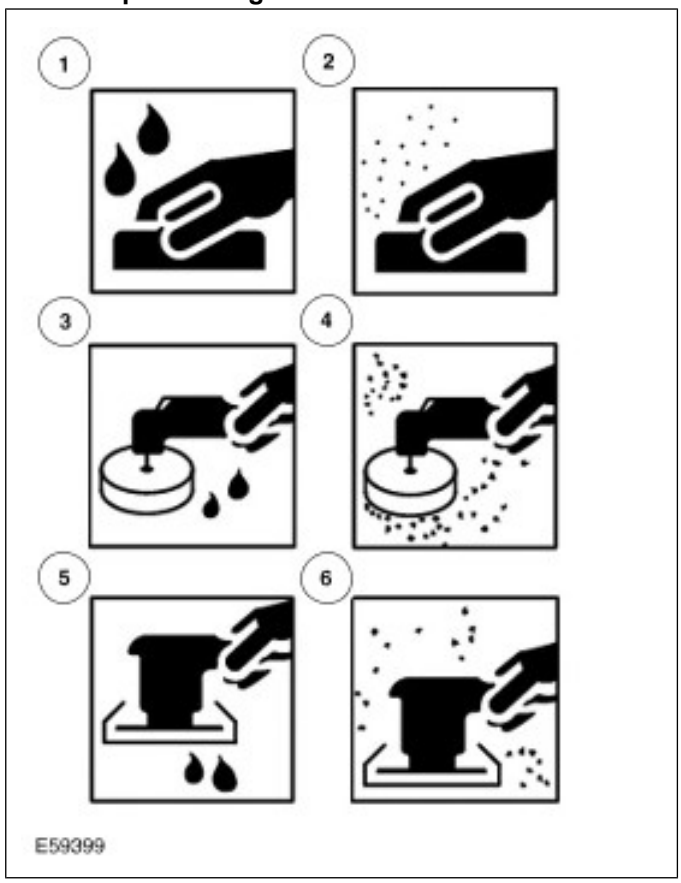
Item	Description
1	Flow-beaker spray gun
2	Suction-beaker spray gun
3	Spray passes
4	Filler
5	Coat
6	Underbody protection spray gun

Dry



Item	Description
1	Ventilate
2	Drying time
3	Drying time with infra-red dryer

Further processing

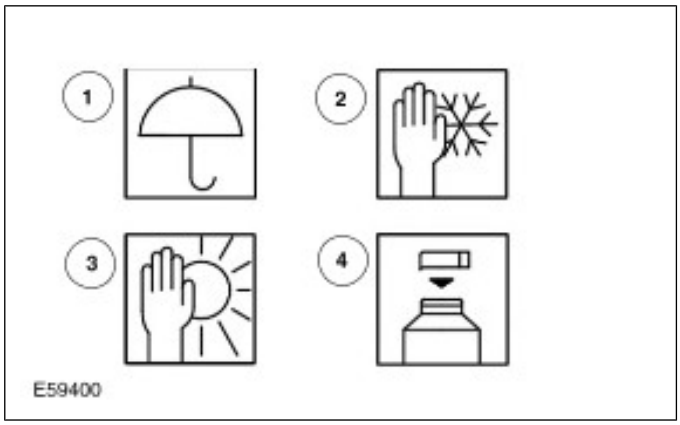


Item	Description
1	Hand abrade (wet)
2	Hand abrade (dry)
3	Eccentric sander (wet)
4	Eccentric sander (dry)

DESCRIPTION AND OPERATION

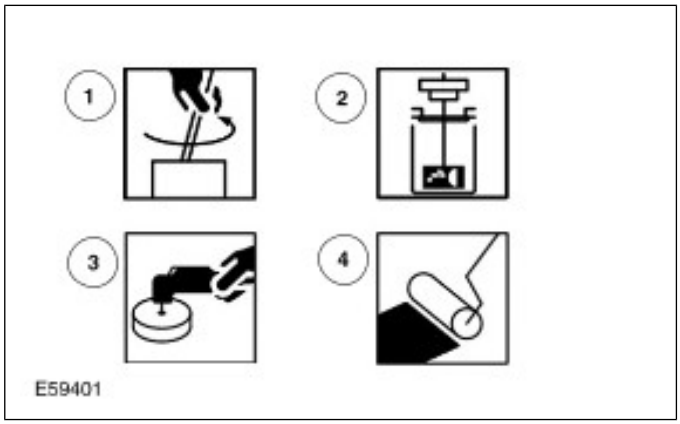
Item	Description
5	Oscillating sander (wet)
6	Oscillating sander (dry)

Store



Item	Description
1	Protect from moisture
2	Store in a frost-free environment
3	Store in a cool place
4	Close the container

Other



Item	Description
1	Stir by hand
2	Stir using a mixing machine
3	Polish
4	Roll

DESCRIPTION AND OPERATION

Health and Safety Precautions

General instructions for the paint shop and handling paint materials

Hazardous areas in repair paint shops:

- Danger from fires, explosions and hot surfaces.
- Dangers to health and safety from the effects of harmful substances because of their absorption through the skin and/or inhalation.
- Dangers caused by electricity, compressed air, power tools and noise.

WARNING: During painting work there is an increased danger of fire or explosion. Prevent any sparks being created. Fire, naked lights and smoking are forbidden.

Measures:

- Wear protective footwear made from anti-static material.
- Only use tools made of wood, brass or copper to clean stands and extraction ducts. Do not use tools made of steel.

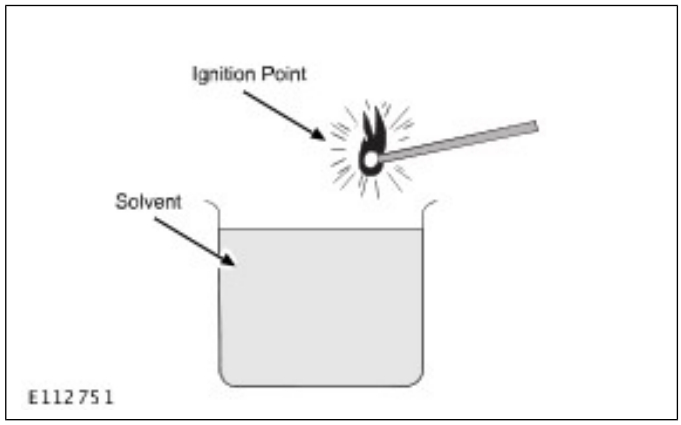
Only fill or decant paint materials in a specially marked area.

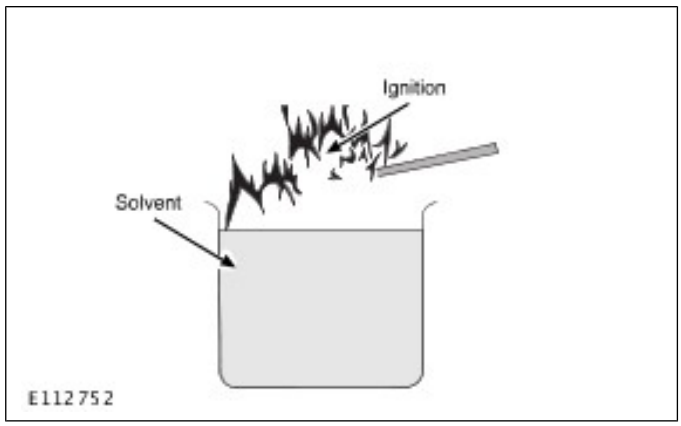
As well as these general instructions on the dangers in repair paint shops, all national and international regulations must be observed:

- Health and Safety at Work Act
- Ordinance on Hazardous Substances
- Technical Rules for Hazardous Substances
- Regulations for the Prevention of Industrial Accidents
- EU Directive on Hazardous Substances, 98/24/EU
- EU Directive on Noise, 2003/10/EU
- EU Directive on Volatile Organic Compounds (VOC), 1999/13/EU, 2001/81/EU, 2004/42/EU
- Safety instructions of equipment and tool manufacturers

Fire Danger and Fire Control

Paint and thinner used for vehicle repair have low flash and ignition points which can result in fire. If the paint or thinner reaches the critical temperature, it will produce combustible vapor and will be ignited. The flash point is the standard of flammability of the paint/ thinner. The flash point is defined as the lowest temperature at which the solvent can be ignited while increasing toward the ignition point. The ignition point is defined as the lowest temperature at which the solvent ignites while its temperature is being increased. The ignition point is far higher than the flash point.





Fire Prevention in the Factory

Ventilation

As the vapor of organic solvent is heavier than the air, it always flows to a lower place. When the vapor of the solvent and air are mixed at a given ratio, and an ignition source is located near the mixed gas, it may explode below the flashing point temperature. Therefore install the discharging outlet as low as possible.

NOTE: The explosive limit is the concentration of solvent below which it dose not explode.

- Gasoline: 1.4 (7.6%)
- Thinner: 1.0 (7.0%)

Check the Equipment and Tools

Always lubricate the sliding portion of any equipment (where metal friction generates heat.)

DESCRIPTION AND OPERATION

Always check that the exhaust fan dose not contact the wall of the painting booth and check for wear of the fan belt. Use safe tools (spark-free tools) when possible and use other equipment and tools carefully and correctly. Pay attention not to drop them or subject them to shocks.

Electrostatic Prevention Measures

Solvents have poor electrical conductivity. If paint or thinner is stirred in a container, static electricity is produced and when the electrostatic level reaches a critical value, it may cause a spark and ignite the solvent. Always connect a ground cable. To maintain a certain humidity in the painting booth, spray water on the floor. Wear anti-static coated cotton overalls avoiding synthetic fiber clothes.

Handling Organic Solvents

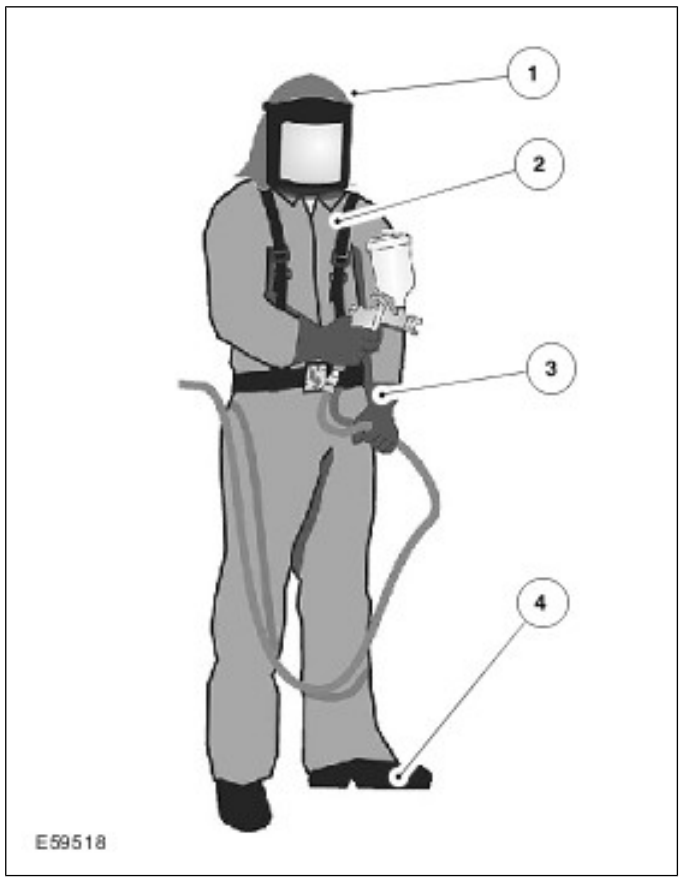
The organic solvent categories include: inflammable, explosive, toxic, and radioactive. In order to prevent fire, pay attention to the following items:

- Never use flame in the painting booth. If there is no choice but to use flame, suspend the painting work.
- When the paint or thinner is not being used, always cap its container. If it is spilt on the floor, wipe it up with a cloth.
- Do not put the paint and thinner in the sun or in a hot place.
- Always spray water in the painting booth to maintain enough humidity in order to reduce the danger of ignition.
- If the spray dust from the oil paint, the sanding waste of polyester putty or used cloth are massed together, there is a danger of autoignition. Keep them in a container filled with water until they are disposed of.

Personal protection

Besides the body and limbs, several organs vital to life are in very particular danger. Because damage is mostly irreparable, special attention and comprehensive protection are necessary.

WARNING: Solvents cause damage to the health through inhalation. Splashes in the eyes or on the skin can cause bodily harm. When working with solvents, always use suitable means of protection.



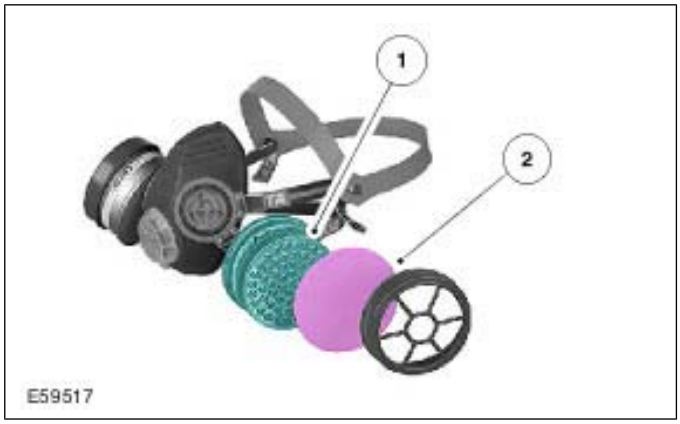
Item	Description
1	Protective hood with fresh air supply
2	Protective clothing
3	Protective gloves
4	Protective footwear

Breathing protection

During painting work and in the preparations for painting, gases, vapors, mists or dusts can appear in dangerous concentrations in the areas where fellow employees breath.

For short periods of work or minimal concentrations of hazardous substances, breathing protection devices with a combination filter are suitable as breathing protection equipment.

DESCRIPTION AND OPERATION



Item	Description
1	Activated charcoal filter
2	Coarse filter

For higher concentrations of harmful substances, breathing protection devices which are independent of the local atmosphere are suitable.

In these types of isolation systems, a compressed air hose carries natural air from the compressor line into the protective mask. During supply, the air undergoes pressure reduction, water removal, fine filtration and usually warming to natural breath temperature.

WARNING: Vapour or spray mist containing isocyanate as a paint base or hardener can cause toxic respiratory disease (conditions similar to asthma) leading to permanent damage, even when inhaled in the lowest concentrations.

Filter masks with wadding, sponge or colloid filters and also paper masks are all unsuitable for working with coating materials because they do not stop solvent vapors.

The instructions for use provided by the manufacturer must be observed when working with breathing protection equipment.

Skin protection

Spray painters who are subject to considerable exposure to coating materials must wear suitable protective work clothing (flame-proof and anti-static).

NOTE: Also, when working with water based materials, comprehensive skin protection must be worn, because these materials are very easily absorbed through the skin.

The protective clothing must be changed at the proper intervals. Items of clothing which are contaminated with coating materials can easily catch fire.

When selecting protective clothing, it must be taken into account that cloth containing a high proportion of easily melted plastic thread considerably increases the degree of burns injury (melted plastic on the skin!). This must also be taken into account in the choice of underwear.

For areas of skin which are not covered by protective clothing, suitable skin protection, skin cleaning and skin care agents must be used.

Eye protection

Working with portable hand sanding machines on which the tools move unguarded, at speed and with power is fundamentally dangerous.

Goggles must be worn not only when sanding, but also when working with paints and their additives. These contain substances which are harmful to the eyes. Damage ranging from irritation of the cornea to incurable illnesses are possible.

The protective goggles must be inert toward splashes of solvent, and fully enclose the areas at the side of the eyes on both sides. The best protection during spray painting is offered by full mask respirators or helmet respirators with a built-in visor.

Ear protection

Noise disturbance in repair paint shops caused by various sources is particularly high. Sanding and compressed air machines, paint cabin extractor fans (compressors) and extractor ducts in the work rooms are the causes of the high levels of noise.

WARNING: Avoid damage to your hearing! Wear ear protection.

Suitable ear protection is offered by ear plugs or ear defenders.

DESCRIPTION AND OPERATION

Environmental Regulations

Waste disposal in the repair paint shop

More than ever before, since the introduction of EU directives, rigorous attention is paid to the avoidance of waste materials and to recycling in repair paint shops. In this respect, repair paint shops must take into account and comply with the following requirements:

- Separate waste according to its recycling and disposal methods.
- Produce evidence for the correct transport and disposal of waste.

NOTE: The organization of disposal in the plant must comply with the requirements of the Waste Avoidance and Management Act: The avoidance and recycling of waste must always take priority.

However, despite all measures which may be taken, waste cannot be completely avoided.

NOTE: Waste which is not allowed in household rubbish, and which can no longer be utilized, must be disposed of as special waste.

Paint residues containing solvent, application residues, sanding dust, waste containing peroxides, solvents, soiled cleaning cloths and paint slurry all count as special waste. Each of these must be collected in a separate, sealed and suitably labeled metal container and properly disposed of using a specialist company.

Careful separation allows some waste to be usefully re-used.

- Empty metal containers can be sent for scrap instead of being disposed of as waste.
- Contaminated cleaning thinners can be separated by distillation.
- Packing material and masking paper can be added to the recycled paper collection.

Residues which cannot be used must be correctly disposed of.

All remaining waste must be treated as commercial waste and disposed of according to the local regulations.

The new VOC (Volatile Organic Compounds) solvent regulation

Keeping the air clean protects the environment and the population from the heath-damaging effects of air pollutants.

In certain atmospheric conditions, volatile organic compounds contribute to summer smog.

NOTE: For comprehensive information, please refer to the European VOC Directive, 1999/13/EU. Furthermore, the effective national regulations must be complied with.

The European VOC (Volatile Organic Compounds) Directive has controlled the limits for such compounds since August 2001. It applies to production coating companies and those which undertake repair painting of private and commercial vehicles.

Not least because of the VOC legislation, modern, low solvent and solvent-free lacquers and paints are finding greatly increased distribution across industry and the trade. Up to the year 2007, emissions from painting work will drop by at least 40%.

At the same time, the paint manufacturers guarantee for example that they will produce a ready-to-spray product consisting of base paint + hardener + thinners, with a permitted VOC level.

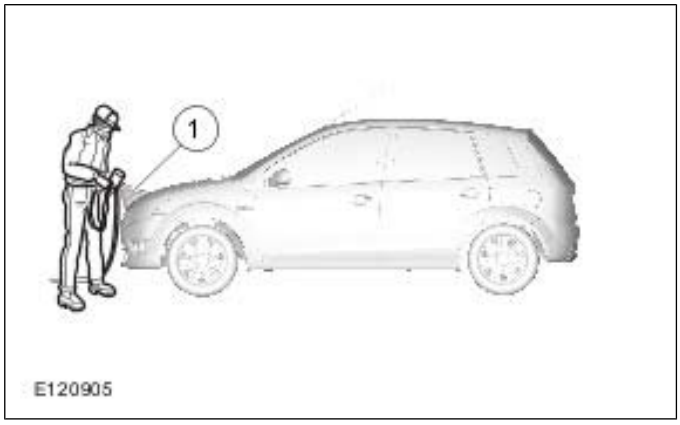
A company in business today can conform with the stipulated requirements by introducing water-based paints and using the other necessary products from the relevant paint manufacturers.

For more detailed information, please refer to the EU VOC Directive.

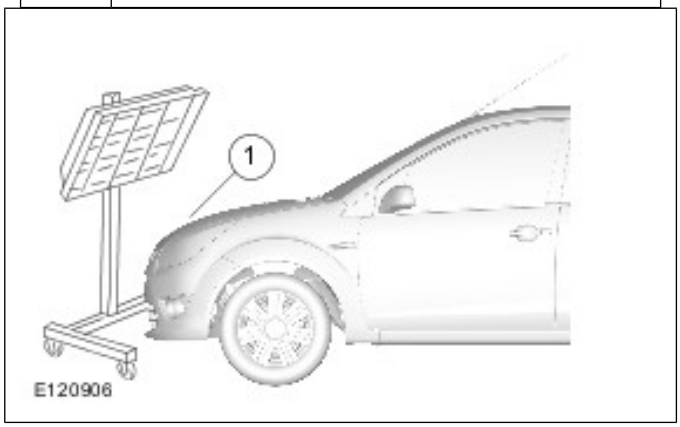
DESCRIPTION AND OPERATION

Factory Paint Application

Painting General



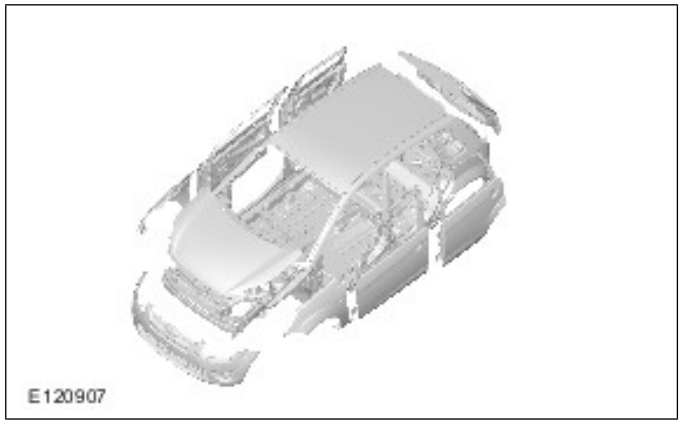
Item	Description
1	Painting

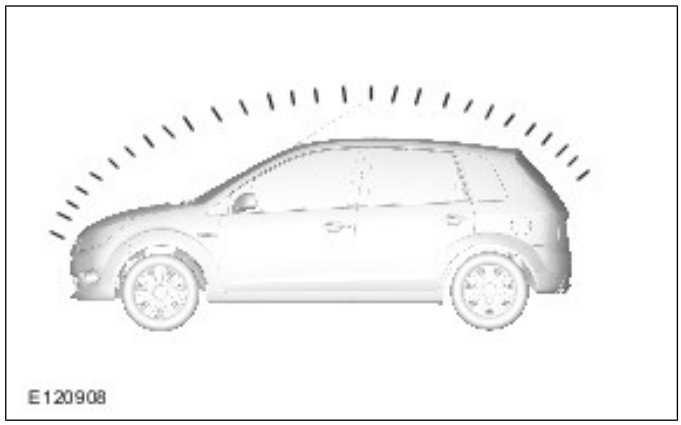


Item	Description
1	Drying

Painting is a process to make a thin layer of paint (liquid or powder) over an object and then the layer is hardened by drying it.

Painting Purpose





Protection of painted object

An automobile is mostly made from steel. When it is exposed to air, the steel tends to produce rusts on it. Once rust start to grow, covering the steel object, it becomes difficult to keep the characteristics of steel like its strength and even its original shape. By painting over it, thus preventing rust from growing on it, it becomes possible to retain its original characteristics much longer than without being painted.

Improvement of external appearance

Its commercial value would be much higher, if it is painted beautifully when compared to another unpainted car even though both of them have the same configuration and the same functions and performances. As is exemplified by a fire engine and a police car, color shows to the public what the car is intended for instantly.

DESCRIPTION AND OPERATION

General fundamentals of paint technology

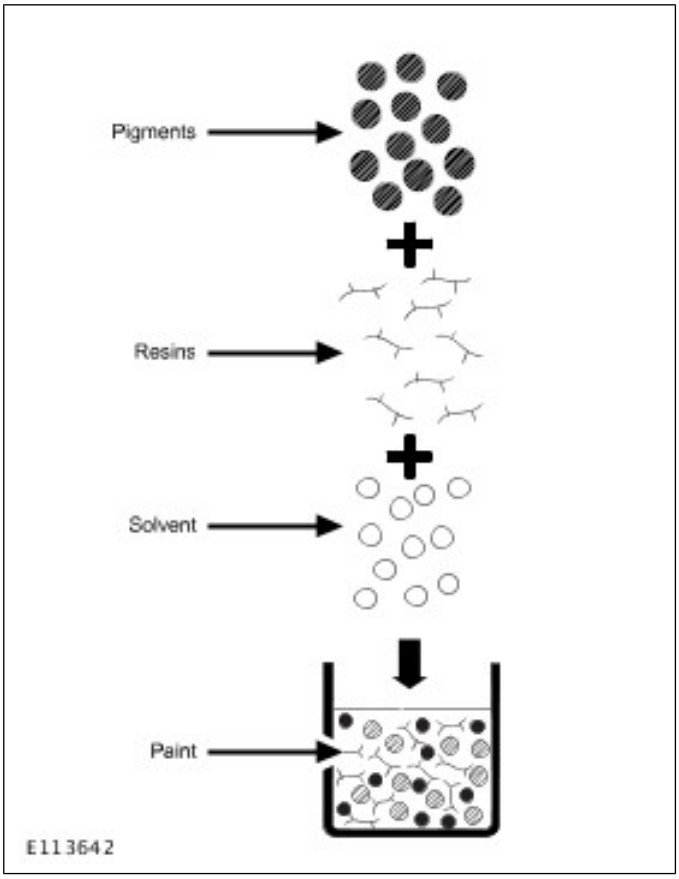
Paint is a pigment-containing liquid which undergoes chemical and/or physical processes after it has been applied to a surface, so changing into a solid film covering.

Repair paint consists of binder, pigments, filler and solvent.

NOTE: Organic solvent is being replaced by solvent based on water.

Constituents of paint

- Binder
  - Mostly semi-fluid resins which bind together the other components of the paint when it dries.
  - Makes the paint durable.
  - Ensures good surface coverage.
- Pigments
  - Fine, colored powders, which give color to the paint.
  - Cover the components below (covering power).
- Additives
  - Additives give the paint special properties.
  - e.g. flow improver, softener, drying accelerator, thickener.
- Solvent
  - Thins the paint and allows it to flow more freely.
  - Evaporates during drying.



Contents of Paint

Pigments

Pigment is powder of extremely tiny particles insoluble to water, oil, and any solvents. Pigment alone cannot be attached to any object. Therefore, by mixing it with resin and other components changing it to paint, it becomes possible to adhere to objects. Body Pigment reinforces and gives fleshiness to paint layer. Mainly used for undercoating. Anti-rust Pigment Mainly used for undercoating to prevent rust from growing. Color Pigment Mainly used for undercoating to prevent rust from growing. Ordinary pigment gives colors to the paint such as red, blue, yellow, etc. Metallic pigment contains powdered aluminum particles gives metallic brightness to paint layers. Titanized mica pigment Titanium oxide is coated on pieces of mica, giving pearl brightness to paint layers.

Resins

Resin is a main content, together with pigment, that forms a paint layer normally a sticky transparent liquid. After being painted on an object and dry-hardened, it becomes a paint layer. The quality of the resin affects the finish (luster, brightness), the easiness of work (drying, polishing)

DESCRIPTION AND OPERATION

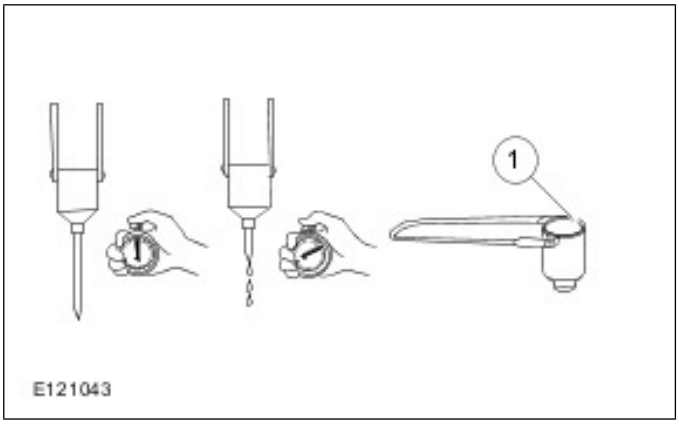
and the quality of the paint layer (hardness, anti-solution, weatherproofing). Natural Resin Mainly taken out of plants, it is usually used for varnish and lacquer. Synthetic Resin is produced through chemical reaction from chemical materials. Most of the kinds of resin now being used are synthetic resin. Synthetic resin is divided into thermoplastic and thermosetting resins. Thermoplastic resin: It has a characteristic to soften if heated and to harden if cooled. This characteristic is repeatable. Some of the typical ones are Nitro-cellulose, Cellulose acetate, polypropylene, and nylon. Thermosetting resin: If heated, it hardens and becomes insoluble, never returning back to the original state. Some of the typical ones are amino, polyurethane, or epoxy resins.

Solvents and Thinner

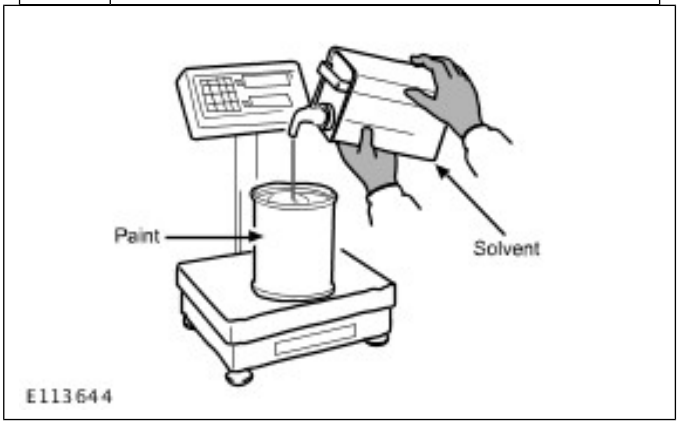
Solvent is usually mixed with paint, which melts resin to make pigment and resin mix easily. Thinner is a mixture of several solvents. It is added to paint to optimize its viscosity. Solvent and thinner evaporates as the paint dries and does not remaining in the paint layer. Various kinds of resins are used in paint. Therefore, to dissolve them all, different kinds of solvent must be used. If some of them does not dissolve, it will affect the resulting effects. In consideration of this, special thinners are available in which different kinds of solvents are mixed together. In addition, depending upon outdoor temperature, such as summer or winter use, different kinds of thinner with different evaporation times, are available.

Paint viscosity

A term to indicate the degree of viscosity of paints. The paint made soft through dilution of thinner is called “Its viscosity is low”. If the paint is too sticky, it is called “Its viscosity is high”. Because adjustment of the viscosity of paint depends on the addition of solvent, the proper selection of solvent is important and must be made carefully.



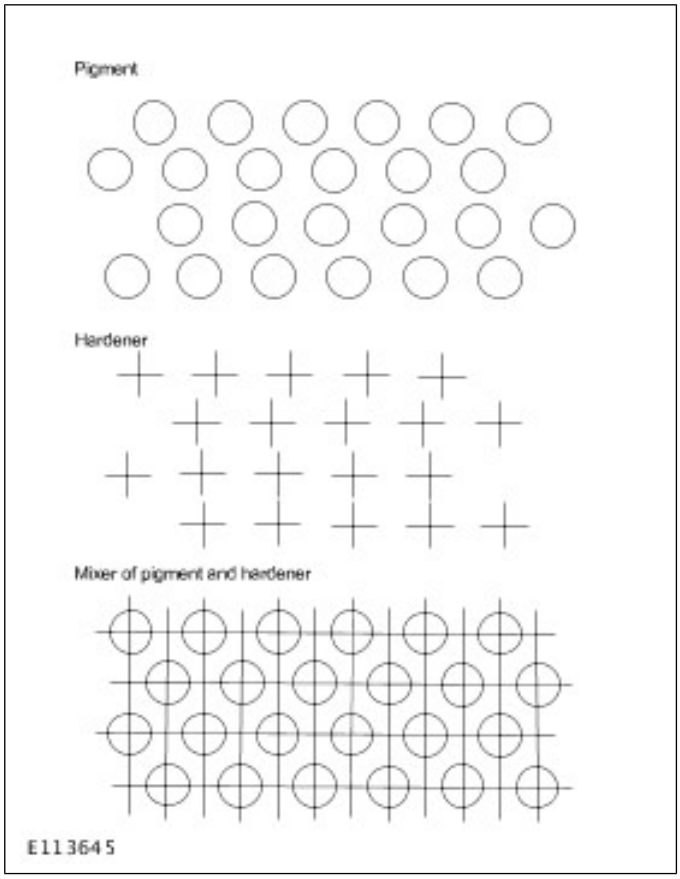
Item	Description
1	Viscosity Measurement



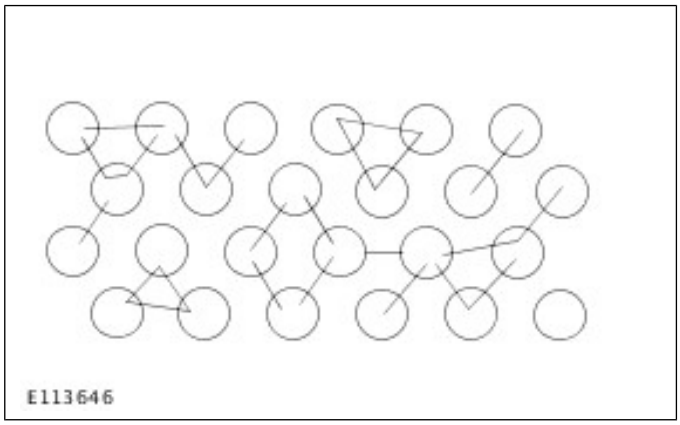
Hardener

The paint of a two-liquid mixing type needs to be mixed with hardener to achieve its optimum paint characteristics. Acrylic urethane paint is mainly used for car paint repair together with isocyanine chemicals as hardener.

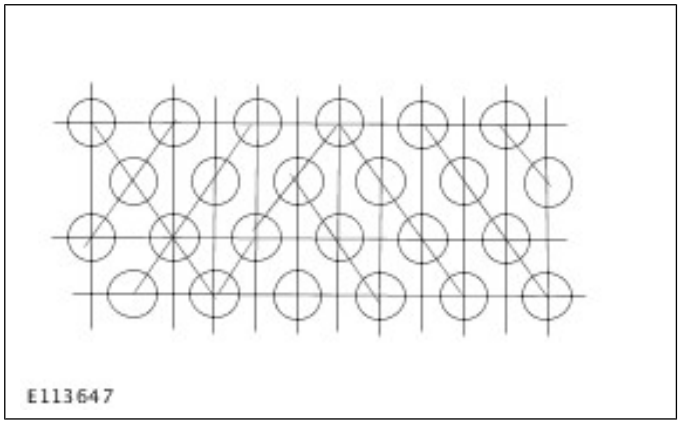
DESCRIPTION AND OPERATION



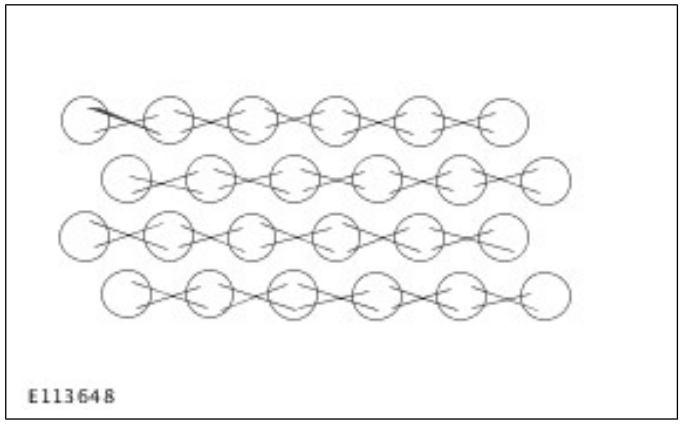
In the case that it is little amount of hardener.



In the case that it is too many amount of hardener.



In the case that different hardener is mixed.



Dry-up of Paint

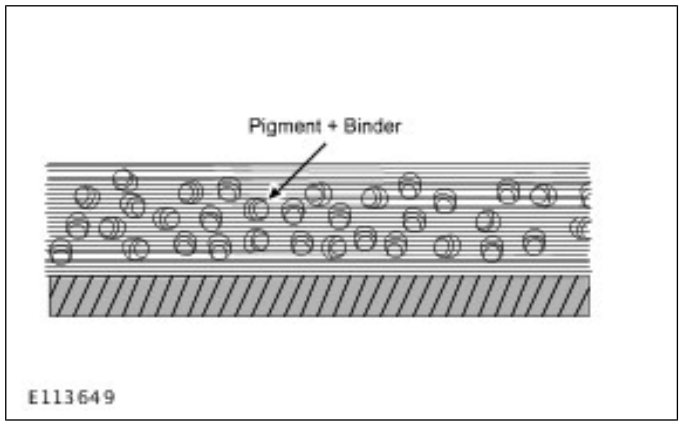
Types of Dry-up

The process of the paint applied being changed from the state of liquid to that of solid is called “Dry-up”. In the course of the process, the contents of the paint change as follows while the resin in it hardens forming a paint layer.

- **Solvent**: does not remain in the paint layer as it evaporates in the air.
- **Pigment**: remains in the paint layer as powder particles as before the process.
- **Resin**: that has been liquid in the paint turns out to be a hard solid.

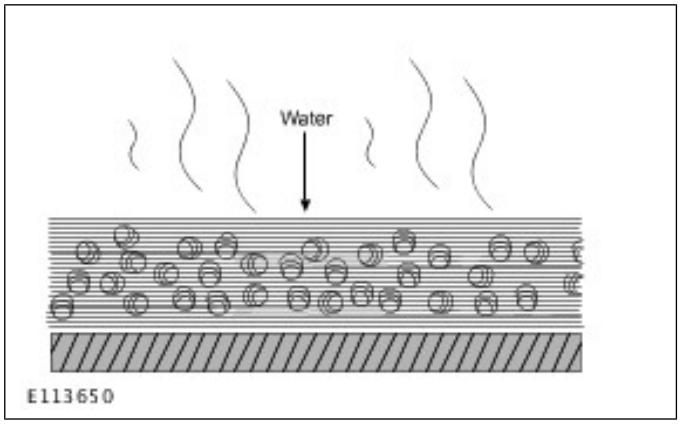
Water Evaporation Dry-up Type

Wet film after spraying

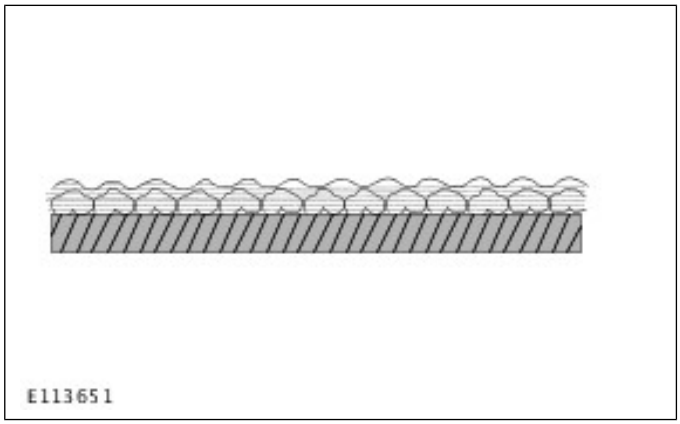


Water in the paint is evaporated by air blow.

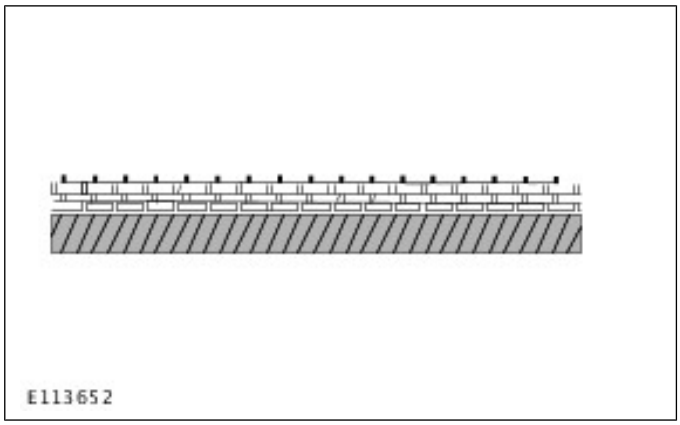
DESCRIPTION AND OPERATION



Paint layer is formed after water in the paint are evaporated in to air.



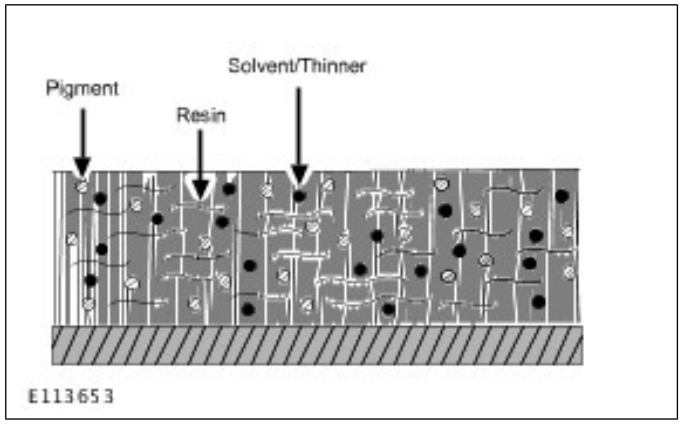
After dry-up, the combination of resin molecules does not take place.



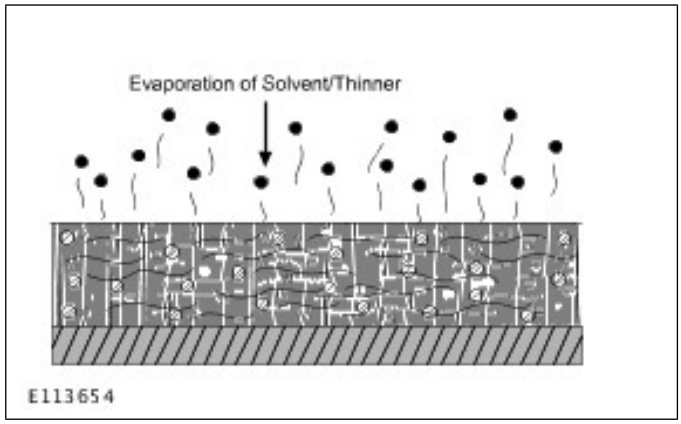
Solvent Evaporation Type

Paint layer is formed after solvent and thinner in the paint are evaporated into the air. The combination of resin molecules does not take place. If the paint layer is wiped with thinner after dry-up, the layer is dissolved. As its is inferior to reaction type dry-up paint in anti-solution and weather-proofing it is rarely used nowadays.

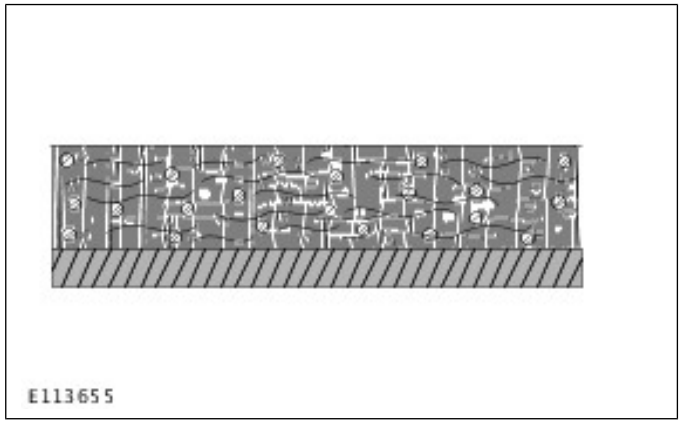
Wet film after spraying.



Solvent and thinner evaporated.



Dried film Without cross linkage among resin molecules (2 dimensions).



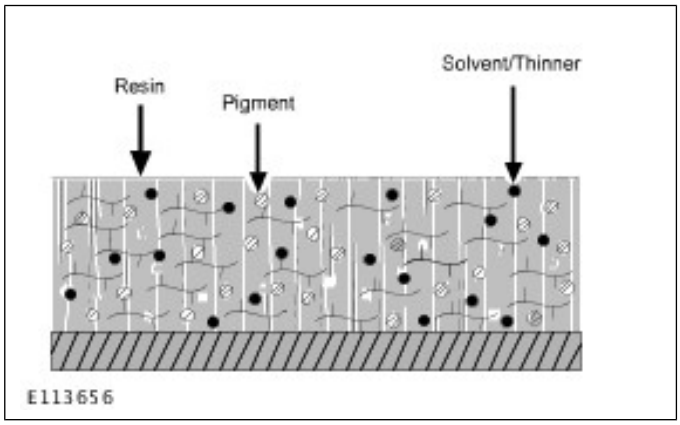
Reaction Type

Generally, as far as the reaction type paint is concerned, the finer the meshed layer surface is, the better the antiweather and anti-solution characteristics are. The important feature of the reaction type paint is that, unless something that causes chemical reaction is added, it never hardens. After the solvent and thinner in the paint have been evaporated, the resin molecules react to heat and chemicals and dry-harden to form a paint layer. Due to the chemical reaction, chemical resin compounds of a small molecular weight

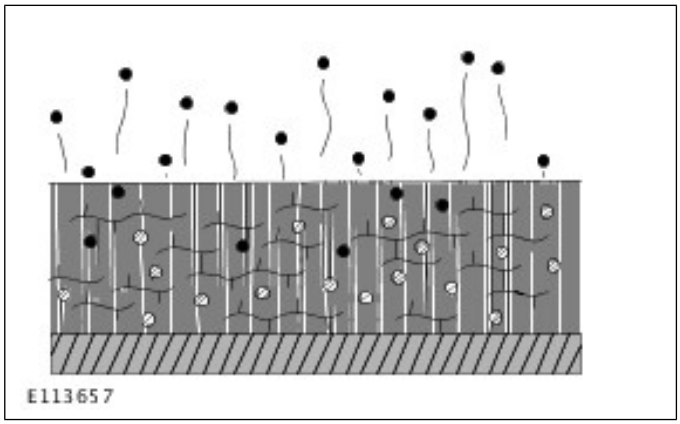
DESCRIPTION AND OPERATION

combine with each other to form compounds of a larger molecular weight. After dry up, it becomes a strong paint layer insoluble to any solvents.

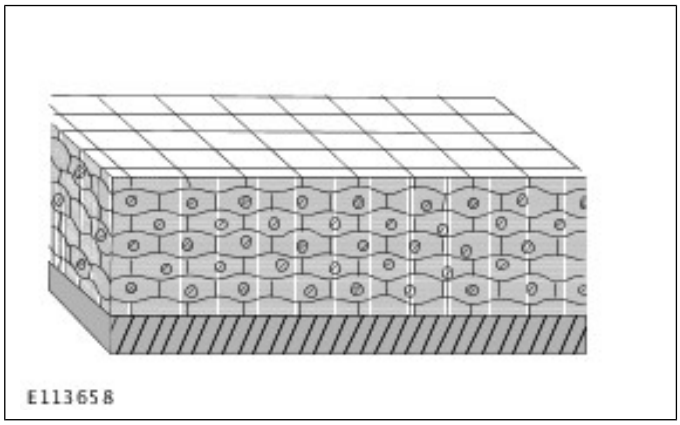
Wet film after spraying.



As soon as the thinner is evaporated, the resin molecules start to react and produce a meshed layer.



When the dry-up has been completed, the reaction of the resin molecules is finished forming a paint layer. In fact, the meshed paint layer is 3 dimensional as shown.

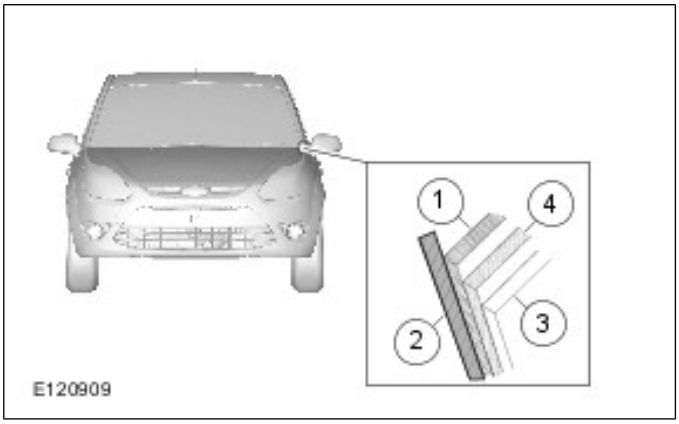


Paints for Automobiles

Performance of Paints

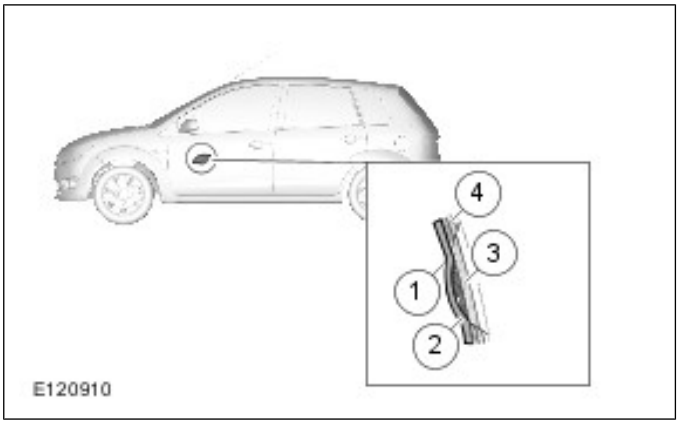
In painting a car, just one layer of paint of one kind is not enough to meet all the requirements of the paint on the car. So, in order to secure what is required of the paint, it is necessary to paint different kinds of paints on the car layer upon layer.

Example of paint composition in a new car:



Item	Description
1	Under coat (ED)
2	Steel panel
3	Top coat
4	Intermediate coat

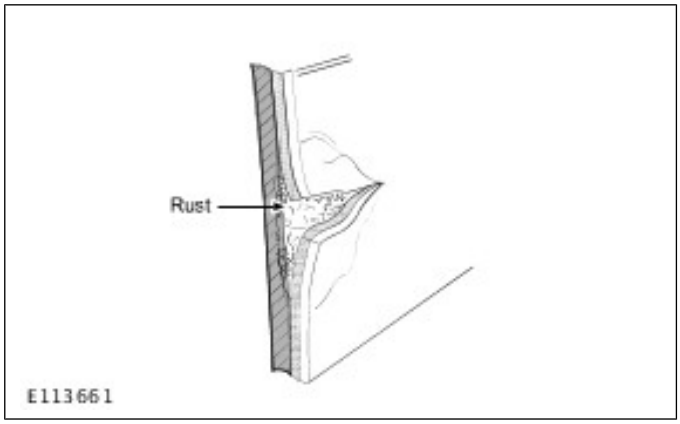
Example of paint composition after paint repair:



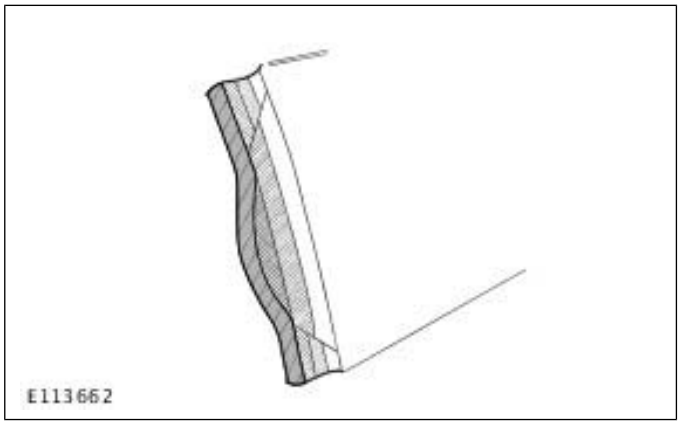
Item	Description
1	Steel panel
2	Putty
3	Under coat/Intermediate coat
4	Top coat

Anti-rust treatment: Treatment to be employed to prevent rust from growing.

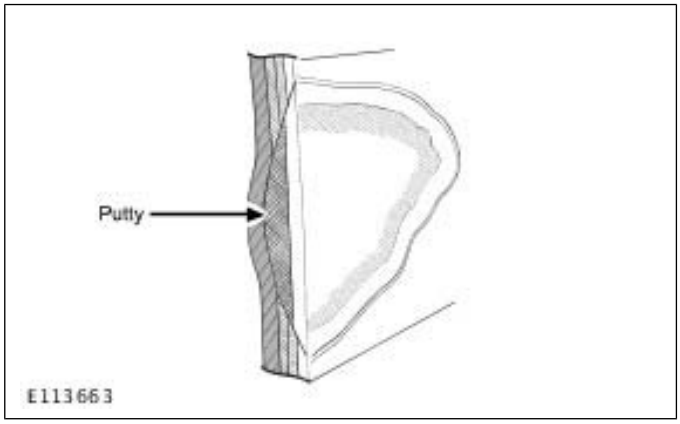
DESCRIPTION AND OPERATION



Filling: Process to fill a dent, deep scratch or cavity in undercoat.



Prevention of suck-up (sealing): If often happens that the top paint painted on the intermediate or undercoat is sucked into the lower paint layer causing its thickness to be thinner than normal or getting rid of its luster. In order to prevent the suck-up, it is necessary to coat a paint that has a sealing effect just below the top coat.



Luster: Fresh color, shining quality, appearance of smoothness, and its capacity for keeping these qualities for a long periods of time.

Adhesiveness: The quality of the paint adhering tightly to it's adjoining layer. This quality dose not allow the paint to peel off easily.

Workability: Does not take too much time for preparation, easy to paint, quick dry-up, easy to polish.

Degreasing/Washing Agent

Remove oil, grease, or fat adhered to metal surfaces, previously painted surfaces, or degrease undercoats. Remove smeared dirt on previously painted surfaces or on undercoats.

Quickly dry up. It is a solvent that has solubility of a low level and can remove oil and grease on the surfaces without corroding painted layers.

There are a few different kinds, one of which prevents defects due to static electricity and another is used only for plastic surfaces to prevent the occurrence of static electricity.

Primer

Primer has the following effects:

- Prevent rust from growing.
- Adheres well to raw materials such as steel sheet.
- Adheres well to the paint coated on it.

It is normally painted sparsely and does not need to be polished. Due to recent common use of primer surfacer, it is rarely used for paint repair now.

Epoxy Primer: Main content is epoxy resin and is normally a two-liquid mixing type. Superb in anti-rust effect and adherence, but drying time becomes so low below normal temperature 68°F (20°C), it is necessary to force-drying using a temperature of about 140°F (60°C). On line-produced cars, epoxy resin based water paint is painted in electric painting (ED painting) and dried up using a high temperature above 302°F (150°C).

Urethane Primer: Main content is urethane resin and is normally a two-liquid mixing type. Superb in anti-rust effect and adherence, but drying time becomes so low below normal temperature 68°F (20°C), it is necessary to force-drying using a temperature of about 140°F (60°C).

Wash-Primer: Main contents are a body material, in which butyrated resin is mixed with zinc chromate (anti-rust pigment), and additives of which the main content is phosphoric acid. There are two kinds of this type. One is a single liquid type and another is a two-liquid mixing type. The two-liquid mixing type is superior to the single liquid type in anti-rust capacity and adherence.

DESCRIPTION AND OPERATION

Lacquer Primer: Used as an undercoat for lacquer nitrate paint. The application of this primer improves the quick dry up time, anti-rust effect, and adherence of the layer, however, inferior to other primers in anti-rust effect.

WARNING: Avoid contact with skin. Wear an approved respirator, gloves, eye protection and appropriate clothing when painting the primer including phosphorus acid.

Putty

A material used to fill and flatten recesses such as dents or holes in the undercoat. Unlike other materials, main content is a high molecular substance so that its shrinkage rate is minimal.

It is applied using a spatula. After it has been dried up, the surface is polished.

There are a few different kinds of putties such as sheet panel putty, poly putty, lacquer putty, etc. depending upon the depth to be filled.

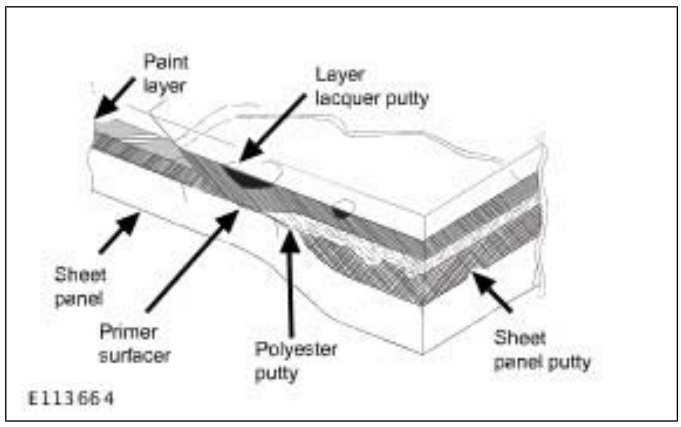
Sheet Panel Putty (Body Filler): Its main content is unsaturated polyester resin and is normally a two-liquid mixing type using organic peroxide as hardener. Usually used to fill deep dents of a 20 to 30 mm (0.8 to 1.2 in.) deep. It has cavity holes and is inferior when polishing.

Polyester Putty: Its main content is oil denatured unsaturated polyester resin and is normally a two-liquid mixing type using organic peroxide as the hardener. Usually used to fill dents of 1 to 3 mm (0.04 to 0.12 in.) deep. It is inferior in adherence to steel panel. It is not favorable to apply it directly on a steel panel.

Lacquer Putty: Its main contents are cellulose nitrate and alkyd resin. Used to fill dents and scratches of less than 0.2 mm (0.08 in.) deep.

NOTE: At present, a new putty called “Intermediate putty” is now being developed that is good in thick application, fast drying time, high adherence to other materials, easy polishing that is owned only by ester putty, and molding.

Limit of putty thickness at a time: According to types, the thickness of putty application is different.



Primer Surfacer

Primer surfacer plays a role between a primer and a surfacer. However, recent primer surfacer is required to be more of a surfacer.

- Anti-rust effect (required of primer)
- Smoothness effect (required of surfacer)
- Anti-suck up effect (required of surfacer)
- Adherence effect (require of both primer and surfacer)

Lacquer Primer Surfacer: Its main contents are nitro cellulose and alkyd resin. Because of its characteristics of quick drying and superb polishing effect, and workability. As it is inferior to two-liquid mixing type in the quality of the paint layer.

Urethane Primer Surfacer: A primer surfacer of a two-liquid mixing type that needs to get mixed with hardener before being used. Because it is not soluble to thinner after hardened, it has a high sealing effect. As it is slow in drying up, it is preferable to use forced drying.

Heat Hardening Amino Alkyd Primer Surfacer: It is a heat hardening type of paint and is used for panel paint repair. It needs to be baked at 230 to 284°F (110 to 140°C) for 20 to 40 minutes and, after that, dried up. The same level of paint effects as that of a new car is obtained through the use of this primer surfacer.

Surfacer: Rather than acting by itself, it improves the adherence of the primer and the top coat to each other, their durability, and anti-water penetration effects. Further, in order to make the top coat more shiny and beautiful, this is used to get rid of sandpaper scratches on the putty surface and to fill small scars and cuts on the undercoat. Because of the wide spread of the use of primer surfacer, it is now being replaced by primer surfacer.

DESCRIPTION AND OPERATION

NOTE: Use urethane primer surfacer for repair work in order to maintain the same paint quality as in mass production vehicles.

Sealer

Depending upon the purpose of using a sealer, several kinds of sealers are separately selected to use.

- To prevent blotting of paint.
- To prevent shrinkage of paint.
- To prevent suck-up of paint.
- To improve adherence between paint layers.
- Because defects caused by blotting, shrinking, and suck up can be prevented by the use of urethane primary surfacer, sealer is rarely used for these purposes. The type of sealers that is coated to hide minor color defects, such as of red and yellow, on top coat is called color sealer or color base.

NOTE: The sealer used for improving adherence effect may cause adhering defects if it is used where polishing is hard to do. It is, therefore, necessary to make sure of its capacity of adherence beforehand. Also the use of it should be limited to minimum.

Top coat paint

The paint painted as the upper most layer on a car panel is called “top coat” and processed at the end of final painting processes to maintain the external appearance. The top coat, with lots of resin content, gives color to the panel surfaces and retains luster of the paint. The weatherproof characteristic is well considered so as not to change color or lose luster.

Constant Dry-up Type (Lacquer Family): This type of top coat is dried up after its solvent evaporates without any chemical reaction taking place. Depending upon differences of resins contained, they are categorized into NC lacquer, NC acrylic lacquer, and CAB acrylic lacquer. They have been used as panel repair paint for long years, but they have been now replaced with a top coat of a two-liquid mixing type.

Two-liquid Mixing Type (Urethane Family): The main content of this paint is urethane resin that is a product of a chemical reaction between poly-al and isocyanine and called as such because it contains urethane compounds in it. It is also termed a two-liquid mixing urethane because the paint is mixed with hardener before being applied. Depending upon the types of resins used and the length of dry up time, they are divided into three types.

Acrylic urethane lacquer: Because isocyanine is used as a hardener in the same way for the two-liquid mixing type acrylic urethane, it provides the same level of adherence and weatherproofing effects as urethane paints. Its workability especially in quick drying up time is better than those of other urethane paints because of the higher molecular weight of its main content and low hardener content ratio. The use of this paint requires vigilance later when a re-painting work or a two tone color overlapping painting work is done. Because there are two contents existing together in the painted layer, one that is soluble to solvent and another not soluble to it. If the repainting or two tone color work proceeds relying only on the surface hardness, it may happen that a stain may remain when a tape is adhered to the surface. It is used at a painting shop not equipped with a painting booth or dryer, but in fact, it is now being replaced with acrylic urethane paints.

Standard Acrylic urethane: A two-liquid mixing type with a main content of acrylic resin that has good weatherproofing and isocyanine as its hardener. Because of the three dimensional structure formed by the reaction between the two liquids, the paint layer formed after dried up is extremely strong, but its drawback is that it takes 68°F (20°C) x 12 hours for drying up. Therefore it can be said that its workability is inferior to lacquer family paints. If forced-drying is used, it can be dried up in about 140°F (60°C) in 1 hour. The same level of paint quality is obtained. Because the luster after drying up is superb and, in addition, no polishing is required, it is widely used for painting a wide area of painting including a whole car.

Quick drying acrylic urethane: The characteristic of acrylic urethane are retained improving, its workability. This paint is painted with isocyanine as its hardener added to the body content of acrylic resin. Because of its quick drying and good layer qualities, it is now most widely used.

Painting Methods

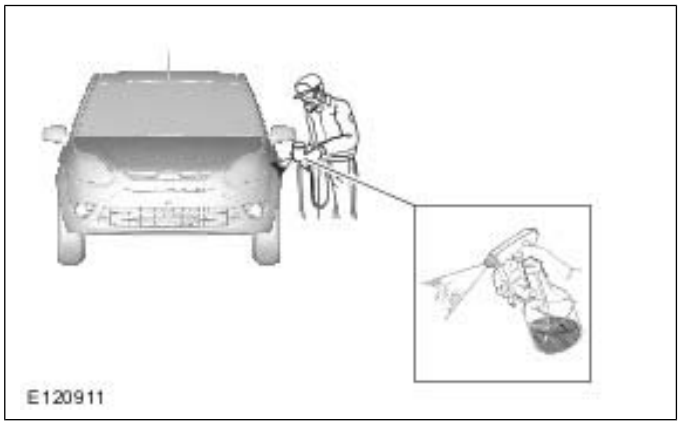
Spraying Painting

Using a spraying force, paint is sprayed over an object to form a paint layer. Air spraying painting, airless spraying painting and electro statistic painting belong to this category.

DESCRIPTION AND OPERATION

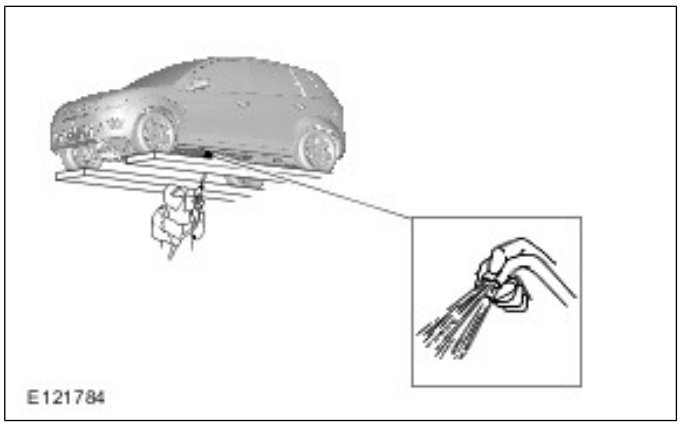
Air Spraying Method

Making use of the principle of an atomizer and by the force of compressed air, paint is sprayed over an object to be painted to form a paint layer. In spite of some paint to be wasted, it is widely used for minor painting jobs, as it is easy to do paint jobs without any particular facility. As even a complicated surface of the panels can be painted beautifully, it is the most ideal way for panel paint repair.



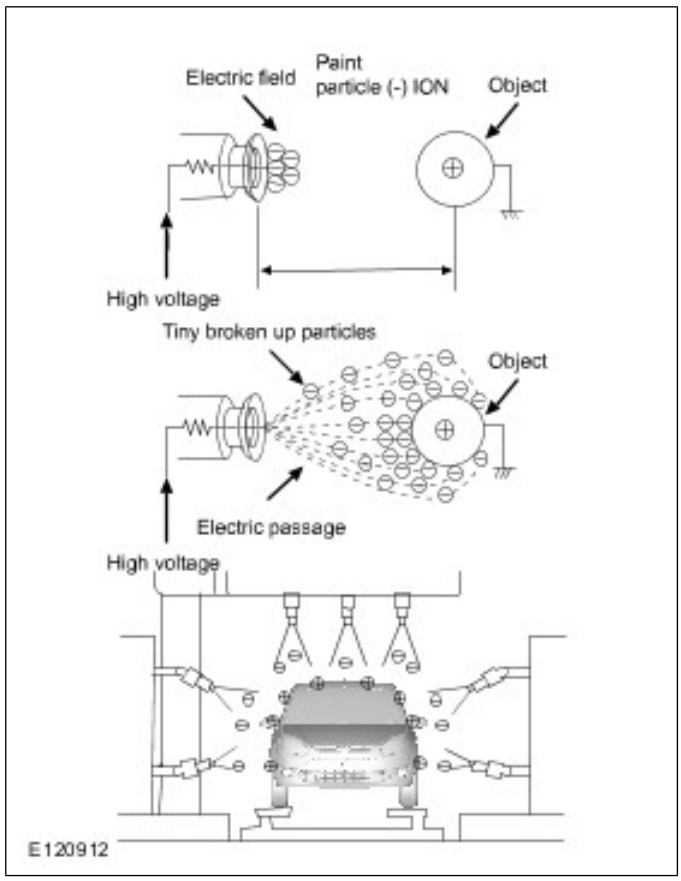
Airless Spraying Method

High pressure is added to the paint to let it spray out from a small nozzle over an object and make the paint layer on the object. Because less air is mixed with the paint, the wasted splash of paint is minimized and at the same time, the paint of a high viscosity can be sprayed. As compared to the air spraying, the sprayed surface is not as smooth so that this method is mostly used for under body coating.



Electrostatic Painting

By connecting the grounded object to be painted to the plus terminal (+) and the paint spraying device to the minus terminal (–), and turning on electricity of –60 kV to –120 kV, make an electro statistic field between the two terminals. The paint particles coming out of the paint spraying device are broken up and made tiny while they repel each other and are attracted to the plus (+) terminal and attached to the object to be painted. Because the paint is electrically attracted to the object, the loss of paint is minimal. Because the paint particles are broken up due to electrical repulsion, the surface of the paint layer is superb and, therefore, this method is used for intermediate and top coating on mass-production line through the use of automatic electro statistic painting machines.



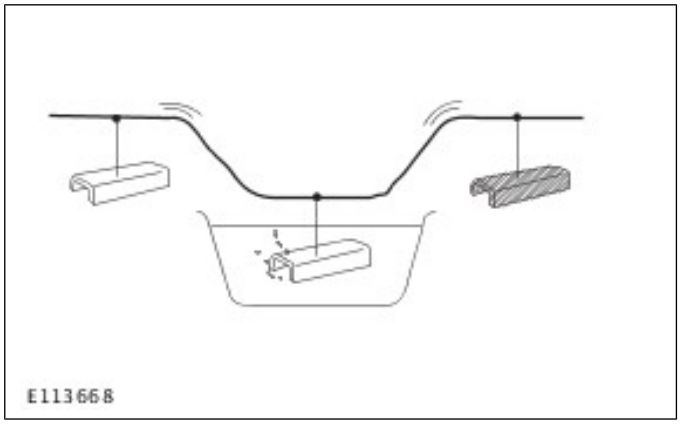
Permeating Painting

The object to be painted is dipped in the paint in a tank. There are two types of this painting method. One is the dipping painting and another is the electro deposition painting.

Dipping Painting Method

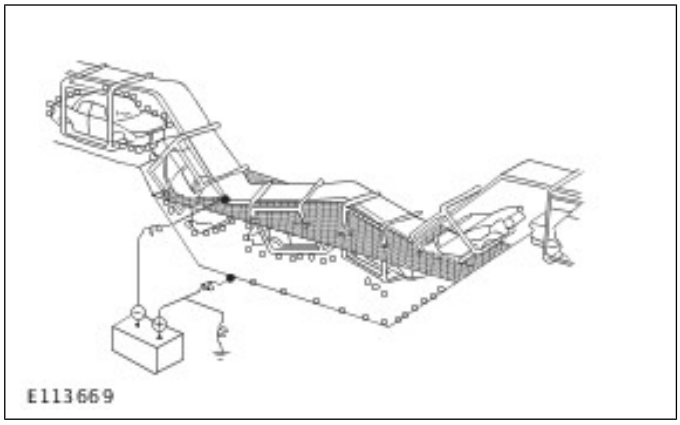
As, by dipping an object to be painted into the tank, the whole surface is painted at one time, this method is ideal for a massproduction process. Though the loss of paint is minimal, due to the movement of lifting the product from the tank, the difference of paint layer thickness is significant depending upon places of the object. Depending upon the sectional shape of the object, it may happen that part of it is not painted as desired.

DESCRIPTION AND OPERATION



Electro Deposition

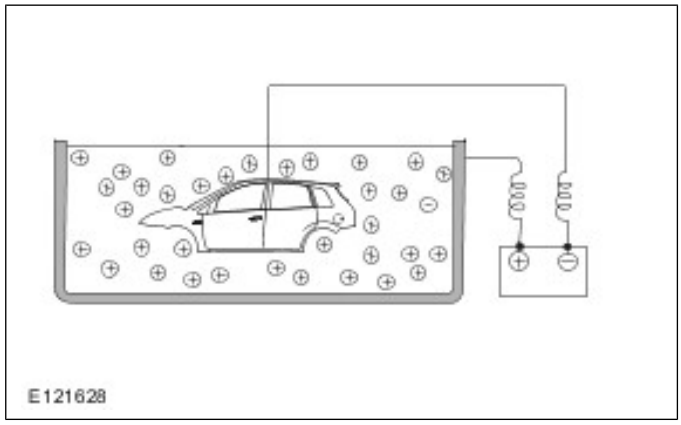
With the object to be painted in the paint tank, electricity is turned on to the object to be painted and paint. By so doing to electrically paint the object, an even paint layer is formed on it. Another advantage of this method is, because the paint layer thickness is electrically controlled, even a surface with a complicated section can be evenly painted without any paint flow mark. There are two kinds of electro deposition paintings. One is the cation electro deposition painting and another is the anion electro deposition painting. Cation electro deposition painting: The painted object to the minus terminal and the paint to the plus terminal connected. Anion electro deposition painting: The painted object to the plus terminal and the paint to the minus terminal.



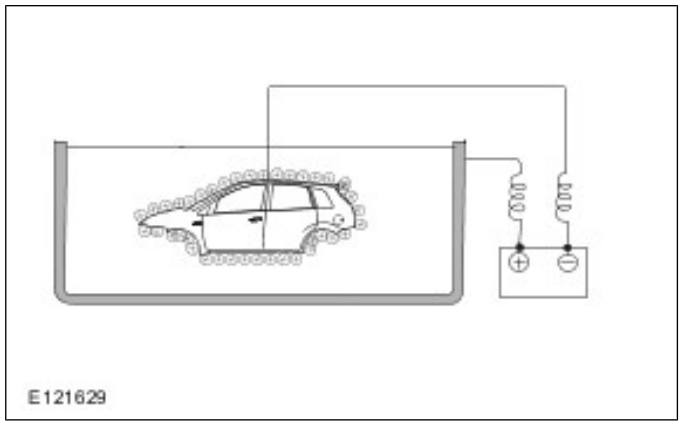
Pointing Process

On actual car production line, the cation electric deposition method (body-minus terminal) is employed because, if the anion electro deposition method is used, phosphoric zinc paint layer attached during the process of chemical treatment line is attracted to the minus terminal on the paint, thus making this layer thinner and, as the result, its anti-corrosive effect is decreased.

1. When a direct-current electro-loaded object is dipped in the electro-loaded paint fluid, the paint moves toward and attaches to the object by to electrophoresis.



2. Once the paint is attached to the object; it loses its electric charge, thus forming a paint layer. The water in the attached paint is dehydrated, thus forming a hard paint layer without any water content in it.

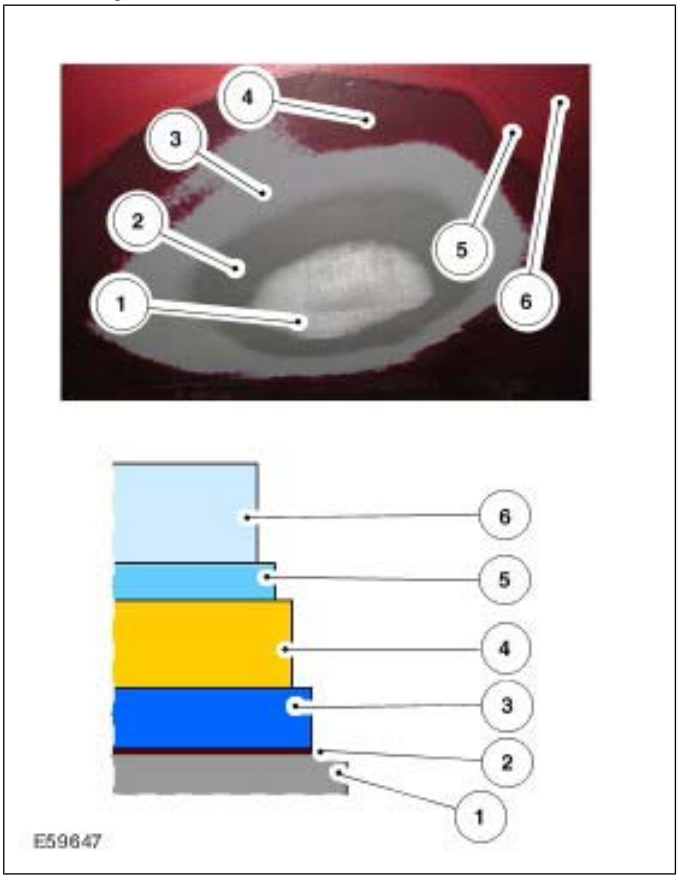


The structure of an original paint finish

During construction of the original paint, a total surface thickness of between 120 and 130 µm is achieved. The thicknesses of the layers may vary however, because they are greater for horizontal surfaces than vertical ones.

DESCRIPTION AND OPERATION

Paint layers

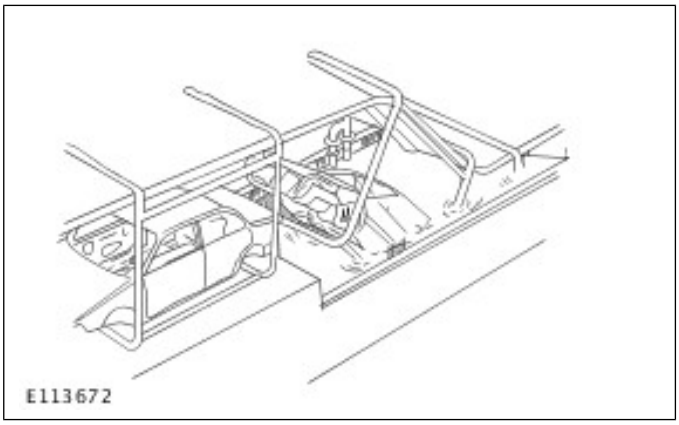


Item	Description
1	Steel panel
2	Phosphate layer 2.9 g/m², corresponding to 2 µm.
3	Cathodic dip paint 30-35 µm
4	Filler 30-35 µm
5	Base paint 15-20 µm
6	Clear varnish 55 µm

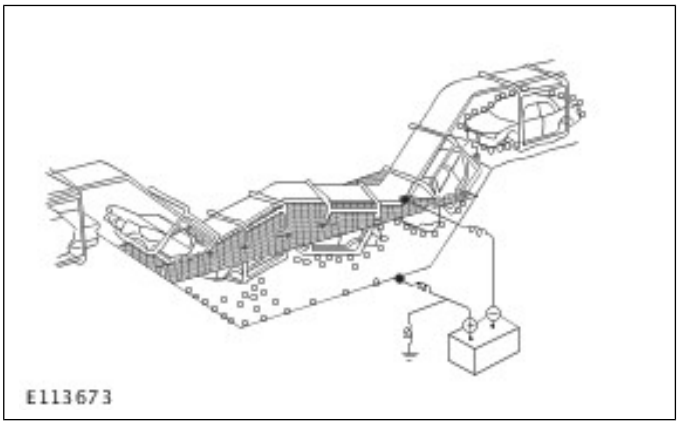
Painting Processes on Production Line

The major requirements demanded in body painting on a new car are good external appearance, durability, and anti-corrosiveness, all of which contribute greatly to the quality and commercial value of the car. In the painting work line are the chemical treatment and undercoat processes for the purpose of improving anti-rust characteristics and durability and the intermediate and top coat painting process to produce finishing external appearance. In addition to all these, there are several other processes to maintain the high level of quality.

1. **Chemical treatment process:** Employing the full dipping method, a whole body is submerged in the alkali tank to get rid of oil, fat, grease, and other impurities followed by another full dipping in the tank to form a crystallized phosphoric zinc layer.

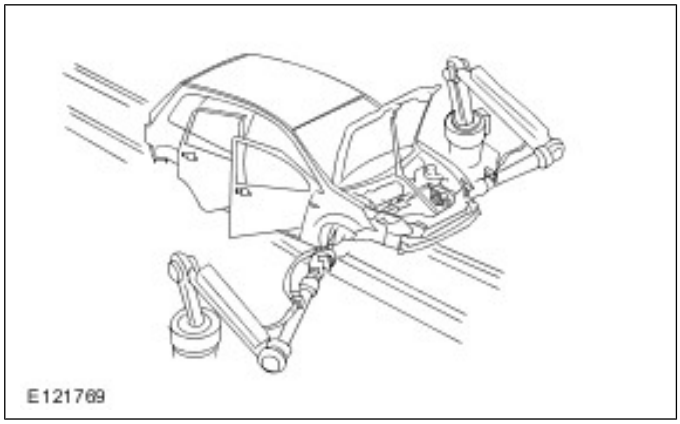


2. **Undercoat process:** In order to improve the quality of durable anti-rust characteristics, a whole body is, again, dipped in the paint tank for electro disposition painting so that a good paint layer is formed everywhere on the inside of the body. Epoxy resin paint is used as the electro deposition paint.

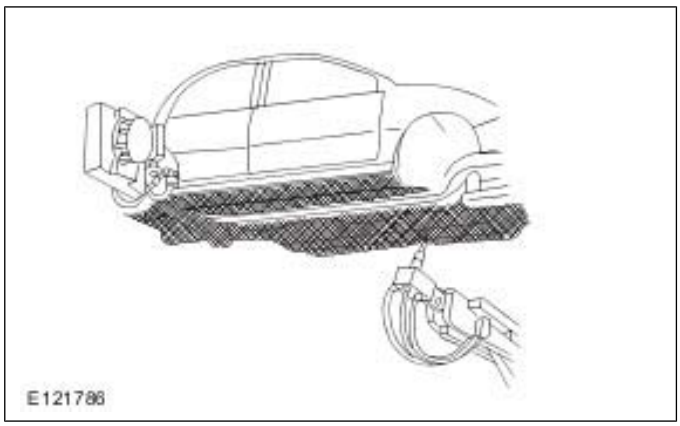


3. **Sealing process:** Using a press-feeding sealer gun, apply sealer along the body component welding joints, parts mating joints, and hemmed area such as at the doors. Sealing those areas secures water-tightness, anti-rustiness, and anti-dustiness within the panels of the body.

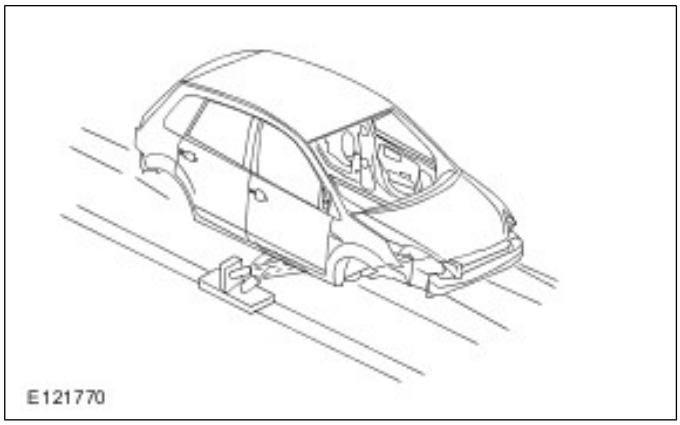
DESCRIPTION AND OPERATION



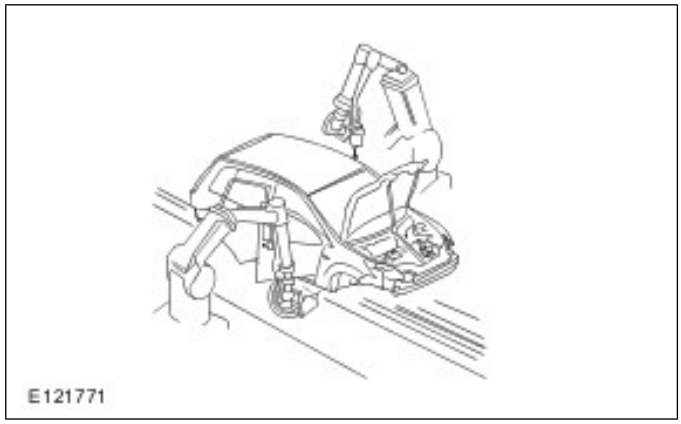
4. **Undercoat painting process:** Apply PVC (polyvinyl chloride) over the under body areas including the wheelhouses. This process not only protects the under body from chipping caused by flying stones, but also improves anti-noise, anti-vibration, and heat insulation effects.



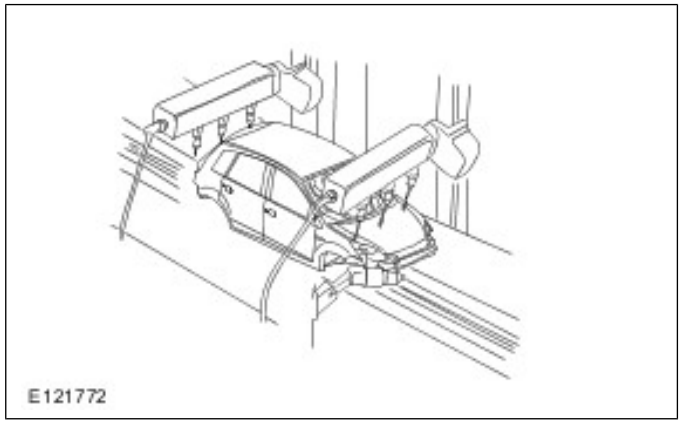
5. **Hard chipping painting process:** Apply chipping primer on the side sills to protect them from the paint damages caused by flying stones.



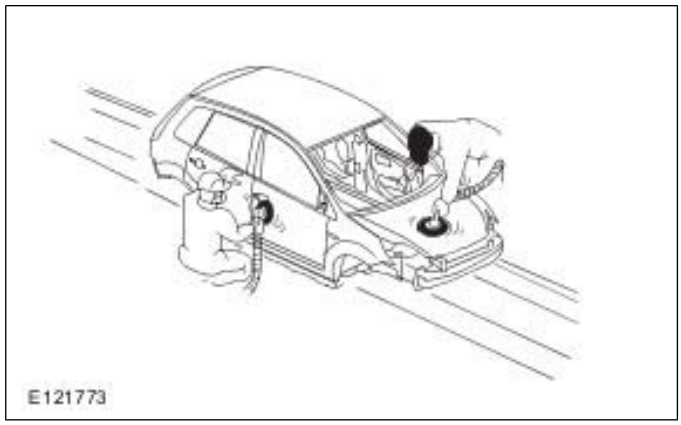
6. **Soft chipping painting process (for seaside-area cars only):** Apply soft chipping primer along the edge of the engine hood, roof, and doors. To prevent damages on painting layer due chipping.



7. **Intermediate painting process:** Secure necessary thickness of paint in order to maintain luster and brightness of the painted surface as a whole including the top coat. A Mini-bell automatic painting machine is used to secure even painting.



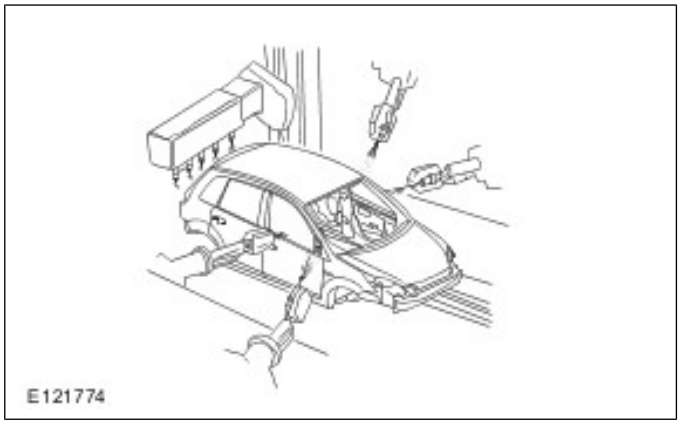
8. **Intermediate polishing process:** Polish the surface of the intermediate paint layer to improve the smoothness and good adherence to the top coat.



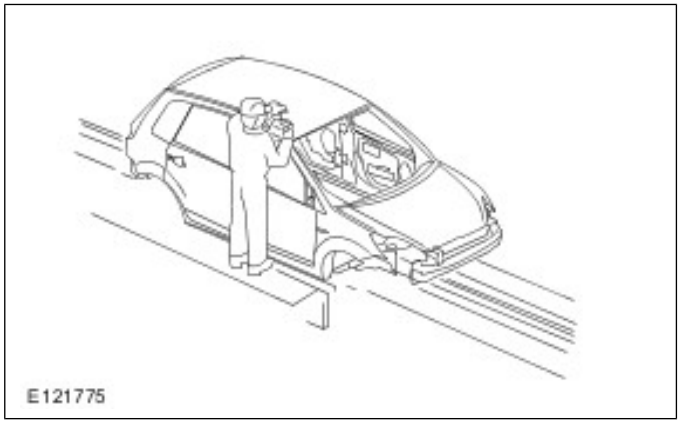
9. **Top coat process:** Making use of the automatic painting robots, apply enamel paint on the inside and outside of the body. For metallic color or pearl color cars, clear painting is carried out after the enamel painting. For the top coat painting, the highest quality acrylic paint or water-soluble paint is used to improve not only

DESCRIPTION AND OPERATION

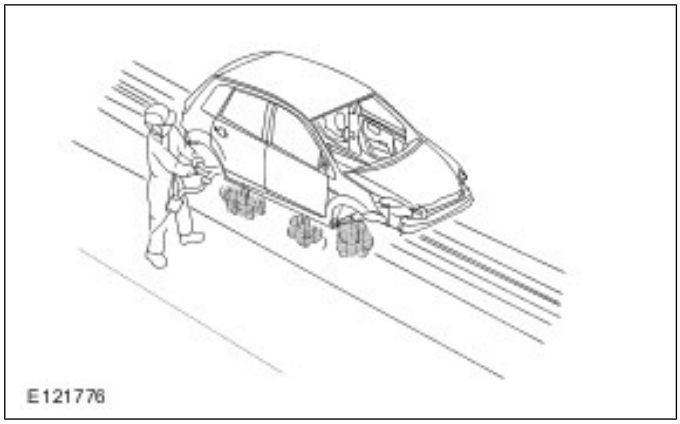
anti-rustiness but also to heighten its commercial valve.



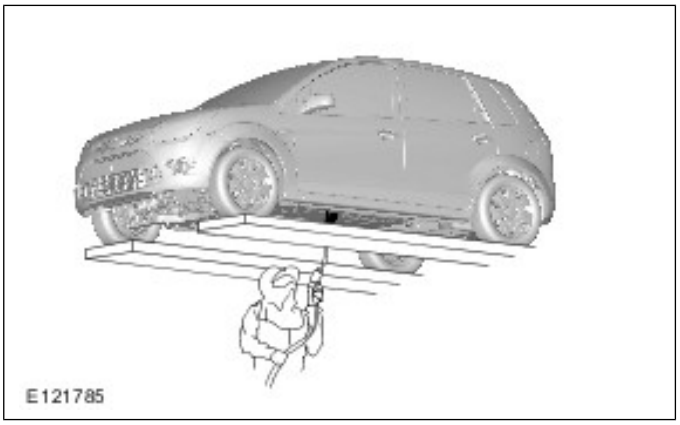
10. **Painting final inspection process:** In accordance with the judgment criteria, inspect the results of the painting process. The state of paint layers, the thickness of the paint layers, the paint hardness, the level of adherence between the layers are inspected visually as well as through measurement by use of measuring devices.



11. **Inside anti-rust process:** Apply special zinc-based anti-rust paint or wax on the major areas that require anti-rust treatment using a spray gun to further heighten the anti-rust quality.



12. **Completed car anti-rust process:** Anti-rust treatment is carried out on both the outside and inside panel surface. Using a special wax-applying gun, wax is applied even on the farthest corners of the tailgate, door panels, and the body to maintain durable antirust quality.



Painting process and corrosion protection.

In production, painting consists of individual steps which are optimally matched to each other.

Bodywork consists almost entirely of steel panels which have been pre-coated with zinc. The zinc layer is between 5-10 µm thick and acts as the first corrosion protection layer of the steel panel.

Production sequence:

- Clean and de-grease
  - In the first step, the bare bodywork is initially dipped in a cleaning bath and cleaned with a degreasing solution.
- Phosphatising
  - The cleaned bodywork is dipped in a bath containing various phosphate salt solutions. This creates a crystalline metal-phosphate layer which offers the optimal prepared surface and also corrosion protection.

DESCRIPTION AND OPERATION

- CDP base
  - The cataphoretic dip paint (CDP) base acts as a further corrosion protection layer.
  - In this process the bodywork is completely immersed in a bath consisting of a paint and electrolyte solution.
  - By application of an electric voltage, an electric field is created.
  - Positively charged paint particles settle on the negatively charged bodywork and form a protective layer up to 20 µm thick.
  - Next the bodywork is placed in a dryer, where the CDP base is hardened at 180°C.
- Sealing, stone-chip protection
  - Edges, seams and but joints are sealer with a sealing compound.
  - Vulnerable areas are coated with stone-chip protection.
- Filler
  - Filler protects the body panels from stone impacts. Furthermore, any unevenness of the metal surface is flattened out, in order to create the most homogenous and fault-free undersurface possible.
  - Once the filler is dry, it serves as the base on which paint is applied.
- Top coat
  - The top coat is applied as a single layer or two layers of paint.
  - When working with two layer paint, in the first job step the initial colored base paint is applied. In the second job step, a clear lacquer is applied, giving the base paint shine and hardness.

Colored fillers applied in production

Filler which gives color is used in production. Its use makes the base paint and clear varnish unnecessary on certain vehicle interior surfaces (engine, doors).

Not every exterior paint has its own matching filler. It is more that the tones of the filler are color compatible, i.e. they have similar intensity to the top coat.

During repair painting the filler color tones must be used according to the manufacturer's instructions.

DESCRIPTION AND OPERATION

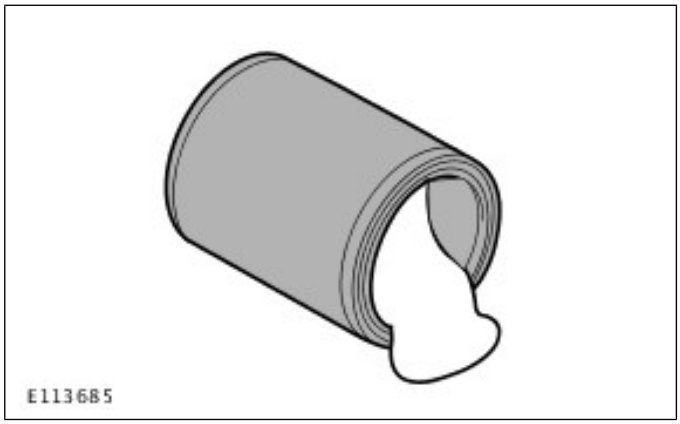
Paintwork Defects and Damage

Claims on Pre-paint condition

Gelling (Increased Viscosity)

Paint loses fluidity causing gelled paint or increased viscosity of the paint.

Paint partially or entirely reacts and hardens, leading to gelled paint.



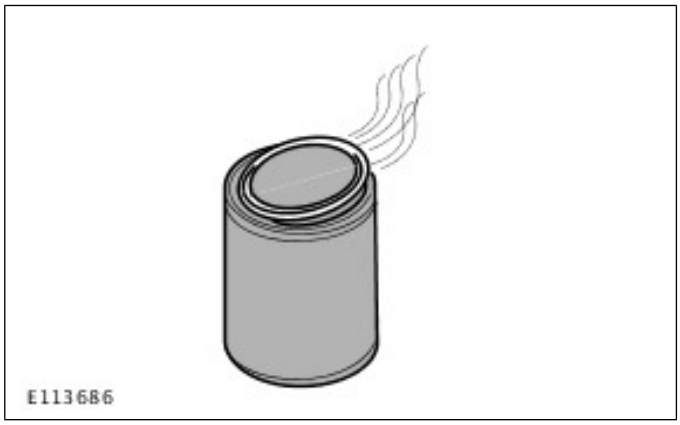
Causes

Prolonged storage in high temperature place

Paint can (container) not sealed with the lid securely, allowing the solution to evaporate and water to enter the can.

Paint mixed with a different brand of paint or curing agent before storage

Diluted with improper thinner



Countermeasure:

Seal the paint can (container) with the lid securely, and store it in a cool 68°F (20°C or below) dark place.

Avoid mixing the paint with a different brand of paint, curing agent and improper thinner.

Action:

Discard

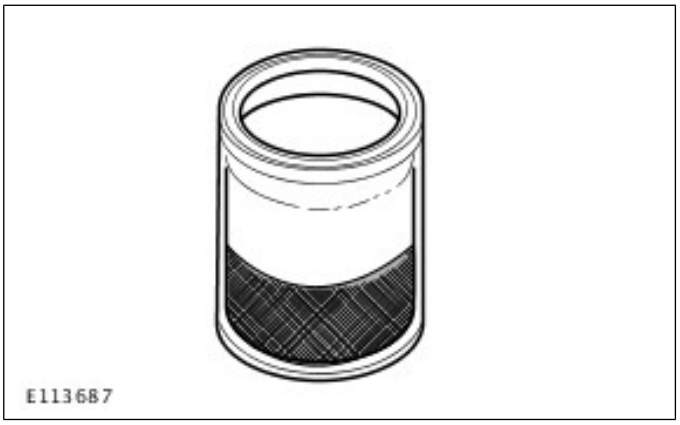
If the paint is a lacquer type and increase in viscosity is small, it can be used by stirring up the paint well and diluting it with the recommended lacquer thinner.

Sedimentation (Caking)

Pigment of the paint is settled in the bottom of the can.

Hard deposit: Hard caking

Soft deposit: Soft caking



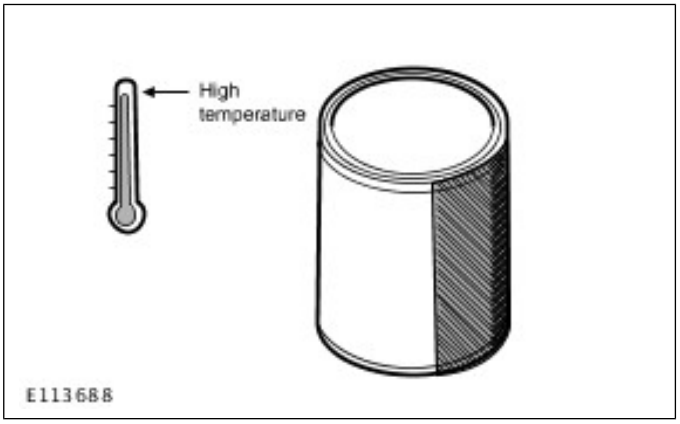
Causes:

Prolonged storage in high temperature place

Specific gravity of the pigment too large

Paint pigment proportion too large

Paint viscosity too low



DESCRIPTION AND OPERATION

Countermeasure:

Store the paint in a cool 68°F (20°C or below) dark place. If it is stored for a prolonged period, invert the can periodically.

Do not store the thinner-diluted paint for a prolonged period. Stir it up thoroughly before reuse.

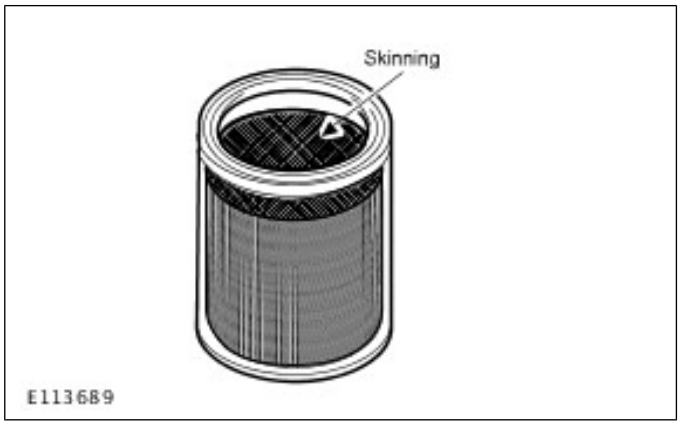
Action:

Discard the hard deposit (hard caking). If the deposit is soft (soft caking), stir it up thoroughly to make the density equal in the can before reuse.

Skinning

Paint surface gets skin on top of it.

It tends to appear on the air-dry type paint. Paint surface gets hardened by the oxygen in the air, creating the paint skin.

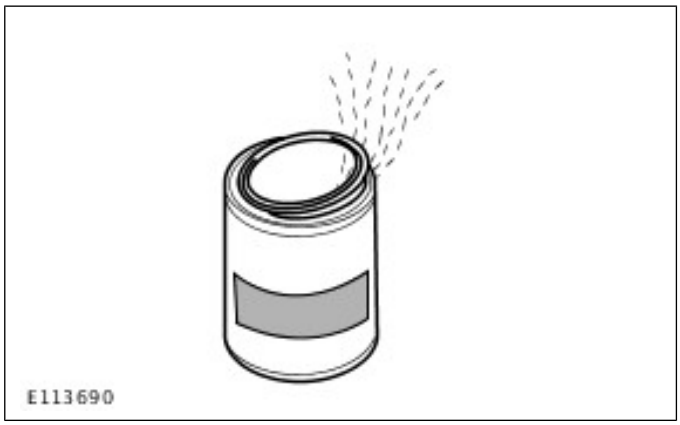


Causes:

Can not sealed with the lid securely.

Prolonged storage in high temperature place

Paint volume in the can decreased, causing increased space ratio in the can (air-dry type)



Countermeasure:

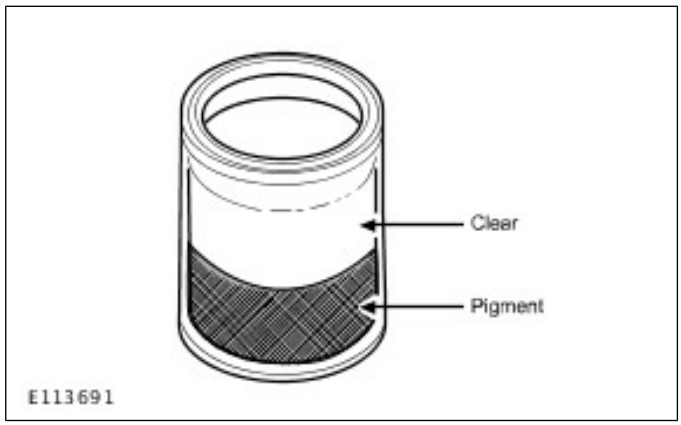
Seal the can with the lid securely and store it in a cool 68°F (20°C or below) dark place.

Action:

If the paint skin is thick, discard the paint. If it is thin, remove the paint skin, stir it up thoroughly and filtrate it before reuse.

Separated Varnish (Clear-up)

Paint containing pigment separates into two parts during storage producing the clear part in the upper part of the can, and the pigment in the lower part of the can.

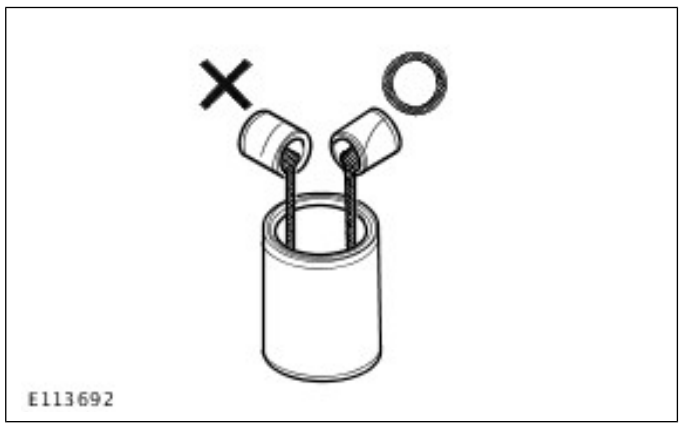


Causes:

Prolonged storage in high temperature place.

Paint viscosity too low.

Paint mixed with a different brand of paint.



Countermeasure:

Avoid prolonged storage in high temperature place. If the paint is stored for a prolonged period, invert the can periodically.

Do not return the paint diluted with the thinner to the original can.

DESCRIPTION AND OPERATION

Action:

Stir up the paint thoroughly before reuse.

Diagnosis and Damage Assessment

Paint concerns, regardless of their causes, are part of the everyday work in the paint shop. Correct damage assessment and determination of the cause are preconditions for a professional resolution of a paint concern.

Paint concerns can still occur through a variety of causes, despite improved paint materials and new spray methods.

NOTE: A first appraisal of the paint damage should be done before cleaning. External factors such as rust, droppings, incorrect or insufficient paint care can then be more easily detected.

Diagnosis is best done in daylight but not in direct sunlight. Exact evaluation can also be done under artificial light from special luminescent lamps.

Paint damage guide

The most important paint damage concerns which make a paint repair necessary are:

- Damage from biological paint contamination such as bird or insect droppings, tree resin and aphids.
- Chemical paint damage caused by industrial contaminants such as smoke, fuel, acids, oils.
- Mechanical damage caused by stone impact during operation, scratches in the car wash and parking.
- Damage caused by faults in treatment. Application defects such as paint runs or orange peel.
- Dirt inclusions in the paint layer, e.g. caused by dust in top coat or textile lint.
- Damage due to corrosion.

Before repair of such paint concerns, exact diagnosis must be performed to determine the cause exactly. On the spot diagnoses using simple aids and processes are often enough.

Diagnosis without disturbing the paint is done by:

- Optical inspection without visual aids, under suitable light conditions from a suitable angle and correct distance.
- Optical inspection with the help of a magnifying glass.
- pH paper.
- Measurement of the thickness using FE / NFE coating thickness meters for ferrous (FE) and non-ferrous metals and non-magnetic steel (NFE) - magnetic process on steel panels, eddy current process on non-metals.

A test method where the traces of testing can be easily removed again is the finger nail test. With suitable experience the existing hardness of the paint can be determined.

Test methods where the paint is partially destroyed are:

- Pencil hardness test.
- Adhesion test using adhesive tape.
- Lattice cut test process to check the strength of adhesion.

Under certain circumstances these test methods are not enough for a certain diagnosis. In this case, paint diagnosis under laboratory conditions must be performed.

Measuring and testing equipment for painted surfaces

Coating thickness measuring devices

Magnifying glass

pH paper (together with water)

Suitable photographic equipment with macro lens

Shine measuring equipment

Paint damage caused by environmental factors

- Bee droppings
- Bird droppings
- Insects
- Tree resin and sap
- Aphid secretions
- Tar spots
- Cement, plaster and slaked lime
- Rust film/deposits from industrial fallout
- Battery acid
- Brake fluid

In all the cases of paint damage described below, if the damage is irreversible a new paint finish must be applied.

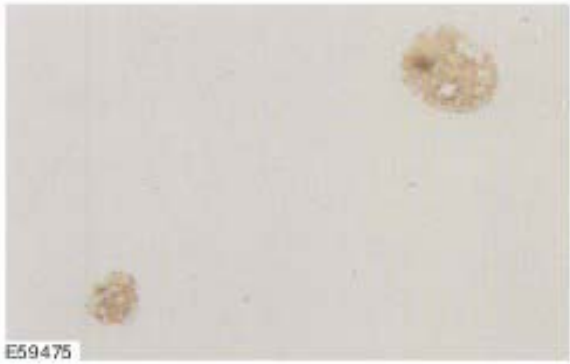
DESCRIPTION AND OPERATION

Paint damage cause by bee droppings

Bee droppings can be recognized on a paint surface through its yellow or brown color and sausage or drop-like shape with a diameter of 3-4 mm.

Cause/damage pattern:

- In combination with heat and high air humidity, bee droppings leave discolorations and cause paint decomposition.
- The paint can be destroyed down to the filler.



Repair of damage:

- If the damage is light, perform a polishing repair.

Paint damage caused by bird droppings

Bird dropping damage appears most often as matt, etched topcoat areas of various sizes. If left on the vehicle for a long time, crack formation and etching down to the filler will occur.

Cause/damage pattern:

- Bird droppings are particularly harmful in combination with heat and moisture. The urea (white part) has a very high salt content and is very aggressive.
- The intensity of the damage varies depending on the type, quantity, contact time and extent.
- Cracks, etching, marks up to dissolution of the top coat are the results.

Repair of damage:

- If the damage is light, perform a polishing repair.

Paint damage caused by insects

At insect impact locations on the hood, roof and bumper, small etched or etched through paint marks with partially visible spots of filler.

Cause/damage pattern:

- The top coat layer is destroyed in a short time by surface swelling and etching.
- Colliding insects stick to the paint surface. In combination with moisture and heat, because of the resulting acids the insect bodies sink into the paint top coat.
- The corrosion is G, C, U or O shaped and is only a few millimeters thick.

Repair of damage:

- Wash the vehicle, treat the affected area with insect remover. Clean the paint surface several times.
- Protect with hard wax.

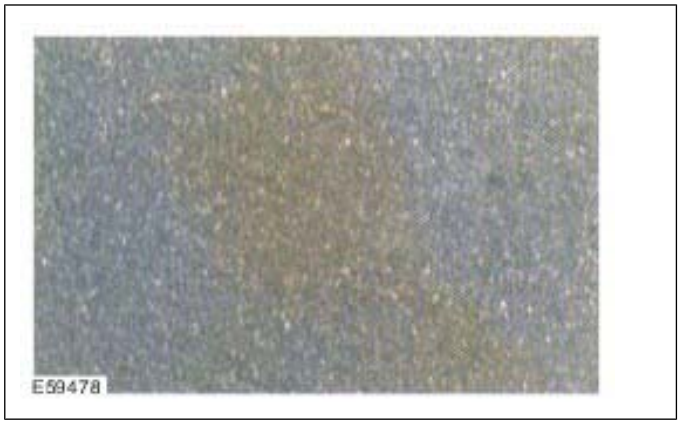
DESCRIPTION AND OPERATION

Paint damage caused by tree resin or sap

Small yellow-brown marks or drops on the horizontal parts of the vehicle. The drops melt in sunlight. Resin damage only occurs in the warm summer months.

Cause/damage pattern:

- Because of their chemical composition, tree resins combine with or adhere very well to paint top coats and cause them to swell. The higher the temperature, the more intensive is the chemical bonding between the resin and the paint topcoat surface.



Repair of damage:

- Soak several times using a cloth saturated with a petrol & paraffin mixture.

NOTE: After successful cleaning the top coat must be preserved.

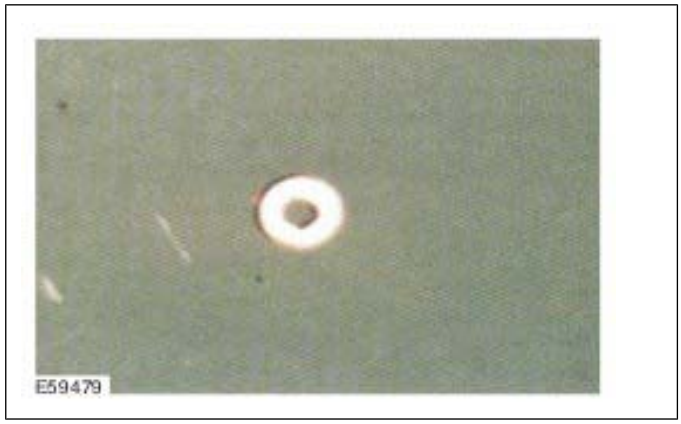
- Swellings can be removed by warming.

Paint damage from aphid secretions

Small, round, matt marks about 1 mm diameter and etching with small islands down to the filler. Fresh aphid excrement looks like small drops of honey.

Cause/damage pattern:

- Aphids produce a mixture of starch, leaf acid and sugar from sap in leaves. Under the effects of warming and moisture this can turn into alcohol.
- The round shape of the damage and the island of intact paint are typical.



Repair of damage:

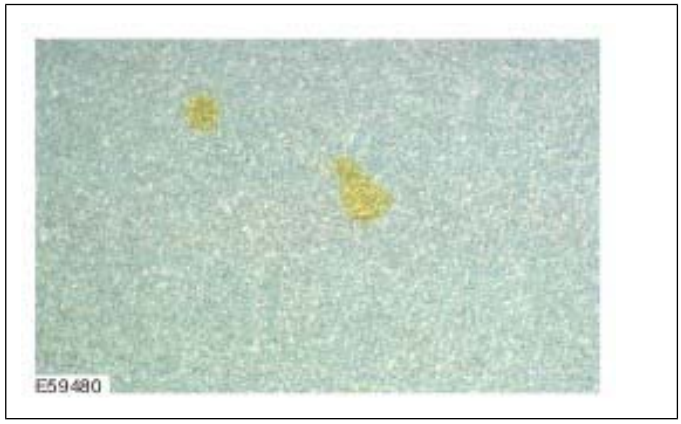
- Remove the excrement as soon as possible.
- Small single matt locations without etching can be repaired using a polishing repair.

Paint damage caused by tar spots

Yellow or dark marks.

Cause/damage pattern:

- Firmly stuck spots of tar which lead to discoloration of the surface. In some cases penetration through the clear lacquer into the top coat.



Repair of damage:

- Clean the paint surface with tar remover and polish.

Paint damage caused by cement, plaster and slaked lime

Damage appears as whitish matt marks on the top coat.

Cause/damage pattern:

- Corrosive alkaline compounds interacting with moisture.

DESCRIPTION AND OPERATION

Repair of damage:

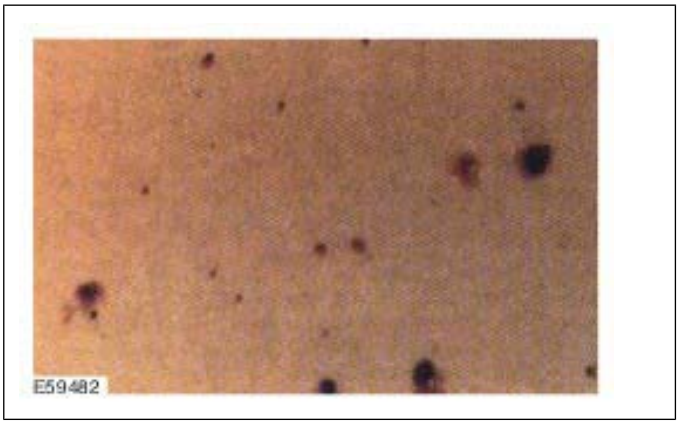
- Wash immediately if the contamination is fresh.
- If the contamination has dried on, dissolve and neutralise it with vinegar, then thoroughly wash off with water and rinse.
- Rectify mild damage using a polishing repair.

Rust film/deposits from industrial fallout

Small round marks, about 1 mm in size, in all shades from black, grey, blue to reddish, on the horizontal surfaces of the vehicle.

Cause/damage pattern:

- Deposits from oil fired systems and industrial plant, especially at high humidities and inversion weather conditions, cause damage to the paint top coat.
- As the activity time increases so called rust halos form. They spread as long as the deposits corrode.
- Industrial fallout containing iron will no longer be removable after a few days!



Repair of damage:

- Remove the dust using an industrial fallout remover and thoroughly wash.
- Polish the paint surface.

NOTE: Never try to remove the particles of industrial fallout by polishing or rubbing!

- Use cleaning dough.

Damage caused by battery acid.

Splashes of battery acid caused by carelessly topping up the battery.

WARNING: Batteries contain sulphuric acid. When working near the battery, or where there is battery acid on the vehicle body, protect the skin and eyes from contact with the acid. If battery acid contacts the skin or enters the eyes, flush the affected area immediately with water (flush for at least 15 minutes) and call a doctor without delay. If acid is swallowed, call a doctor immediately. Failure to follow these instructions may result in personal injury.

NOTE: High temperatures accelerate the attack on the top coat. At 50°C the top coat layer breaks down after about 15 minutes!

Cause/damage pattern:

- Etching of the paint layer to decomposition of the paint finish.

Repair of damage:

- Flush the acid splashes with plenty of water and neutralize with car washing liquid.
- If the contact time of the acid was short, perform a polishing repair.

Paint damage caused by brake fluid.

Careless handling of brake fluid. The glycols contained in the fluid cause swellings.

DESCRIPTION AND OPERATION

Cause/damage pattern:

- The temperature and contact time are critical. Splashes lead to loss of shine and lightening of color.

Repair of damage:

- Flush immediately with plenty of water.
- The swellings can often be made to recede completely by treatment with the radiant heater or in the paint drying oven at max. 60°C for about 1 hour.

Mechanical damage

Stone impact damage or mechanical damage

Mechanical damage caused by impact of stones or other hard objects and extending down to the metal panel lead very quickly to corrosion and rusting under the paint on the adjoining surface.

Cause/damage pattern:

- Paint damage caused from the outside, down to filler, primer or metal panel.

Repair of damage:

- Sand or blast out.
- Use anti-corrosion primer.
- Apply top coat.

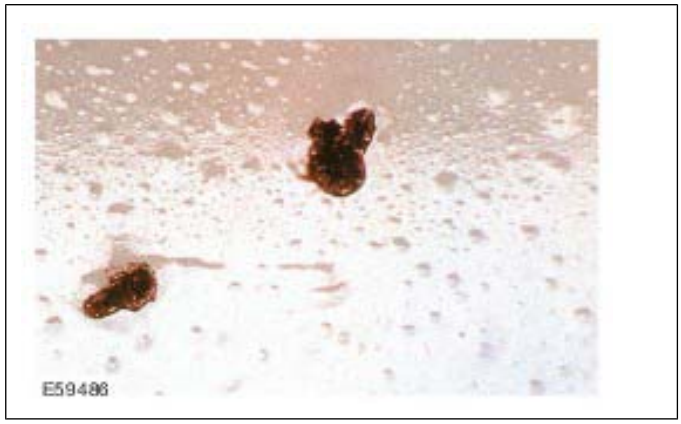
Damage due to corrosion

Blistering/rusting below

Air or water filled blister-shaped raised areas in the paint film.

Cause/damage pattern:

- Overpainting corroded steel panel.
- Condensation in the spray air.
- Sanding water not dried out or salt crystal residues.
- Road chippings and road winter grit containing salt.



Repair of damage:

- Sand the affected area of damage or the body component and re-create the paint finish.
- More severe and larger areas of rusting below must be repaired using the corresponding repair painting, Repair Level III or IV.

Damage caused by faults in treatment

- Craters
- Paint boils
- Adhesion defects
- Adhesion defects - clear lacquer
- Sanding scores
- Formation of stripes
- Peeling/blistering on plastic parts
- Blistering on polyester material
- Peroxide marks in metallic paints

DESCRIPTION AND OPERATION

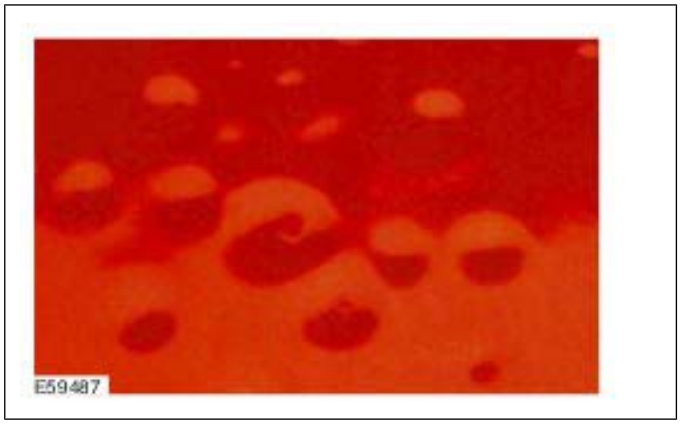
- Crack formation
- Shrinking back/zone edge marks
- Blistering
- Etching
- Paint wrinkles/puckering
- Cloud formation
- Spots/metallics
- Metamerism/color deviations
- Washing out
- Loss of gloss
- Covering ability/areas of thin paint
- Flow problems/orange peel
- Dirt embedded in metallic base paint
- Dirt embedded in top coat
- Water marks
- Paint runs
- Swirl marks

Craters

Crater-like single or extensively occurring depressions with raised edges, in top coat or the intermediate layers.

Cause/damage pattern:

- Substrate not adequately cleaned with silicone remover.
- Spray air contaminated by oil residues and water accumulations.
- Filter ceiling not adequate for requirements.
- Use of polishes, cleaning agents or sprays (e.g. interior sprays) containing silicone.
- Oil, wax, grease, silicone containing residues.
- Working clothes contaminated by materials containing silicone.



Repair of damage:

- Sand paint surface, clean with silicone remover and apply one thin spray pass. Let it begin to dry well, then apply several thin and dry sprayed passes.

Paint boils

Small, hard, closed or burst blisters in the paint top coat. They appear locally in groups or spread individually across the whole surface. Sanding opens up a larger cavity, under which the primer can often be seen.

Cause/damage pattern:

- Paint applied in layers which were too thick.
- Specified flash-off and drying times between coats were not adhered to.
- Specified working viscosity and spray pressure were not adhered to.
- Use of unsuitable hardener and thinner materials. (Solvent combinations in paint system not optimally matched).
- Poor booth conditions.

Repair of damage:

- Single boil blisters can be removed using polishing.
- After thorough drying, sand the top coat at the affected areas, clean with silicone remover and re-paint. Fill any fine pores still present with 2-component acrylic filler.
- On larger areas of damaged topcoat, sand completely away and apply new paint finish.

Adhesion defects

Whole coating detached from substrate or individual layers one from another. Sometimes

DESCRIPTION AND OPERATION

adhesion defects can only be noticed after an external influence such as stone impact.

Cause/damage pattern:

- Substrate not adequately prepared (rust, grease, moisture, sanding, cleaning).
- Unsuitable material used.
- Drying times, flash-off times too short.
- Base paint not sprayed wet-in-wet, instead the intermediate drying times were too long.
- Failure to intermediate sand.
- Condensation formed because of temperature fluctuations.
- Unprofessional preparation (especially on plastics).
- Overheated CDP/intermediate filler.

Repair of damage:

- Sand out the damage and recreate the paint finish. Create the paint finish strictly in accordance with the general technical information.

Adhesion defects in clear lacquer.

Clear lacquer detched from base paint.

Cause/damage pattern:

- Base paint layer too thick.
- Intermediate and final flash-off times of base paint too long.
- Incorrect mixture ratio clear lacquer/hardner.

Repair of damage:

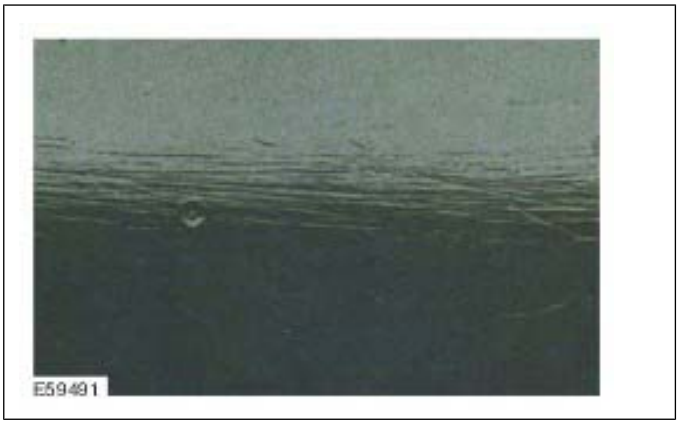
- Refinish sanding and recreate the paint finish.

Sanding scores

Single or wide area clusters of scoring or sanding marks, often with raised edges. Noticeable on metallic paints as light-dark stripes.

Cause/damage pattern:

- Stopper sanded too coarsely.
- Filler sanded too coarsely.
- Filler not thoroughly dried bfore sanding.
- Old paint sanded too coarsely.
- Soft elastic substrates, e.g. TPA base, treated with thinners which was too aggressive and therefore etched.
- Top coat applied too thinly.



Repair of damage:

- If the damage pattern is minimal, after the top coat has dried fine sand the paint surface and refurbish by polishing.
- If the damage is great or on metallic paints, sand the paint surface or substrates and if necessary remove them, then cover the bare metal and re-paint.

DESCRIPTION AND OPERATION

Formation of stripes

Differing, stripe shaped color/effect formations in dark/light areas of a metallic paint finish.

Cause/damage pattern:

- Spray gun (nozzle) not perfect.
- Incorrect spray pressure.
- Thinners not suitable.
- Incorrect spray viscosity.
- Flash-off time too short.
- Unsuitable working temperature.

Repair of damage:

- Apply base paint evenly.
- Repair spray gun.
- After clear lacquer has thoroughly dried, sand surface and paint again.

Peeling/blistering on plastic parts

Paint adhesion insufficient between top coat and filler and/or primer layer. It often happens that the whole of the paint finish detaches from the plastic.

Cause/damage pattern:

- Plastic item not cleaned sufficiently, not or inadequately tempered.
- Unsuitable cleaning agent used.
- Unsuitable materials used.
- Moisture.
- Paint finish underbaked or overbaked.
- Poor or lack of intermediate sanding.

Repair of damage:

- Sand away faulty paint coats and re-apply paint finish.
- In extreme cases use a new part.

Blistering on polyester material

Color shade differences or marks in paintwork subsequently applied to previously unpainted plastic material.

Cause/damage pattern:

- Plastic material is not suitable for painting.
- Incorrect bonding agent.
- Paint used not solvent resistant.

Repair of damage:

- Repaint using suitable materials.
- Install unpainted new part (after consulting customer).

Peroxide marks in metallic paints

After longer period of drying, abnormal marks where the color shade varies.

Cause/damage pattern:

- Too much hardener added to polyester stopper (over 3% can cause this damage pattern).
- Polyester stopper not well enough mixed.

DESCRIPTION AND OPERATION

Repair of damage:

- Sand, fill with polyester or epoxide filler and re-paint.

Crack formation

Cracks of different lengths and depths running in all directions.

Cause/damage pattern:

- Layers too thick.
- Painted several times.
- Temperature fluctuations.
- Mechanical effects e.g. distortions.
- Substrate not thoroughly hardened.
- Old paint not completely dried out.
- No or insufficient hardener added.
- 2-component materials used on nitro or TPA.

Repair of damage:

- Sand away layers until sound substrate is reached and create new paint finish (prime, fill, apply topcoat).

Shrinking back/zone edge marks

Lifting or dropping in of edge zones (edges which accentuate themselves in the top coat), flow problems and loss of shine in top coat.

Cause/damage pattern:

- Old paintwork not rubbed down to a seamless transition.
- Stopper and filler on a viscoplastic base primer.
- Filler sanded and overpainted when not thoroughly hard.
- Previous materials overworked too early, substrate not sufficiently hardened.
- Primer applied in layers which were too thick, and not dried for long enough.
- Sanding paper too coarse.
- Top coat thinned too much.

Repair of damage:

- After hardening off the top coat, fine sand the surface and polish up, apply filler if necessary and paint once more.

Blistering

Small, spot-like, air-filled or water-filled blister shaped high-spots in the paint construction. Their dimensions can range from pin-head to pin-point size in a closed paint film. Arrangement and accumulation very variable. In the advanced stages, circular flaking of the paint from the substrate. These are neither boils nor corrosion.

Cause/damage pattern:

- Moisture absorption by substrate.
- Insufficient drying of the substrate after wet sanding (especially on polyester material).
- Humidity too high before painting; condensation formation because of temperature fluctuations.
- Pores/sink holes in substrate not sanded out.

DESCRIPTION AND OPERATION

- Polyester material not covered.
- Sweat from hands.
- Salts and minerals in sanding water.
- Spray air contaminated.

Repair of damage:

- Sand away damage, matt sand remainder of surface, clean with silicone remover, fill and re-paint.

Etching

The base paint is etched by the clear lacquer. This causes the aluminum pigments to change their alignments. The color of the etched base paint seems more grey than that of normal base paint. Result is that the surface structure of the clear lacquer becomes increasingly more matt.

Cause/damage pattern:

- Base painted too wet.
- No intermediate flash-off time.
- Layers too thick.

Repair of damage:

- Sand and re-paint.

Paint wrinkles/puckering

Lifting/puckering of the paint surface.

Cause/damage pattern:

- First paint not hardened through or can be etched.
- Areas of clear lacquer which were sanded through to base paint have not been not isolated with filler, or with unsuitable filler.
- Unsuitable substrate (e.g. spray can painting with TPA or nitro).
- Use of unsuitable primer, paint and thinner materials.
- Paint systems not matched to each other.
- In wet-in-wet process, specified flash-off times not adhered to.
- Synthetic resin top coat (alkyd resin) worked over too soon.

Repair of damage:

- After thorough drying, completely remove the top coat together with the attacked substrate at the affected areas and re-create a new paint finish.
- Before applying top coat, rub down the complete surface.

Cloud formation

Differing, blotchy color/effect formations in dark/light areas of a metallic paint finish.

Cause/damage pattern:

- Spray gun, spray nozzle, spray pressure not perfect.
- Varying spray viscosity, spraying method, flash-off times, spray booth temperature.
- Thinners not suitable.

DESCRIPTION AND OPERATION

Repair of damage:

- Droplet method before clear lacquer application.
- After clear lacquer has thoroughly dried, sand surface and re-paint.

Spots

Points rising up from the paint film.

Cause/damage pattern:

- Metallic base paint sprayed too dry, so that the metal particles could not incorporate into the paint. The clear lacquer could not cover these vertical standing particles because the spray air was too hot or the booth temperature was too high.

Repair of damage:

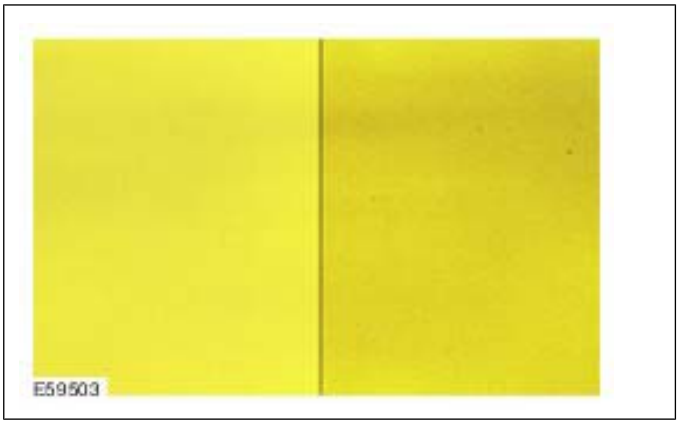
- After the paint surface has dried, lightly sand it with grade P800 sanding paper, clean with silicone remover and re-apply clear lacquer.

Metamerism/color deviations

Noticeable when identical color shades undergo a change of hue as the light source changes (daylight/artificial light). Different pigment composition between original and repair paint.

Cause/damage pattern:

- Use of paints with pigmentation which was not compatible with the standard, e.g. a green can be formulated from yellow and blue, or directly from green.
- Use of an unsuitable mixed or ready made paint to re-tone.



Repair of damage:

- Repaint using the correct paint.

Washing out

On paint which has been newly applied but not yet dried, the interaction of surface tension and very different specific gravities of the different pigments can lead to swirl-like turbulence which results in separation of the pigments.

Cause/damage pattern:

- Layer too thick, paint not stirred enough.

Repair of damage:

- Sand and re-paint.

Loss of gloss

Milky, dreary tarnishing of the paint with more or less even loss of gloss.

DESCRIPTION AND OPERATION

Cause/damage pattern:

- Cold with low air humidity.
- Heat with high air humidity.
- Substrate can be etched.
- Hardener fault or wrong hardener used.
- Paint thinned too much.
- Proportion of pigment too high because of poor stirring.
- Not optimum drying.

Repair of damage:

- After drying, remove the matt effect by polishing. If unsuccessful, rub down complete area and paint again.

Covering ability/areas of thin paint

Different color shades in the surface. The minimum layer thickness is not achieved here. The effects range from local minor shade variations through mottled spray zones to completely missing top coat.

Cause/damage pattern:

- No correct, uniform substrate (effect paint).
- On three-layer systems, wrong filler.
- Insufficient top coat application.

Repair of damage:

- Sand surface and recreate the paint finish.

Flow problems/orange peel

Surface structure bumpy, grained. The surface is similar to the peel of an orange.

Cause/damage pattern:

- Paint viscosity too high.
- Use of fast evaporating, highly volatile thinners.
- Booth temperature too high.
- Spray gun distance too great, too little material applied.
- Nozzle too large.
- Incorrect spray pressure.

Repair of damage:

- Small surfaces: fine sand and polish.
- Sand out the surface and recreate the paint finish.

Dirt embedded in metallic base paint.

Inclusions of contamination in metallic base paint, of different sizes and shapes (grains or lint).

Cause/damage pattern:

- Dust was not properly removed from the surface to be painted.
- Paint material not sieved.
- Function of the painting facilities not optimum.
- Filter contaminated.
- Wearing unsuitable clothing.

Repair of damage:

- Sand and repaint.

DESCRIPTION AND OPERATION

Dirt embedded in top coat

Inclusions of contamination in top coat or under paint layers, of different sizes and shapes (grains or lint). Optical adverse effect.

Cause/damage pattern:

- Dust was not properly removed from the surface to be painted.
- Paint material not sieved.
- Function of the painting facilities not optimum.
- Filter contaminated.
- Wearing unsuitable clothing.

Repair of damage:

- Single inclusions: after thorough hardening, sand out using 1200 - 1500 grade paper and repolish using a suitable silicone-free sanding or painting paste.
- Large area contamination: sand and repaint.

Water marks

Ring shaped marks appearing on the paint surface.

Cause/damage pattern:

- Evaporation of water droplets on freshly painted and not yet fully hardened paint finishes (mostly only found on horizontal surfaces).
- Layer too thick.
- Drying time too short.
- Hardening faults or hardener no longer useable.
- Use of unsuitable thinners.

Repair of damage:

- Rub down only slight marks with sanding paper grade P1000 - P1200 and then polish.
- For heavy marking, sand the surface matt, clean with silicone remover and repaint.

Paint runs

Wave-like paint run tracks in top coat or in an intermediate layer on vertical surfaces. Mostly in the area of swage lines, seams or openings (there they are paint runs, otherwise curtains).

Cause/damage pattern:

- Uneven paint application.
- The specified viscosity was not complied with.
- Use of unsuitable thinner materials.
- Air, material or room temperature too low.
- Layers too thick.
- Spray gun (nozzle) not perfect.

Repair of damage:

- After thorough drying, sand unevenness flat, if necessary leave to dry afterwards.
- Small areas of damage can be equalised using the paint plane, then sand, polish or repaint.

DESCRIPTION AND OPERATION

Swirl marks

Three dimensional appearance in the paint surface in the form of smears or blotches. This effect is intensified in direct sunlight.

Cause/damage pattern:

- Polishing using polishing machine on paint which has not yet hardened throughout.
- Polishing intervals too long or none at all.
- Pressure too high while polishing.
- Incorrect polishing material or polishing tool.

Repair of damage:

- Allow the paint to harden completely and then polish.
- If the damage is irreversible, rub down and apply new clear lacquer.

DESCRIPTION AND OPERATION

Tools and Equipment for Paint Repairs

Compressor

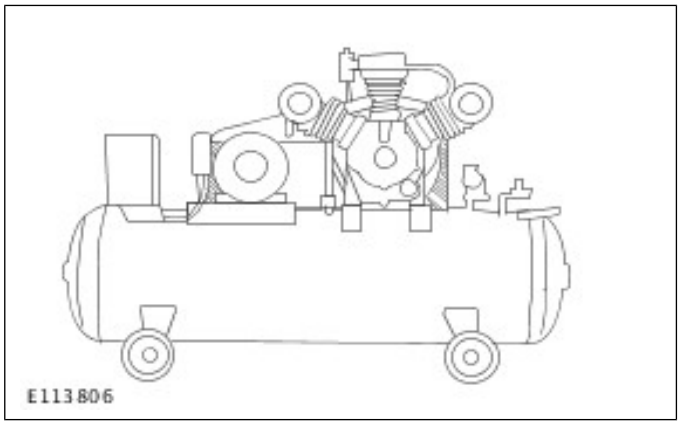
The compressor is one of the most important machines in the paint workshop. A compressor is a machine that squeezes air and raises its pressure, and the high pressure air from the compressor enables you to use spray guns and other air pressure tools. By the structural and functional differences, the compressors are classified as following, and the most appropriate models and types are required to be selected to meet the purpose and application required.

Number of Pressure Steps

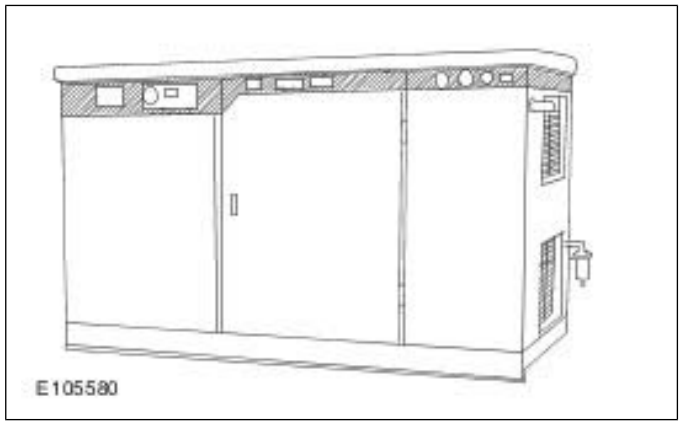
Step Number	One Step Pressure	Two Step Pressure
Application	When air consumption is comparatively small	When over 980 kPa (10 kgf/cm2) of air pressure is constantly required, or when the drop in air pressure is expected to become very large under heavy compression load by the use of many machines at the same time, or when long piping is required for its installation.

Control Methods

Mode	Automatic Pressure Invertor Mode	Automatic Unloader Mode
Operation	Intermittent Operation	Continuous Operation
Feature	The motor shuts off when the air pressure exceeds its specified amount. It starts its operation automatically when the pressure goes down. This is suitable for on-again, off-again operation of air tools by the same one operator under the normal air pressure ranging from 785 to 980 kPa (7 to 10 kgf/cm2).	By the function of unloader valves, no-load operation starts when the air pressure exceeds a prescribed level, and air pressure operation starts when the pressure goes down. This is suitable for continuous and simultaneous use of several units of air tools under the normal air pressure ranging from 490 to 686 kPa (5 to 7 kgf/cm2).



Reciprocating Compressor

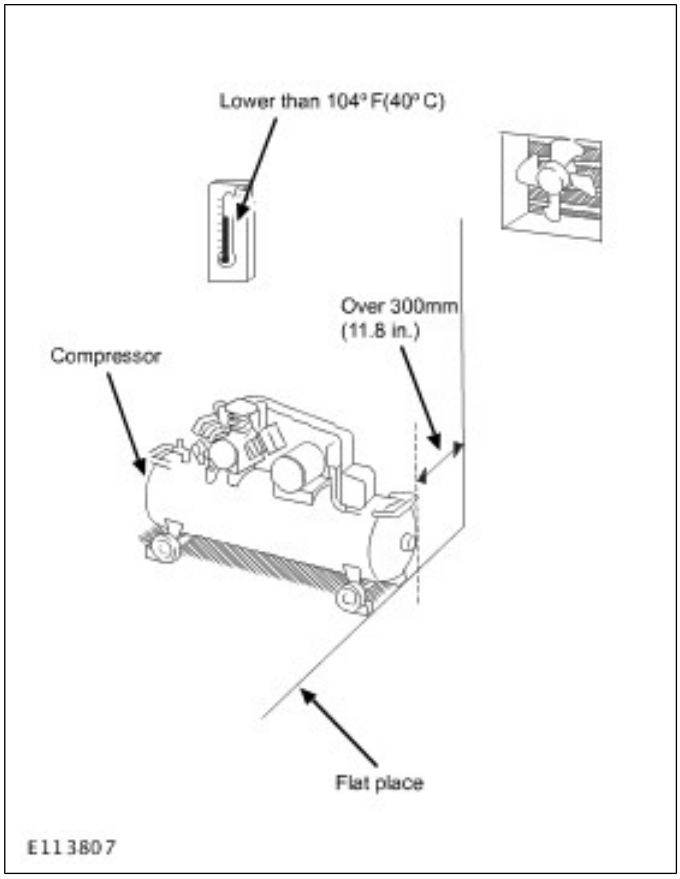


Screw Compressor

DESCRIPTION AND OPERATION

Where to Place the Compressor?

1. Put the compressor on the flat floor, and ensure that there is adequate ventilation, avoiding moisture and dust.
2. Keep the room temperature lower than 104°F (40°C) even in summer and avoid direct sunlight.
3. Provide ample space for maintenance and inspection, and keep a distance of over 300 mm (11.8 in.) from the wall.
4. When you install the compressor in the workshop, be sure to use the explosion-proof type to prevent fire and explosion hazards.



Check and Inspection of the Compressor

Daily Check-up:

1. Oil level Check.

2. Drain the water in the tank, and inspect the drain valve for oil drainage. Especially in case of the polyurethane resin coating of the two-liquid type, be sure to keep supplying clean air constantly because the hardening agent will not always react properly with water to give you the expected performance of the surface coating.

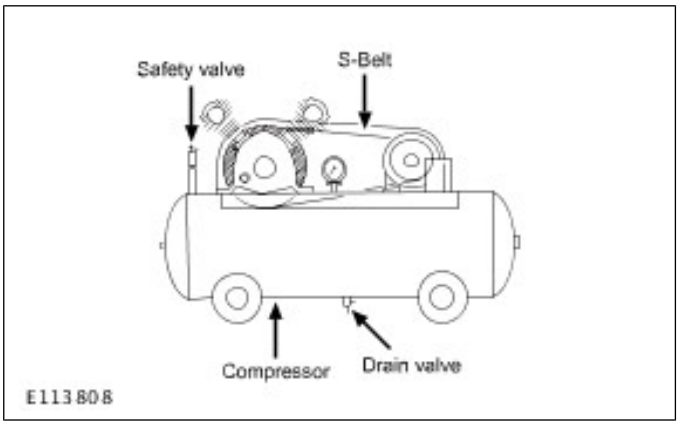
3. Do overall cleaning of the compressor

Monthly Check-up:

1. Cleaning of air filter.

2. Check safety valve.

Check the tension and damage of V-belt.



Air Piping

When you install air piping in the workshop, or use tools by air hose, the following points are to be noted.

Pressure drop: The smaller the inside diameter of the air pipe and air hose size will drop the pressure, and impair the separation of air and water. Use the largest possible inside diameter.

Water removal: The compressed air from the compressor contains water and produces water drops. If the as-is status of the air is used for the sprayer, it may produce a surface coating defect and the risk of machine troubles. Install the ability to for remove water from the compressed air. Give a small amount of tilt to the piping in horizontal direction, to assure that the water and oil will not remain in the pipe.

Example of piping in a Paintshop

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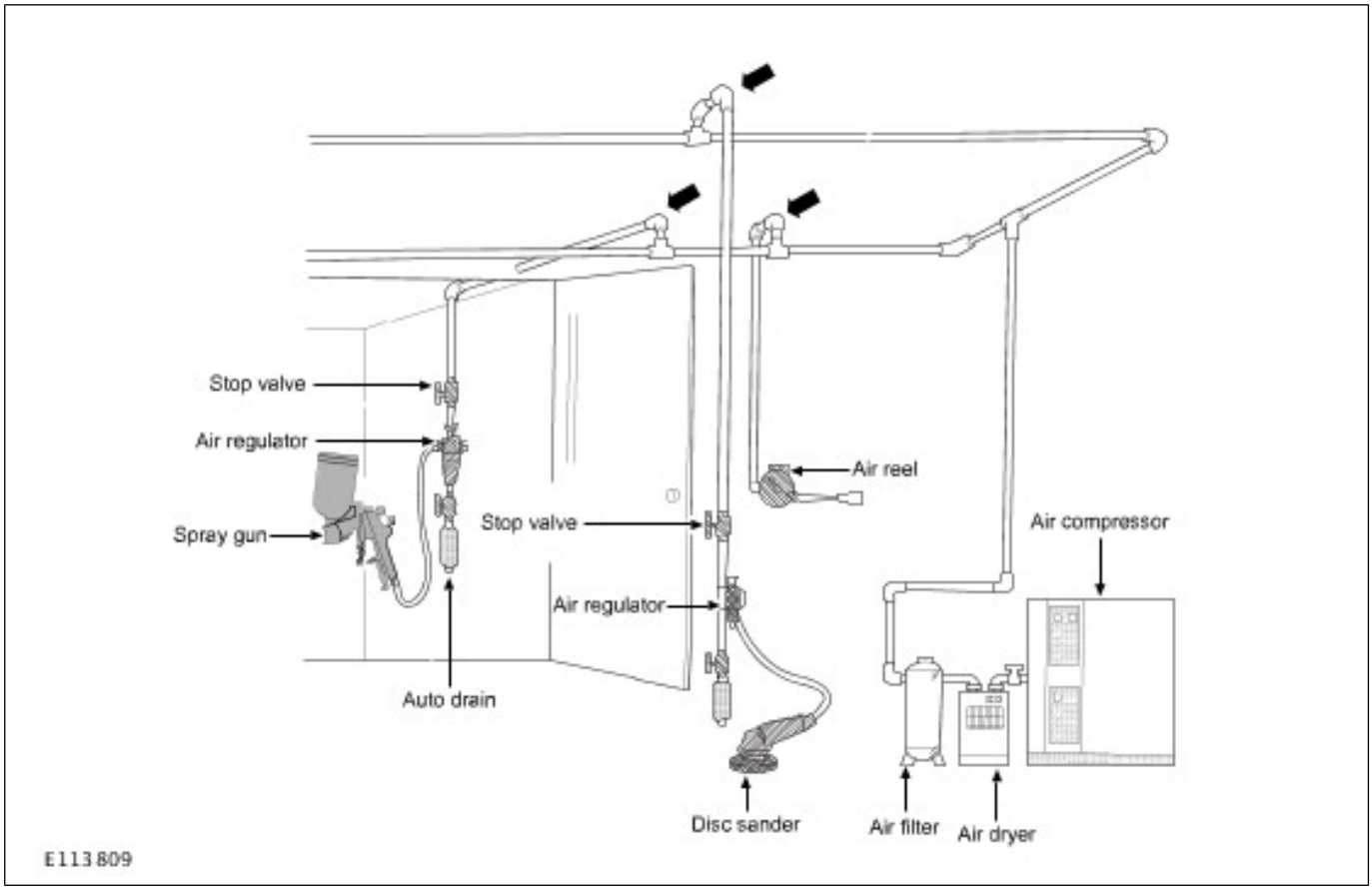
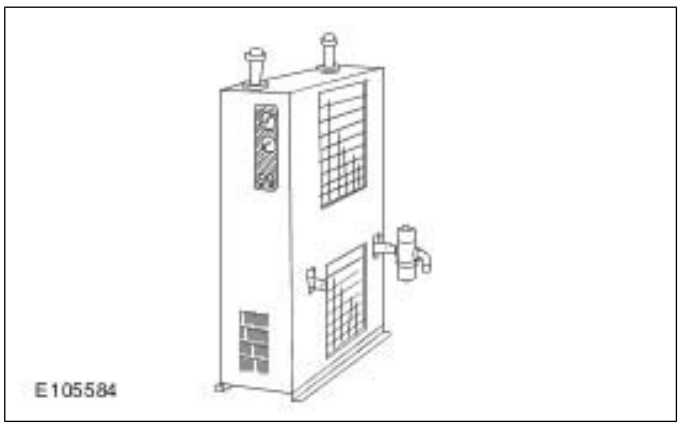


Necessary Attachment

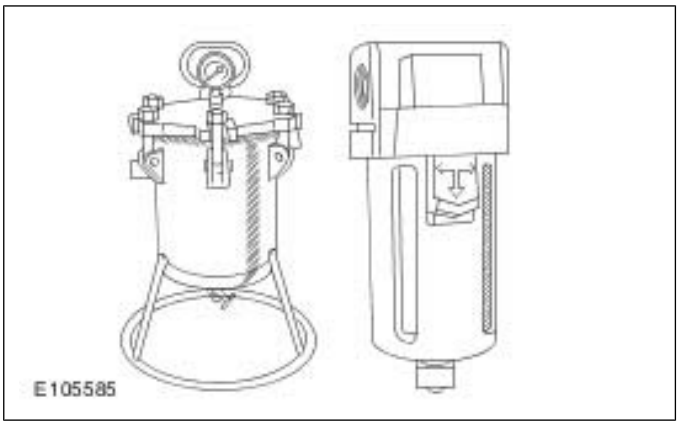
Air Dryer

The freeze-dry type air dryer with a built-in freezer forcefully freezes the hot air from the compressor. As it is different from the natural air cooling method by making the air piping longer, the generation of dew in the air pipes and air hoses can be prevented because the water contained in the air can be removed under the lower temperature than the normal room temperature.



Air Filter

The air filter is designed to separate water drops and dust in the compressed air, applying the swirling motion of the built-in deflector. The air filter is mounted between the air dryer and air transformer. It is designed to remove even the very fine spray from the cooled and compressed air.

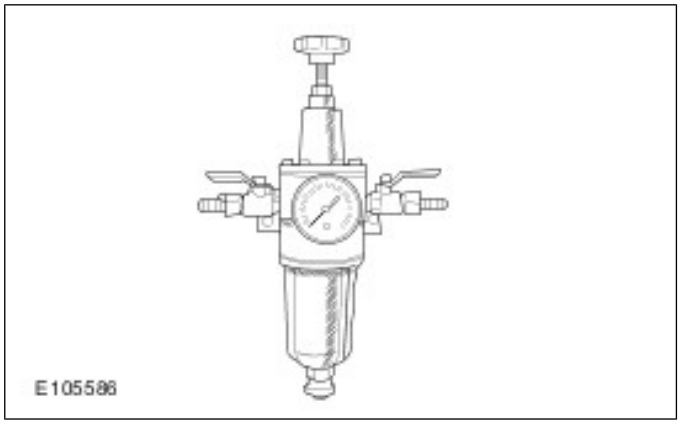


Air Regulator

The air regulator reduces the air pressure from the compressor to the desired pressure level when employing the spray guns and air pressure tools. The built-in filter has a function of removing the water and dust in the compressed air. The air is

DESCRIPTION AND OPERATION

positioned at the final end of the air pipe. Air coming out of the air regulator is directly employed for spray. Check to the air regulator including the drainage daily.



Spray Booth

Spray coating produces a lot of spray mist and solvent gases. This is not only bad for health and safety, but this will also cause various kinds of defects in the work of the painting as well as produce environmental pollution. Therefore, it is necessary to facilitate the spray booth.

Function of spray booth:

1. The forced exhausting system will help protect the workers from the inhalation of the sprayed mist and hazardous organic solvent gases.

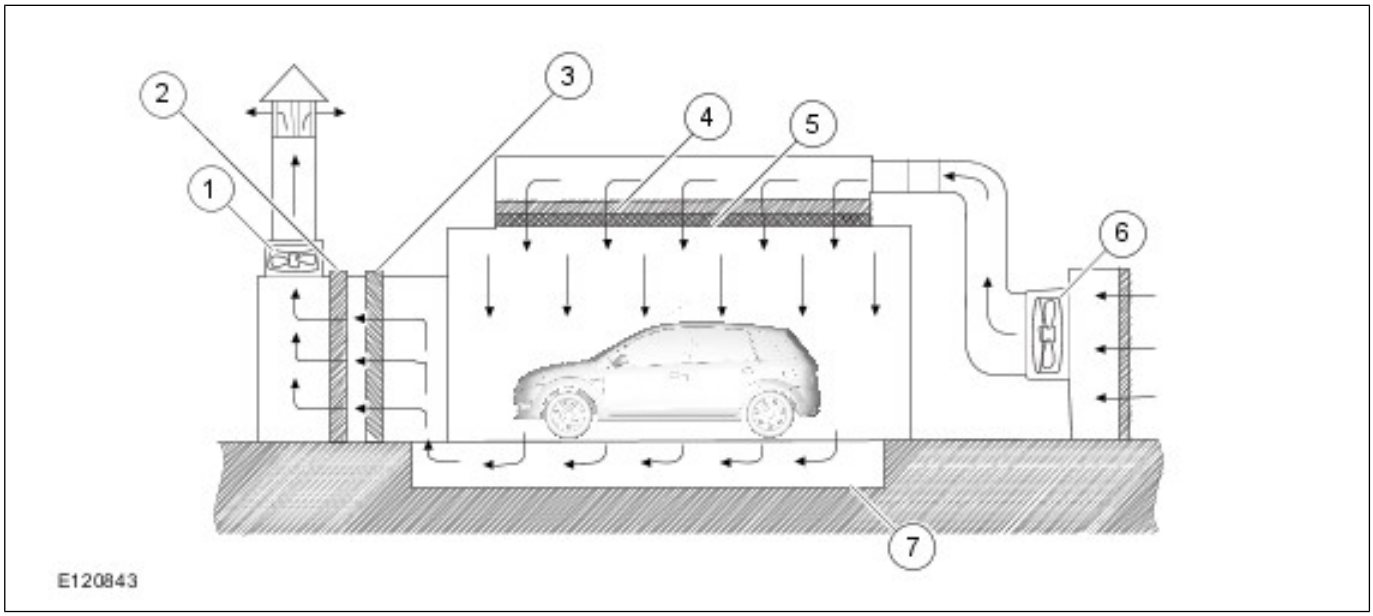
2. The intake air filters will send the clean air to protect the surface coating from the dirt and dust.

3. The exhaust air filters will collect the sprayed mist and protect the work site from the pollution and also protect the surrounding environment from the pollution.

Kinds of spray booth

Natural Intake / Forced Exhaust Type: This is a type which forces only the exhaust system, thereby keeping the state of the internal booth under a reduced pressure. This state creates a drawback of taking in dust and dirt more likely from doors and crevices.

Forced Intake / Forced Exhaust Type (Push Pull Type): This is a type which forces both of the intake and exhaust systems, thereby preventing the invasion of dust from outside, simply by keeping the pressure in the booth a little bit higher. This system can meet the requirement for organic solvent occupation which is stipulated in the Occupational Health and Safety Laws. Therefore, when you use the spray booth, it is necessary to install the stipulated Push Pull Type.



Item	Description
1	Exhaust fan
2	Exhaust secondary filter
3	Exhaust primary filter
4	Intake secondary filter

Item	Description
5	Intake tertiary filter
6	Intake fan
7	Exhaust pit

DESCRIPTION AND OPERATION

Drying Facilities

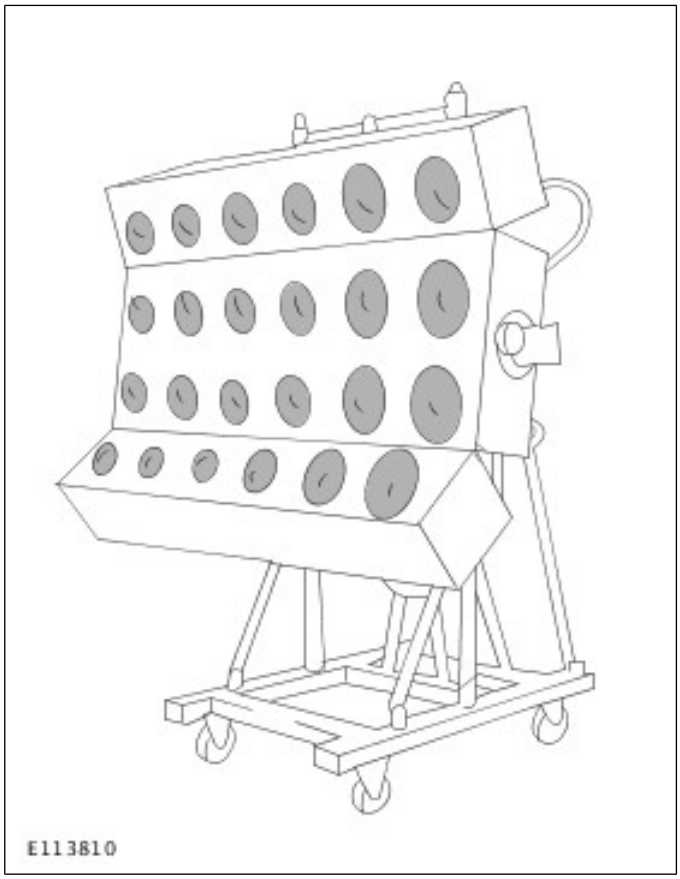
The heat drying method has such advantages as saving more time, better surface coating performance, etc. than the normal temperature drying method.

There are three kinds of heat transfer, by thermal conduction, convection and radiations. For drying the surface coating, mainly convection and radiation of hot air and infrared rays are employed.

In case of partial repair job, a transportable unit of the drying facility is generally used. Hot-are blower type drying is employed for the overall coating.

Near-infrared drying

This uses infrared bulbs as its heat reservoir, and it is easy to handle and enables you to change the irradiation angle as you like. The structure is very simple and it is easy to assemble. Because of these reasons, this facility is widely used.



Far -infrared drying

This system works by the radiant heating of far-infrared radiation from the tube and panel heated by gas and electricity.

Hot air blow type drying facilities

The hot-air blower type drying oven is designed to dry the surface coating by heated air, and this system uses heavy oil, kerosene, gases, steam, electricity, etc. as its heat reservoir.

Generally, for the sake of safety, the forced drying temperature should be kept at 176°F (80°C) or lower degrees. Baking dry means the reaction and cure of baking and coating by the high temperature of 212 to 302°F (100 to 150°C). When the forced drying is given to the spray and touch up repair painting, it is recommended to react under the relatively lower temperature at 176°F (80°C) so as not to give any damages to the battery and electronic circuits of the vehicles under repairs.

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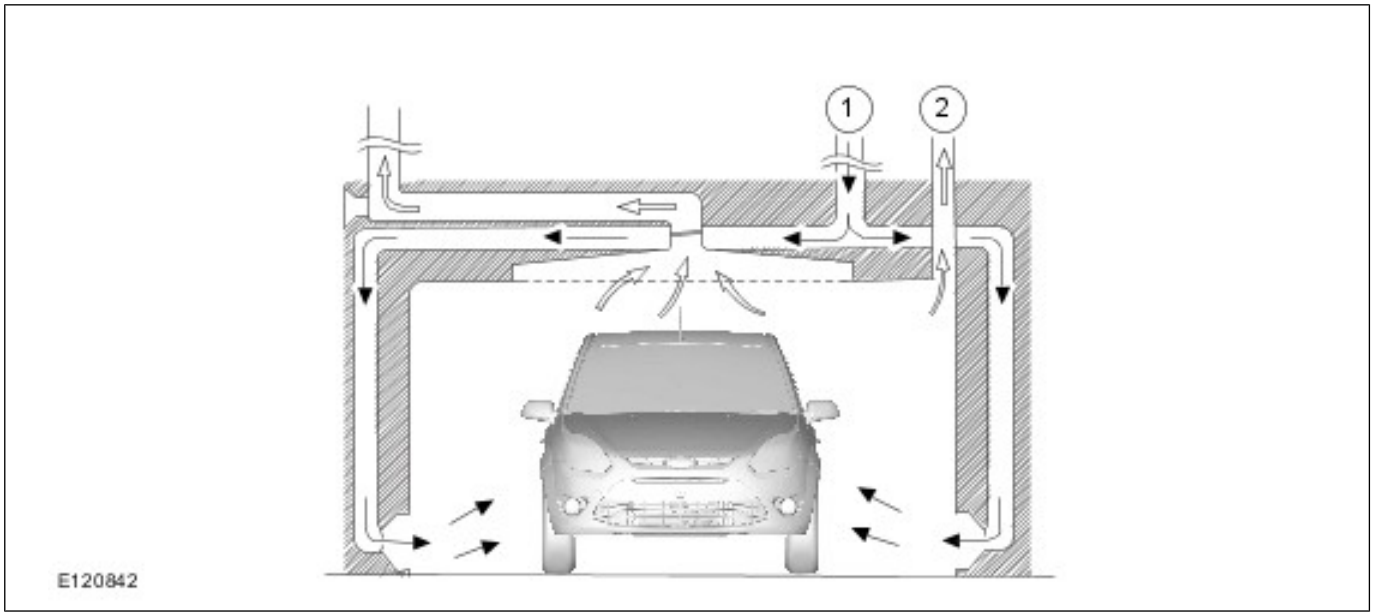
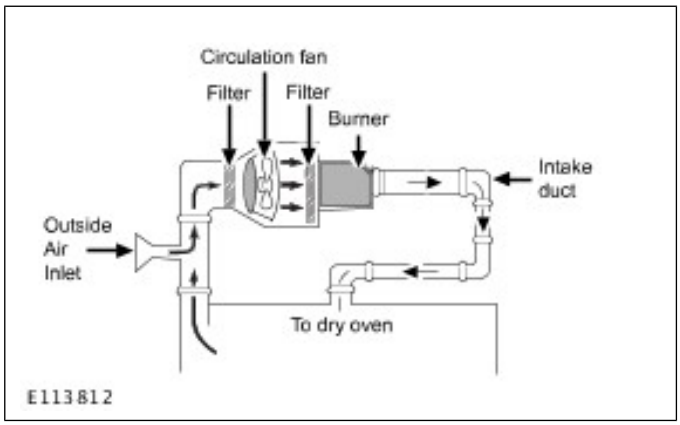


Item	Description
1	Hot air
2	Ehaust duct

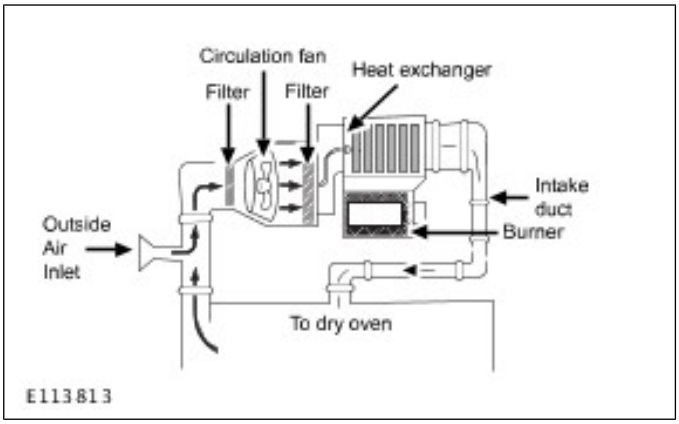
Direct heating oven by hot air

The air heated by burner is sent to the oven through the fan and circulated. Thermal efficiency is high. The facility is compact and the cost is reasonable. Time for increasing temperature is short. The influence of the combustion gas elements may cause some defects on the coating surface.



Indirect heating oven by hot air type

The burner heats the heat exchanger and air is sent to the oven. There is no danger of explosion because there is no contact with flammable material inside. Smoke from the incomplete burning does not flow into the oven. The efficiency of this system is not as good as the direct heating oven. It requires longer heating time. This system is bulky and expensive.



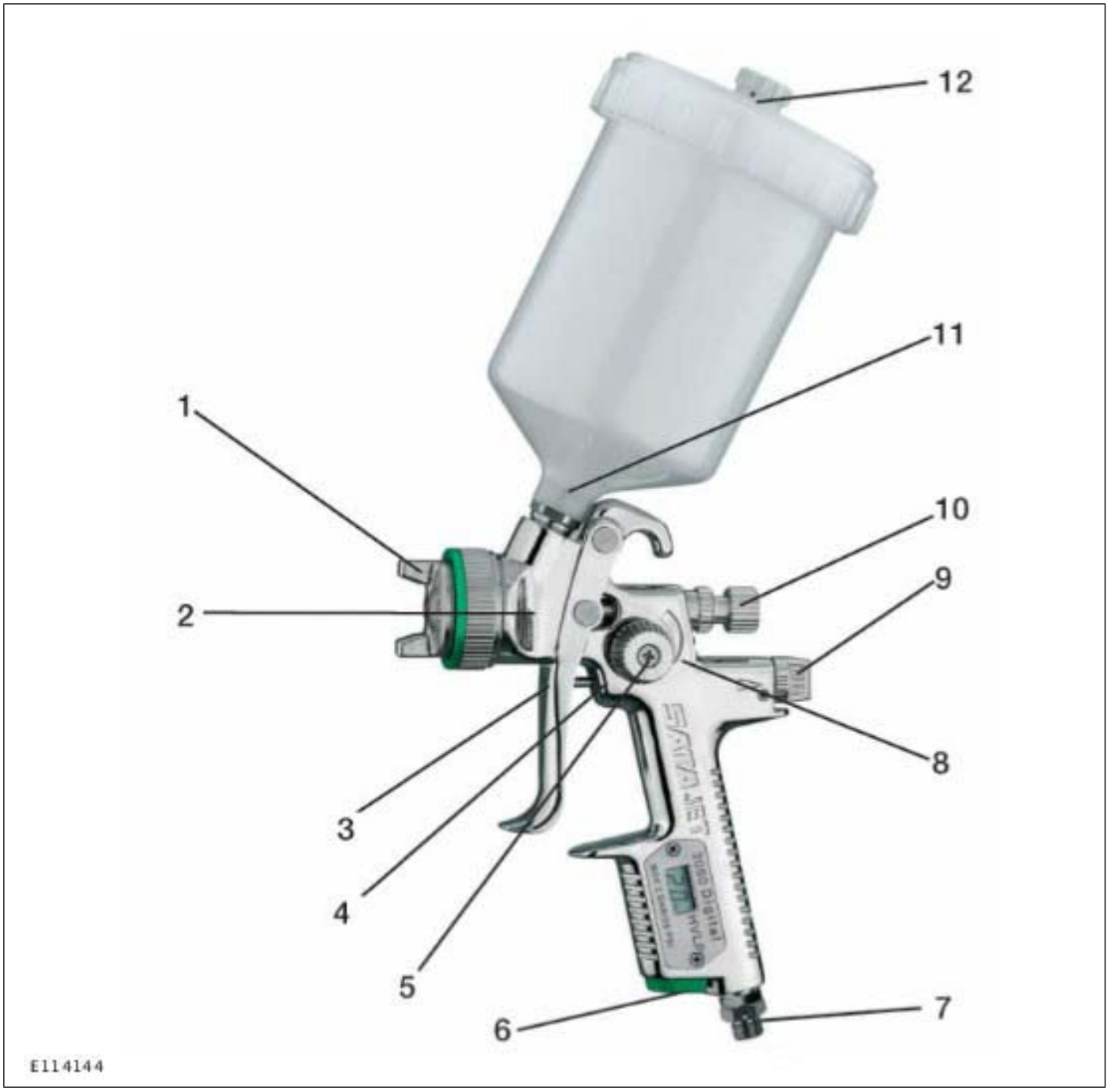
Spray Gun - Component

Spray guns commonly used for refinishing work are typically made from aluminium alloy, with stainless steel or aluminum components, necessary to resist corrosion with waterborne materials.

DESCRIPTION AND OPERATION

Spray Gun Parts

DESCRIPTION AND OPERATION



Item	Description
1	Nozzle set (air cap visible only)
2	Self tensioning needle packing, not visible
3	Trigger
4	Self tensioning air piston packing, not visible
5	Stepless regulation for round- and flat spray
6	Colour Code System
7	Air connection G ¼ outside

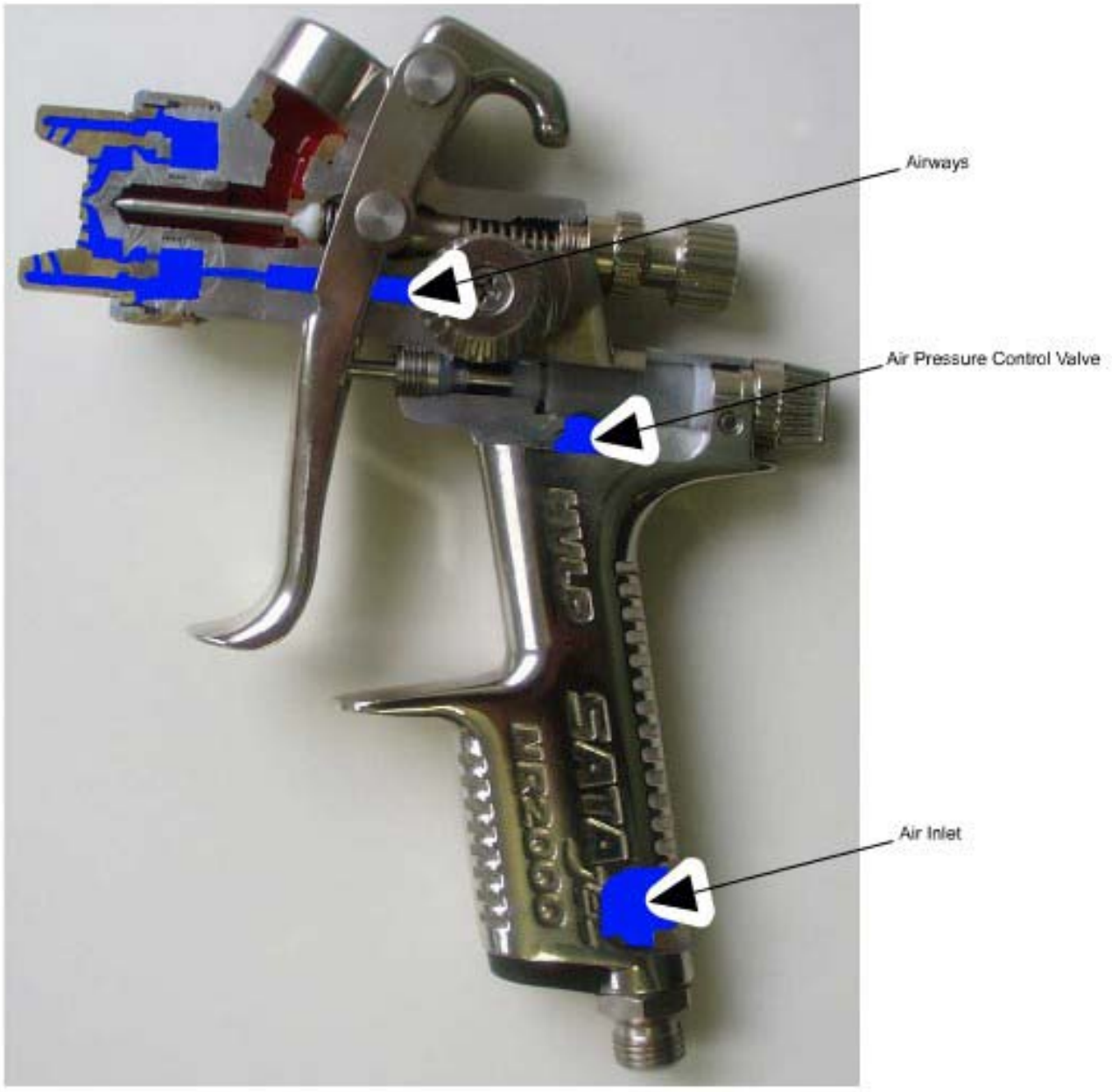
Item	Description
8	Air piston, not visible
9	Air micrometer
10	Fluid adjustment
11	Material sieve, not visible
12	Non-drip device

Spray Gun – Airflow Control

A clean, dry air supply is necessary for successful application.

DESCRIPTION AND OPERATION

Air pressure can be adjusted by the air pressure control valve.

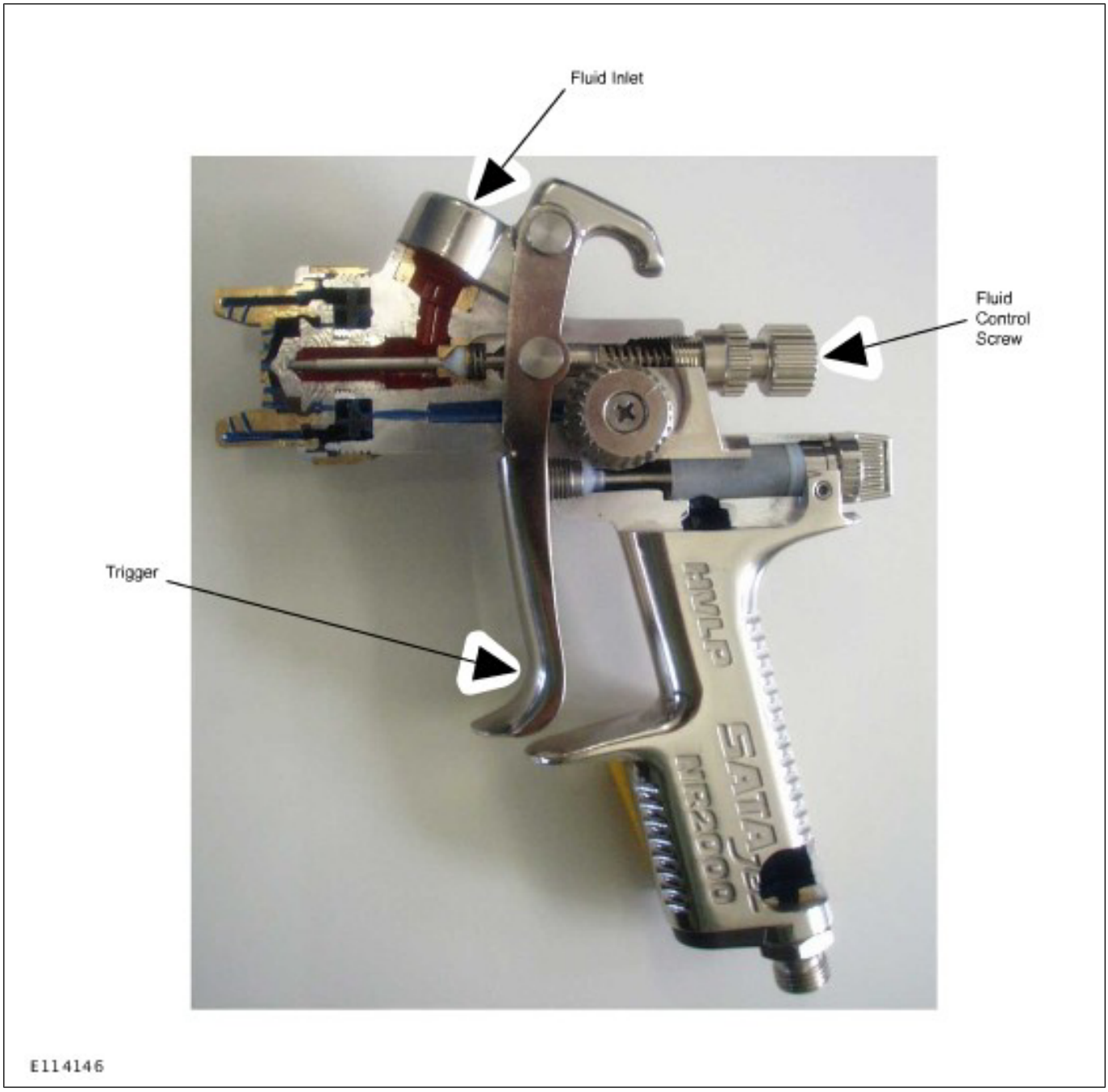


Spray Gun - Fluid Control

The fluid control screw effectively restricts the amount of needle travel, which in turn reduces or increases the flow of fluid for atomization.

Trigger now squeezed, allowing fluid needle to retract from tip and let material through fluid tip.

DESCRIPTION AND OPERATION

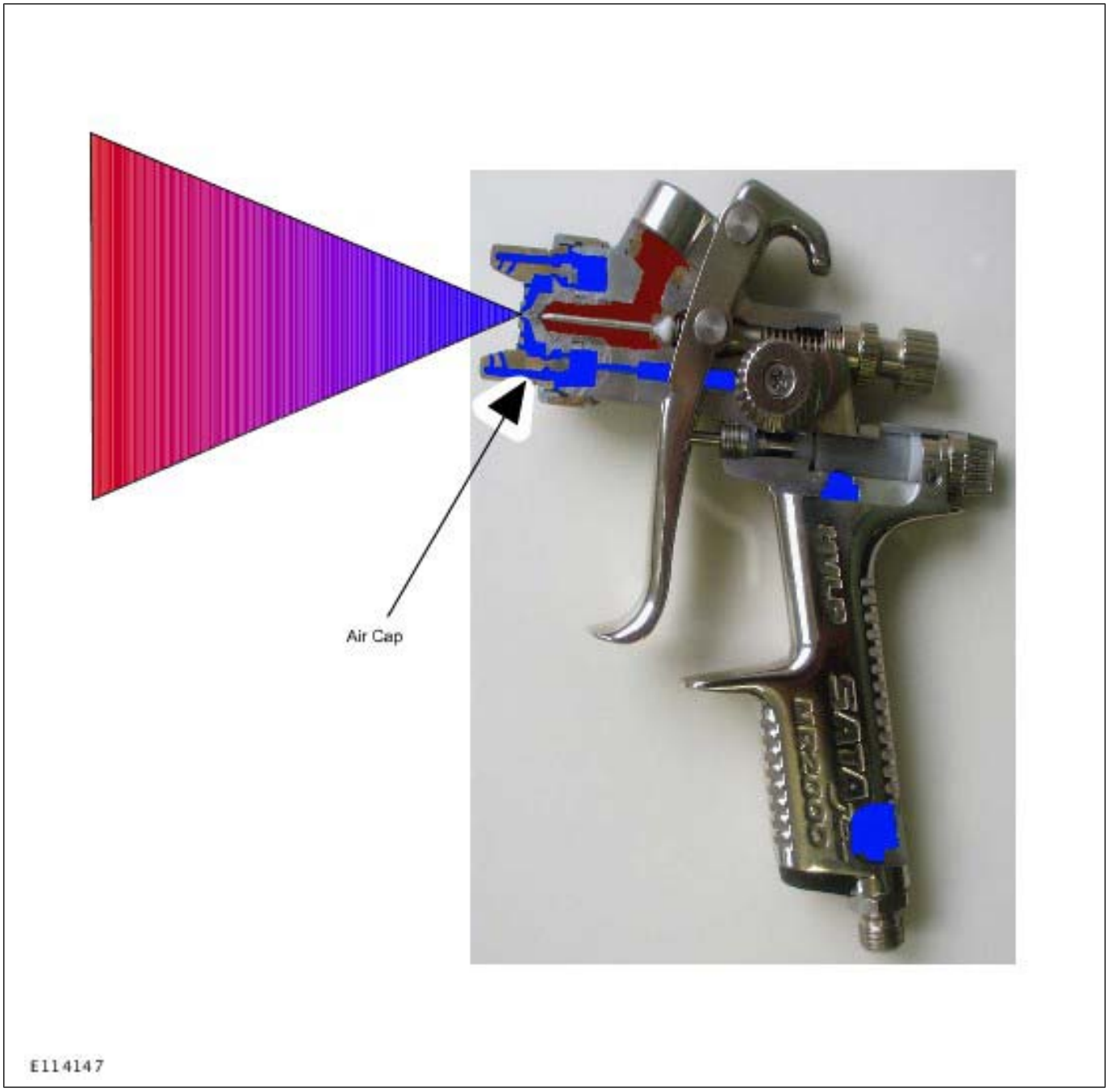


Spray Gun - Atomization

Atomization only takes place outside the air cap, this is where both the fluid material and the air supply become one.

The air supply breaks down the liquid material into millions of minute particles.

DESCRIPTION AND OPERATION



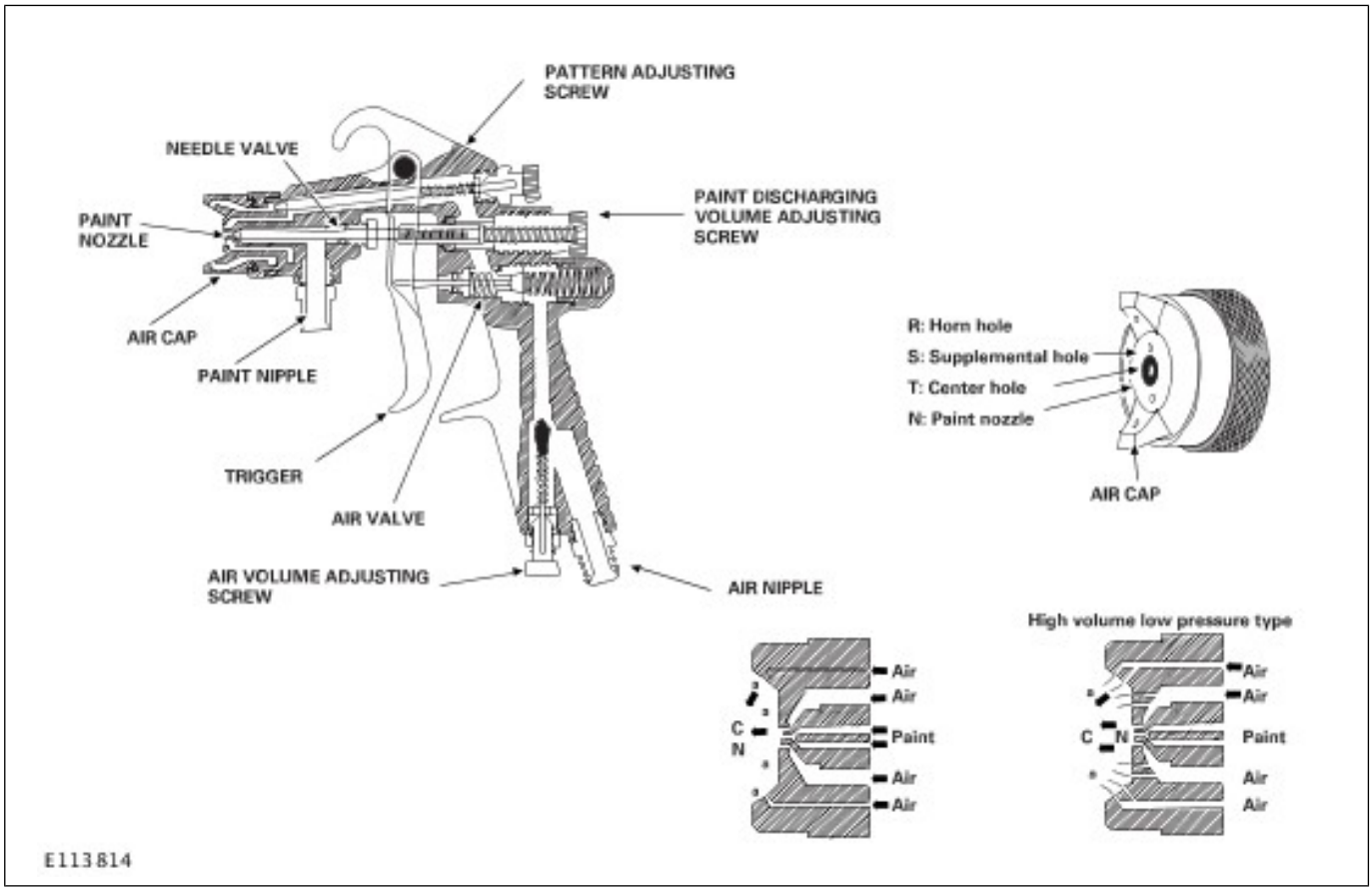
Filler and spray guns

NOTE: Regular maintenance, cleaning after use and careful handling of all individual parts of the spray gun are essential for a high-quality paint finish.

The spray gun is the most important implement in the paint shop. Application of paint using the spray gun can produce a layer with absolutely constant thickness and a smooth paint surface.

DESCRIPTION AND OPERATION

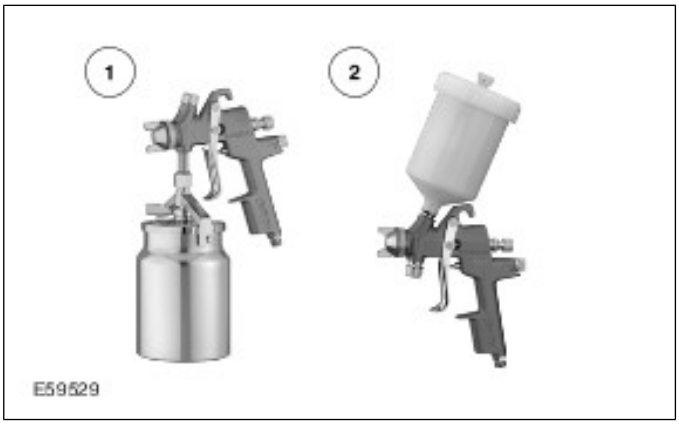
Principle of operation



Because of the construction design and with the aid of compressed air, a spray-ready paint mixture is dragged out of the container to the nozzle by the venturi effect, and is applied to the surface being worked.

When the trigger of the spray gun is pressed to the first pressure point, only the compressed air passage opens. If the trigger is pressed further, the nozzle needle displaces and the air stream drags paint with it at high speed. This produces a spray mist consisting of micro-droplets of paint.

Types of spray gun



Item	Description
1	Suction-beaker spray gun
2	Flow-beaker spray gun

In the flow-beaker spray gun, the paint container is mounted above the spray gun. On the suction-beaker spray gun, it is below.

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Furthermore, spray guns are categorized by their air pressure requirement into high and low pressure guns.

High pressure guns have the disadvantage that they exhibit high consumption of energy and materials. The spray pressure they require is between 1 - 6 bar.

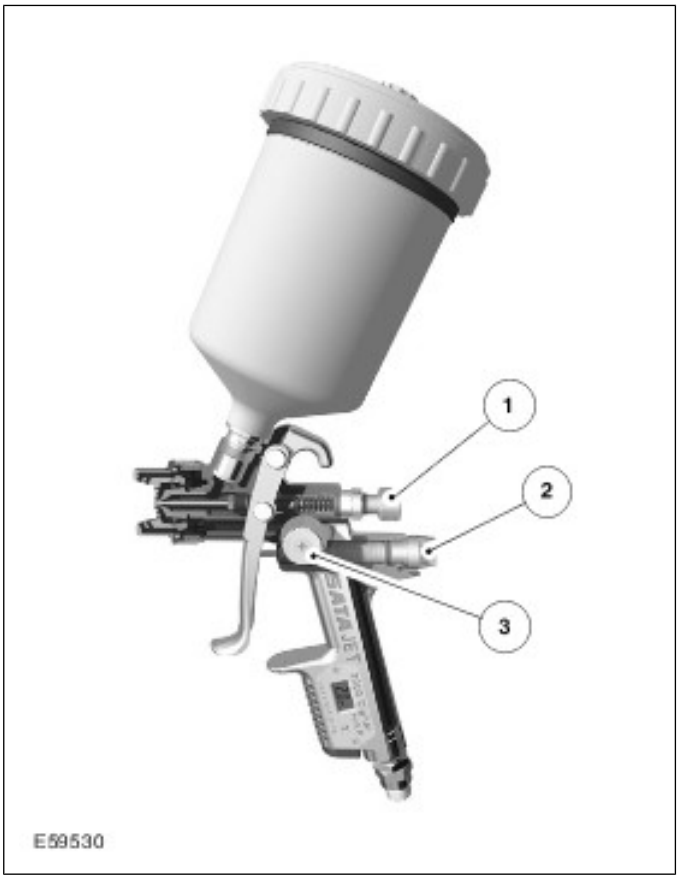
Because of the high air pressure and the large amount of air needed, the result is a powerful paint mist formation (paint transfer rate approx. 35%).

Current practice is mainly to work with reduced mist spray systems (RP and HVLP systems).

Reduced pressure (RP) guns are optimized high pressure guns which have an input pressure at the gun of approx. 2.5 bar and an atomization pressure at the air cap of 1 - 2 bar. In practice this spray technology is preferred for spraying clear lacquer because of the finer atomization.

Low pressure guns have the advantage that they exhibit minimal paint mist formation and because of this the paint transfer rate rises to approx. 65%. The spray pressure required in this case is between 1 - 5 bar. Nozzle sizes from 1 - 2.2 mm can be used.

HVLP spray guns



Item	Description
1	Quantity control
2	Working pressure control
3	Spray pattern control

The high volume low pressure (HVLP) spray gun is a high performance spray gun which forms a soft, fine and homogenous spray pattern. The atomization pressure at the air cap is 0.7 bar when the input pressure at the gun is 2.0 bar.

The low atomization pressure of 0.7 bar together with greatly reduced spray mist provide high material ejection. The low nozzle internal pressure minimizes rebound of the paint droplets from the object and thus the proportion of overspray.

This spray technology has a very high application efficiency. By matching the size of the nozzle, the HVLP spray gun can be used for all repair painting materials.

HVLP spray guns are often used in practice for the application of water based paints.

Mini spray guns are often used for small, localized touching-up work. Use of HVLP spray technology and nozzle sizes of 0.3 - 1.2 mm permits very fine

DESCRIPTION AND OPERATION

work, so that the area of the repair can be kept as small as possible.

In order to ensure that a spray gun operates efficiently for a long time, careful cleaning is absolutely vital after use.

NOTE: During cleaning you must distinguish between water based and solvent based materials.

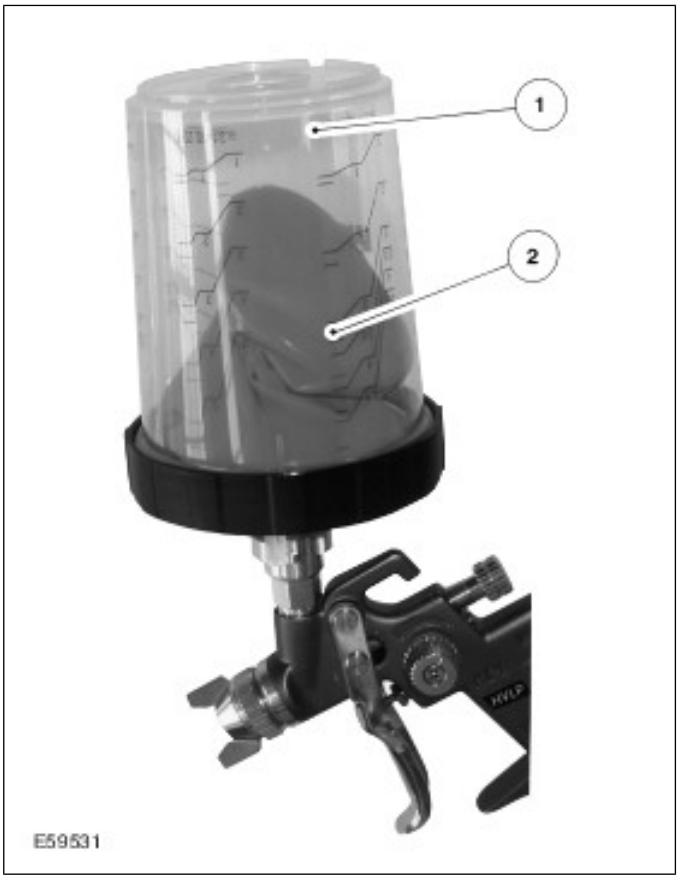
Cleaning by hand:

- Empty the paint beaker immediately after use.
- Flush the gun with cleaner.
- Clean it inside and outside with a brush.
- Dismantle the gun to clean it thoroughly.
- Clean the air cap using a suitable brush.
- Use nozzle cleaning needles to clean bores and nozzles.

A spray gun washing machine is recommended if the painting work is highly intensive.

New types of paint processing systems are replacing the conventional mixing beaker, filter and spray gun flow beaker. This reduces the amount of solvent required for cleaning and the amount of routine waste which remains.

Paint preparation system (PPS)



Item	Description
1	Beaker
2	Color bag

With this system, which is suitable for both suction and flow beaker spray guns, only one beaker is required for mixing and painting.

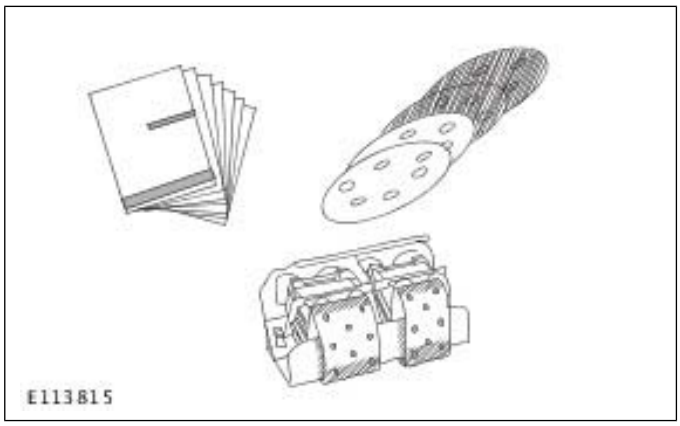
A bag is inserted in the beaker, in which paint can be mixed, processed and stored after use or completely disposed of.

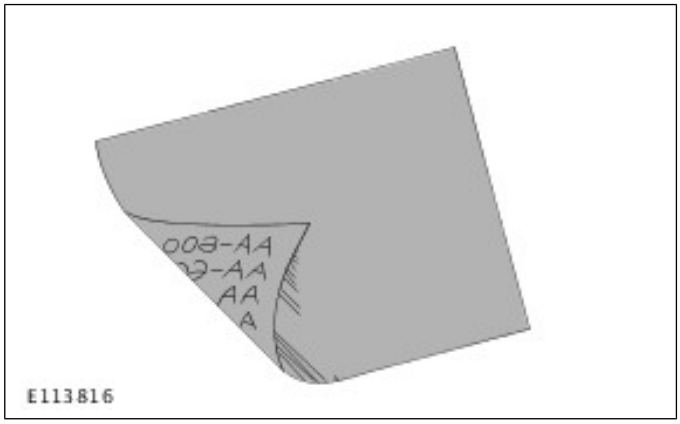
The small quantity of paint remaining in the gun is removed using a minimum quantity of solvent from the pipette bottle.

The amount of cleaner used is reduced because only the spray gun needs to be cleaned.

DESCRIPTION AND OPERATION

Hand and machine sanding tools





Sanding is used to prepare a surface for application of a paint layer, enabling it to adhere well. Sanding materials have a great influence on the quality of a repair paint finish. The correct sanding medium must therefore be chosen for every material.

During sanding, material is mechanically removed from a surface.

In the paint shop, Carborundum or silicon carbide abrasive on a substrate of paper or cloth are the most common sanding materials used.

Carborundum is a very hard mineral consisting mostly of aluminum oxide. During use Carborundum becomes blunt and wears away.

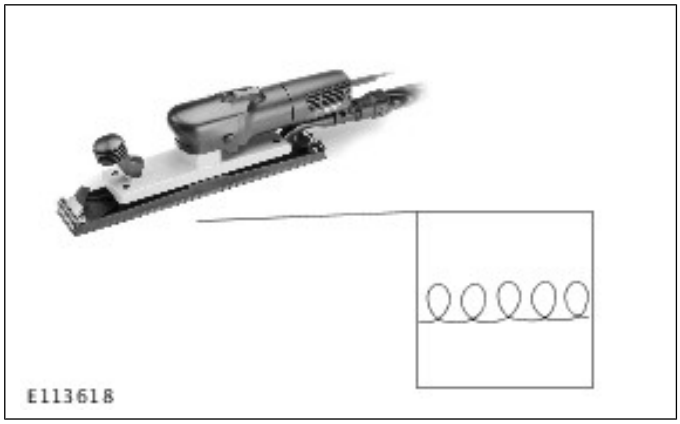
Silicon carbide has a very high degree of hardness, but is more brittle than Carborundum. When silicon carbide is used, the mineral grains break. New long and pointed profiles are formed.

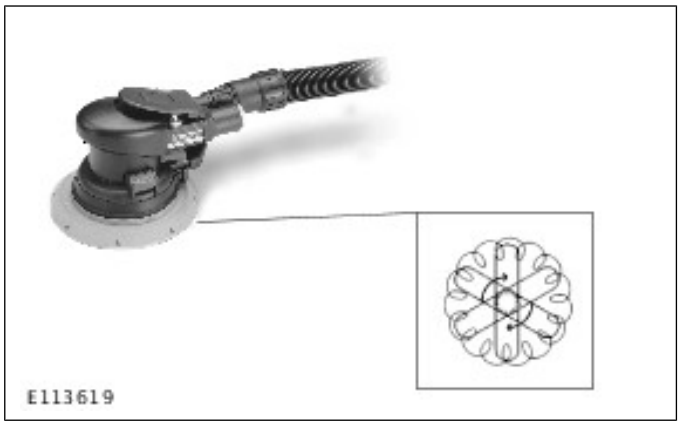
Use of the correct sanding paper depends on the application, the substrates and the tools used. The following table can be used as a guideline, but the recommendations of the supplier of the auxiliary materials and additive materials must be followed.

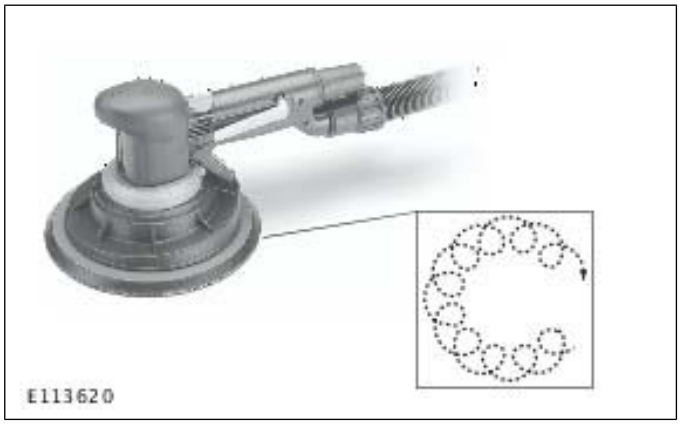
Application	Working area	Grade	Sanding system
Body work, corrosion damage	Equalizing paint system transition	to P150	Orbital sander, dry
			Hand sanding, dry
Stopper	Rough sand	P80 - P150	Orbital sander, dry
	Fine sand	P240 - P320	Orbital sander, dry
			Hand sanding, dry
Spray stopper	Rough sand	P120 - P180	Orbital sander, dry
	Fine sand	P240 - P320	Orbital sander, dry
			Hand sanding, dry
Filler sanding work	Filler fine sand	P400 - P500	Orbital sander, dry
		P800 - P1200	Hand sand, wet
Top coat	Old paint	P400 - P500	Orbital sand, dry
		P800 - P1200	Hand sand, wet
	Touch-up paint surfaces	P1000 - P2000	Hand sand, wet
Paint damage	Sanding out faults	P2000 - P3000	Hand sand, wet

Soft Pads are recommended for manual refinishing of contours, curves and difficult to reach areas. On a Soft Pad the abrasive is found on a coarse structured fleece. Because of this, it is very flexible, does not kink and does not slip in the hand. This enables a fine and even finish to be achieved.

DESCRIPTION AND OPERATION







Notes on working with sanding tools:

- Tools with a rigid backing pad do not adjust to fit the surface. They are used for flat surfaces.
- Tools with a flexible backing pad are used for fine sanding of a surface because they adjust to the shape of the surface.
- Build up an even working pressure over the sanding surface.
- Keep the sanding paper tight on the tool (use self-gripping systems).
- Align the extraction holes in the sanding paper with the holes in the tool.
- Guide the tool flat over the surface to be worked. Do not tilt it.

Hand sanding can be carried out dry but also wet. Wet and dry paper with particle size P 80 to P 1200 is used for this in the paint field.

Ways of sanding

Sanding tools are driven either by electricity or compressed air.

Item	Description
1	Sanding machine
2	Polishing machine
3	Orbital sander

The disadvantage of electrically driven machines is that their own weight is high compared with pneumatic systems. They also become warm during work. They do not however need any special operating equipment for their energy supply.

Sanding machines are categorized by their type of sanding movement.

Rotational sanders

On these machines the sanding paper turns.

DESCRIPTION AND OPERATION

- Advantage:
  - Ideal for heavy sanding work.
  - Fast and aggressive sanding possible.
- Disadvantage:
  - Large amount of heat developed.
  - Difficulty sanding flat surfaces.
- Application:
  - Removal of old paint layers.
  - Preparation of panel for stopper.
  - Removal of rust.

Oscillating sander

On these machines the sanding paper oscillates. The backing pad is rectangular.

- Advantage:
  - Large sanding surface.
  - Ideal for large and flat surfaces.
- Disadvantage:
  - Hardly useable on rounded surfaces.
  - Flexible backing pad not possible.
  - Vibrations because of the poor support of the backing pad.
- Application:
  - Sanding of polyester stopper.
  - Sanding processes on flat surfaces.

Orbital sander

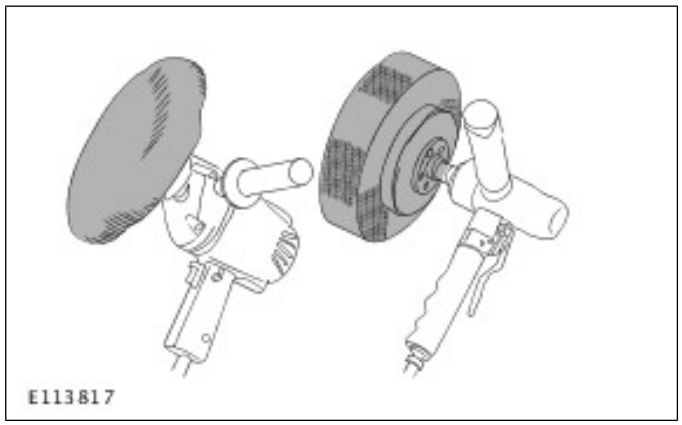
On these machines the sanding paper turns and oscillates.

- Advantage:
  - Easy to handle and good sanding power.
  - Minimal heat development.
- Disadvantage:
  - Not suitable for sanding stopper on flat surfaces.
  - Smooth guidance important, otherwise sanding marks will occur.
- Application:
  - Sanding of paint layers.
  - Well suited for final preparation of a primer.

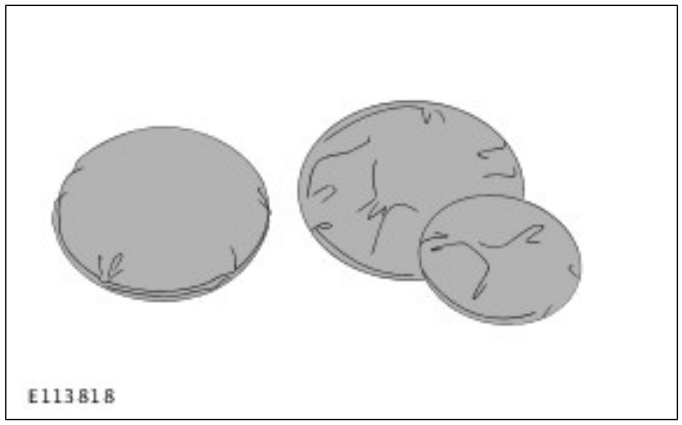
NOTE: Comply with the manufacturer's recommendations when setting the orbital sander.

On the orbital sander, stroke settings of approx. 3 mm for fine sanding work and approx. 5 - 7 mm for coarse sanding work have been established.

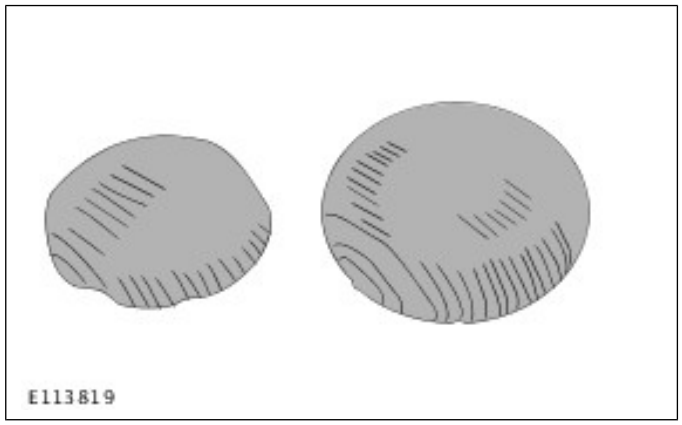
Polishing and finishing tools



Polishers

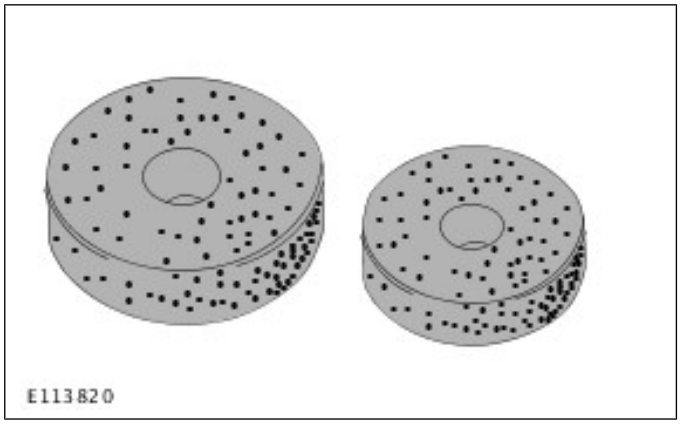


Towel Buff



Wool Buff

DESCRIPTION AND OPERATION



Sponge Buff

The term polishing in the context of paint repairs means the elimination of paint flaws and high shine polishing of neighboring parts.

During polishing the fine sanded surface is returned to a high shine using a special abrasive polish.

Before the actual polishing, all flaws in the paint surface must be removed and the following working procedures must be adhered to:

- Thoroughly clean the vehicle.
- Remove spray mist from all surfaces.
- Sand out and polish particle inclusions.
- Sand down paint runs and polish them out.
- Examine the exactness of the color match in daylight.
- Remove masking edges.
- Remove sanding water, sanding dust and polish residues.

After the polishing process the results must be tested using a special test spray.

Infrared drying technology

The drying process in a painting/drying cabin occurs through heat conductance (convection). When an infrared dryer is used, the drying process is through heat radiation.

The infrared rays penetrate the air and the paint layer without warming them. Because the infrared rays are reflected from the steel panel, the paint coat is warmed from the inside outwards.

Advantages of infrared drying:

- The drying process occurs from the inside to the outside.
- The drying time is shorter than for warm air systems.
- Because the infrared dryer consists of several cassettes which can be switched on independently, the drying area can be optimally controlled.

Independent of the manufacturer's instructions, pay attention to the following:

- Flash-off time of the paint before switching on the infrared dryer.
- Distance between the infrared dryer and the surface.
- Duration of the irradiation.

The most common use of the infrared dryer is to dry stopper and primers. The wait time between the job steps is shortened without having to use the painting/drying cabin.

The painting/drying cabin can then be used exclusively for application and drying of topcoat.

There are two types of infrared dryer:

- Infrared dryer with short wavelength radiation.
- Infrared dryer with medium wavelength radiation.

As an indication, the following drying times are listed for some materials (at 80 cm distance):

NOTE: Observe the material manufacturer's and supplier's specifications.

- Polyester stopper 2 minutes.
- Spray stopper 2 to 7 minutes.

DESCRIPTION AND OPERATION

- Water based primer-filler 7 to 9 minutes.
- Primer 3 to 8 minutes.
- Top coat 7 to 10 minutes.

Air dryers

The air dryer is suitable in places where drying needs to be done, but without great outlay (painting/drying cabin or infrared dryer).

NOTE: Air from the compressor is often too cold for effective drying.

Air dryers use the venturi effect to blow the warm ambient air over the paint surface in a gentle air flow.

Paint mixing system

Because of the many different color variants, it is now seldom possible to store all color shades as ready-made mixtures.

For this reason, vehicle manufacturers make the mixture proportions of their paints available as color codes. The required color shade can be obtained from the paint mixing system using this color code.

All the color components are combined according to their proportions by weight using a precise computer scales to produce a finished color shade.

Painting cabin

The air requirement in a painting cabin is large. The outside air which is drawn in must be passed through filtering and warming equipment. This particularly applies during colder times of the year and especially for combined types of building where the painting cabin is also used as a drying cabin.

It is primarily used to keep the air free of dust. At the same time, explosive solvent-air mixture concentrations are prevented

NOTE: Vacuum will lead to contamination of the newly applied paint. The outside air flows through door gaps, wall joints and other openings and as it does so, brings dust deposits with it.

The air supply quantity depends on the size of the painting space and the quantity of extracted air. Enough air must be supplied to cause positive pressure in the painting space. An air extraction : air supply ratio of about 1 : 1.05 is sufficient.

The filters should have a dust-removal grade of not less than 99.8% and must always be kept clean.

It is especially important that the air supply does not cause strong air currents in the painting cabin. If not, the following problems could occur:

- Paint contamination cause by paint mist, which persists in air eddies and gradually falls on the fresh paintwork.
- Flow problems in the paint because of the high speed of the air, causing the paint to thicken very quickly on the surface.
- Loss of gloss and wrinkle formation because the surface dries too fast.
- Painter disturbance while working.

In modern paint cabins the air supply is provided from the complete surface of the ceiling. The air speed should be 0.3 m/sec (measured in the unrestricted cross-section of the spray cabin). At the same time, the air in the cabin should change about 350 times per hour.

Air extraction is best achieved through extraction channels in the floor of the painting cabin.

NOTE: Refer to the manufacturer's specifications for the operating instructions, safety instructions and notes on the maintenance of a paint cabin.

Smooth walls in the paint cabin should prevent dust deposits. Regular cleaning is necessary however.

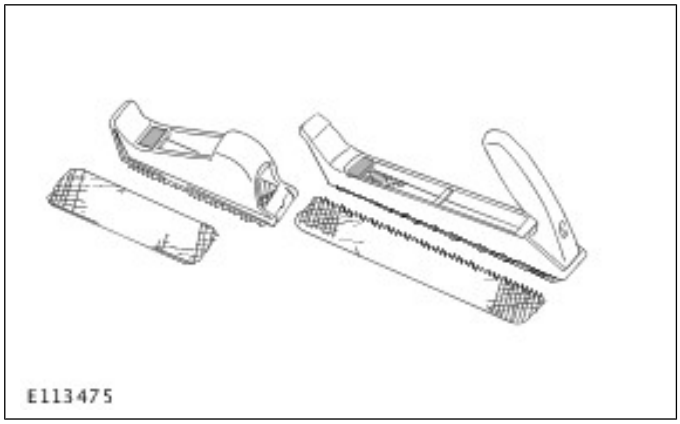
Special easily washed adhesive-bonding paint can be applied to the walls to protect the cabin from paint mist.

Other Equipments and tools

Surform

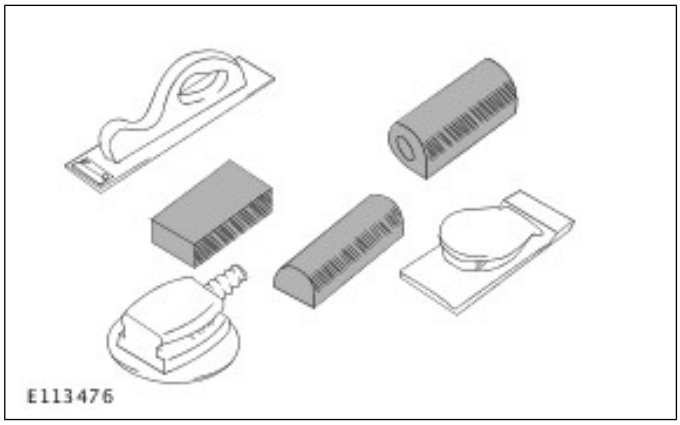
This is designed to use for shaving off the putty surface and making a rough cut of the piled putty.

DESCRIPTION AND OPERATION



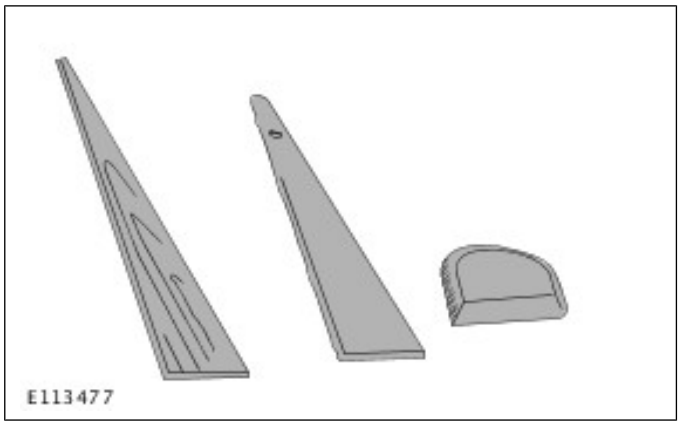
File, Sanding Block

This is designed to use manually for surfacing the primer surfacer coating.



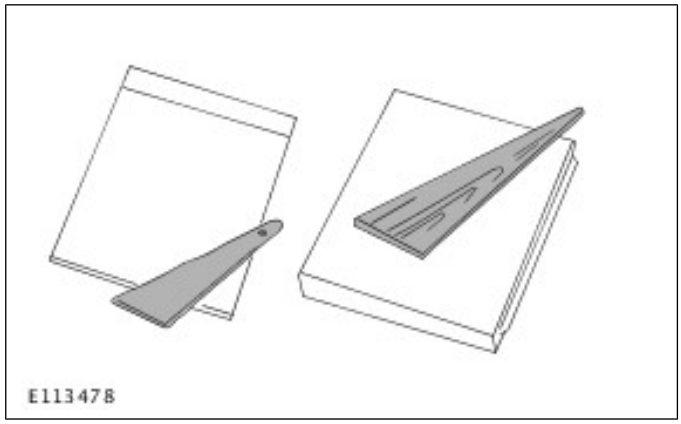
Blade/Spatula

This is used for putting putty on a part deformed, scratched, and any other holes. A wood blade will be suitable for the flat space of the steel plate, and for a curved area, blade of resin or rubber will be more elastic material, and fits much better.



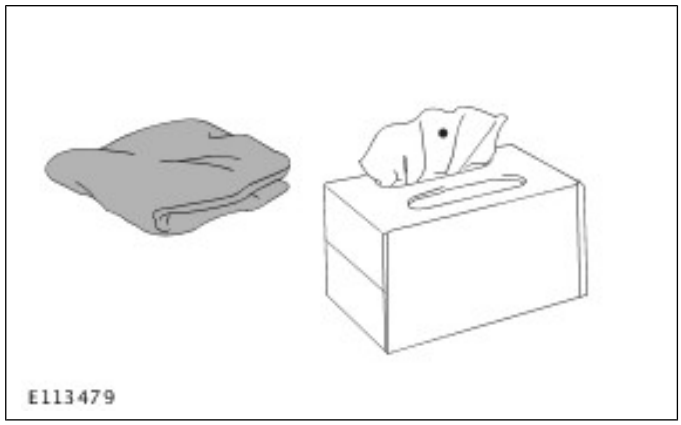
Putty Mixing Board

Use for kneading the putty. The material of the board will be metal, wood, plastic or use some pieces of paper board and make a disposable board.



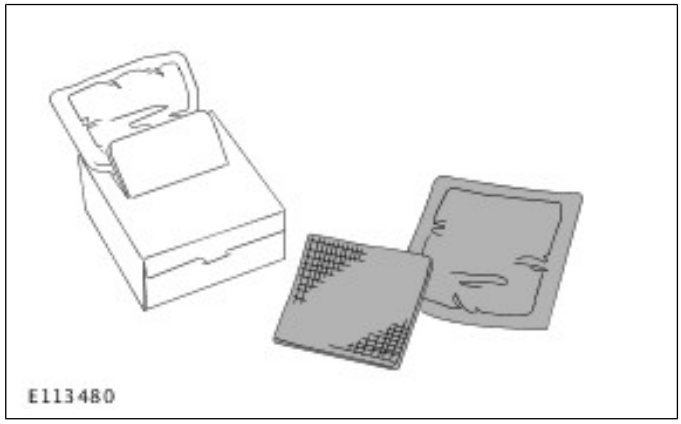
Waste

Waste materials which are used for repair and touch up painting workshop should be the one used but well washed clothes. New clothes will not be so effective for keeping on and wiping off water, because new products reserve oil substance which were used in the manufacturing procedures. Paper waste has better water and oil absorption than the cotton, and efficiency for removing water is more than double of the cotton clothes.



Tack Cloth

Tack cloth is a cloth dampened with tacky varnish and used for wiping the dirt, dust, and sand waste off the coat surface before coating.



DESCRIPTION AND OPERATION

Refinishing Materials

In order to provide best in class paint finish in manufacturing and to provide best paint finish in after market repair, Ford India has host of speciality paint finish vendors, who provide and supply best in class paint and allied products.

In order to equip Ford India Dealership Bodyshops with best in class refinish products and to provide them best in class training and technical information, Ford has launched **BSQC** (Body Shop Quality Care) Program. Dedicated team is deployed to ensure all Ford India authorised bodyshops are aligned with **BSQC** process and enjoys benefits from it.

BSQC process brings high level decipline in Body & paint shop repairs in the following:

- Repair approach
- Transparent estimation
- Smooth cooperation with **FPI** (Ford preferred insurance) agencies for claims proposal
- **BSQC** certified/approved equipments being deployed for repair
- **BSQC** certified/audited processes being followed for quick turn around and defect free flow of repair
- **BSQC** certified/approved refinish materials are used to ensure and enhance the repair quality and to avoid repeat repair
- Final inspection is carried out as per stringent **BSQC** certification criterias
- Vehicle delivery process as per **BSQC** certification norms

BSQC Certified Service/Solution Providers

In order to provide best in class service/solution, a preferred vendor is hand picked in each of the body/paint repair protfolio.

- **Body Shop**- **CAR-O-LINER**
  - Collision repair machine
  - Body Alignment cum smart repair machine
  - Mechanical measuring system
  - Electronic measuring system
  - MIG wleding machine
  - SPOT welding machine
- **Preparation Shop** - **3M**
  - Range of masking products
  - Range of preparatory products
  - Range of glues and adhesives
  - Range of abrasive products
- **Paint Shop** - **Dupont**
  - Range sanding products
  - Range of body fillers and putty products
  - Range of solvents and chemicals
  - Range of base coats
  - Range of top coats
  - Range of metallic/perl coats
  -

After Market Suppliers

These suppliers are hand picked by Ford India service team after thorough discussion and analysis on the products, service offerings and on job training courses offered.

- **Dupont** speciality refinish coating products (Centari, Standox)
- **Akzo-nobel** speciality refinish coating producta (Sikkens)

The manufacturer's instructions must always be followed when dealing with all materials! The information given in the following text is data which is independent of the manufacturer, and it should only be used as an indication.

Stopper materials

- 1-component nitro-combination stopper
- 2-component polyester stopper
- 2-component plastic stopper

Use suitable primer to protect from corrosion areas which have been sanded bare before applying stopper.

DESCRIPTION AND OPERATION

1-component nitro-combination stopper

Nitro-combination stopper has mostly been superseded by 2-component polyester stopper.

Fast drying fine stopper for the smoothing of irregularities.

The working properties of 1-component nitro-combination stopper can be improved by the addition of nitro thinners.

Drying time increases with thickness of the layer.

Application	1-component nitro-combination stopper
Layer thickness	Max. 80 µm
Drying time	up to 2 hours at 20°C
Sand	P240 - P400

2-component polyester general stopper

CAUTIONS:

Do not exceed the quantity of hardener specified by the manufacturer, excess peroxide can cause staining of the paint top coat.

Mix the stopper base and the hardener well to avoid a marble-like effect.

Check that the manufacturer permits use on the substrate to which it will be applied.

2-component polyester stopper is available in coarse and fine grades. The coarse stopper can be used for very uneven areas and surfaces and fine stopper or spray stopper should be applied afterwards.

Application	2-component polyester coarse stopper
Use	Rough equalization of unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 4 - 6 minutes
Drying	20°C approx. 12 minutes
	Short wavelength infrared approx. 4 minutes
	Medium wavelength infrared approx. 5 - 10 minutes

Application	2-component polyester coarse stopper
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150

Application	2-component polyester fine stopper
Use	Equalization of unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 4 - 6 minutes
Drying	20°C approx. 12 minutes
	Short wavelength infrared approx. 4 minutes
	Medium wavelength infrared approx. 5 - 10 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P240

Application	2-component polyester glass fiber stopper
Use	Equalization of unevenness; blending in of vehicle extensions; repair of GRP components
Hardener quantity	approx. 3 - 5%
Working time	approx. 4 - 6 minutes
Drying	20°C approx. 12 minutes
	Short wavelength infrared approx. 4 minutes
	Medium wavelength infrared approx. 5 - 10 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150

2-component polyester fine stopper should always be applied after 2-component polyester glass fiber stopper.

DESCRIPTION AND OPERATION

Application	2-component polyester spray stopper
Use	Equalization of unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 25 - 30 minutes
Layer thickness	200 µm or 4 - 8 spray passes
Drying	20°C approx. 3 hours
	Short wavelength infrared approx. 10 minutes
	Medium wavelength infrared approx. 15 - 20 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150; fine sand - P280

Application	2-component plastic stopper for flexible thermoplastic
Use	Equalization of scratches or unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 25 - 30 minutes
Drying	20°C approx. 15 - 30 minutes
	60°C approx. 15 min
	(Short wavelength infrared approx. 8 minutes)*
	(Medium wavelength infrared approx. 8-10 minutes)*
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150; fine sand - P280

***Infrared drying may adversely affect adhesion, therefore check the manufacturer's instructions.**

Plastic stopper has a very great tendency to shrink back, so that the edge of the stopper repair becomes visible.

Plastic stoppers are flexible and universally applicable on all types of plastic (except for pure PE and PP, these are plastics which cannot be painted). The manufacturer's instructions must be very exactly followed in order that no adhesion problems occur. A special plastic etch primer is specified for some materials.

Primers

Application	1-component primer
Use	Isolation of bare sanded areas.
Spray gun	HVLP 1.3 mm
Spray pressure	2.0 bar
Drying	20°C approx. 15 - 20 minutes
	60°C approx. 10 min
Coat application	Wet on wet, no intermediate sanding

Application	2-component primer
Use	Corrosion protection and bonding agent (steel sheet, zinc coated steel sheet, aluminum)
Spray gun	HVLP 1.3 mm
Spray pressure	2.0 bar
Drying	20°C approx. 15 - 20 minutes
	60°C approx. 10 min
Coat application	Wet on wet, no intermediate sanding

HS primer filler and HS tinted filler

Note:

- Primer filler is available as 1-component and 2-component water based and solvent based forms.
- 1-component products are only suitable for isolation of sanded through bare areas and new painting.
- Water based products are also used for the skinning of thermoplastics and substrates which are sensitive to solvents.

DESCRIPTION AND OPERATION

- Tinted fillers can be individually matched to the top coat color and therefore find uses in effect paints and paints with poor covering power.
- Use dry sand or wet sand filler according to application in order to avoid unnecessary sanding work.
- On critical substrates the use of epoxy resin base filler is recommended in order to avoid adhesion problems.

Application	HS primer filler and HS tinted filler
Use	Equalization of unevenness, edge zones, sanding scores
Spray gun	HVLP 1.6 - 1.9 mm
Spray pressure	2.0 bar
Layer thickness	50 - 70 µm to 150 µm possible
Drying	20°C approx. 2.5 hours
	(60°C approx. 25 min)*
	(Short wavelength infrared approx. 8 minutes)*
	(Medium wavelength infrared approx. 10-15 minutes)*
Coat application	Wet on wet, no intermediate sanding

***In order to avoid boiling out, drying should be performed slowly.**

Paint

The base and the clear lacquer must be matched to one another.

Application	Water based paint
Use	Two layer metallic effect paint and Uni-paint finishes
Spray viscosity	At 20°C 18 - 20 s
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar
Layer thickness	15 - 20 µm
Drying	20°C approx. 2.5 hours
	60°C approx. 25 min
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes
Coat application	Wet on wet
Ventilation time	approx. 5 minutes

The base paint must be dried matt before the clear lacquer is applied.

Application	2-component HS clear lacquer
Use	Gloss providing protective coat for base coat substrate
Spray viscosity	At 20°C 18 - 20 s
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar
Layer thickness	50 - 70 µm
Drying	20°C approx. 10 hours
	60°C approx. 30 min
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Application	2K HS Uni top coat
Use	Color and gloss providing paint layer
Spray viscosity	At 20°C 20 - 22 s
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar - 3.0 bar
Layer thickness	50 - 70 µm
Drying	20°C approx. 8 hours
	60°C approx. 30 min
	Short wavelength infrared approx. 8 minutes

DESCRIPTION AND OPERATION

Application	2K HS Uni top coat
	Medium wavelength infrared approx. 10 -15 minutes

DESCRIPTION AND OPERATION

Additional Materials

WARNING: Always use tested and approved product specified by Ford India through various communications. This safeguards from any eventual hazards arising from chemical reactions and wrong usage of materials.

NOTE: Check the material expiry information prior using it in application. Expired products may be toxic and create chemical hazards.

NOTE: Do not mix various suppliers refinish materials. Each manufacturer provides materials for various applications, however mixing of different manufacturer products may lead to poor quality, not getting the desired results and also evoke potential chemical hazard.

The manufacturer's instructions must always be followed when dealing with any materials! The information given in the following text is data which is independent of the manufacturer, and it should only used as an indication.

Adhesive sealants

Adhesive sealants are permanently elastic, long-lived, can be painted and accept filler.

Application: Sealing of visible and normal seams.

Can be over-painted with 2-component paint, primer and fillers after having dried throughout.

Contamination can be removed using cleaner and thinner.

1-component PUR adhesive sealant

Note:

- Hardens using oxygen from the air. For that reason, it must only be stripped after it has completely dried through.

2-component MS polymer adhesive sealant

2-component MS polymer adhesive sealant is free of isocyanate, solvent and silicones and can be spot-welded.

MS polymer adhesive sealant

Can be over painted with water-based paints.

Suitable for spraying and brushing to obtain a composition true to the original.

MS polymer adhesive sealant is free of isocyanate, solvent and silicones and can be spot-welded.

Underbody protection

Underbody protection products are immune to abrasion, permanently elastic, adhere well and are suitable for a true to original texture.

Underbody protection based on solvent

Application:

- Underbody protection for visible areas.

Properties:

- Can be over-painted, also with 2-component paint.
- Can be colored with a proportion of up to 40% paint.

Note:

- Contamination can be removed using cleaner and thinner.

Water based underbody protection

Can be over-painted with water based paint.

Can be colored with water based paint.

Contamination can be removed using water.

Application	Water based underbody protection
Use	**Underbody protection** for visible areas
Spray viscosity	ready to use
Spray gun	Suction beaker HVLP gun 3 - 4 mm
Spray pressure	4 - 6 bar
Layer thickness	500 - 1000 µm
Drying	approx. 6 hours at 20°C
	approx. 45 - 60 minutes at 60°C

DESCRIPTION AND OPERATION

Application	Water based underbody protection
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Application	Water based underbody protection
Use	**Isolation primer** for peroxide marks, bloomed old paintwork and thermo-plastics.
Spray viscosity	Thin as necessary with distilled water
Spray gun	HVLP gun 1.9 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	40 - 50 µm
Drying	approx. 2 hours at 20°C
	approx. 30 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Paint additives

Application	Sanding test color
Use	To test sanding results
Spray gun	HVLP 1.7 - 1.9 mm
Spray pressure	2.0 bar
Layer thickness	Spray drifted

Application	Fixer additive
Use	Converts solid top coat into two layer solid; multi-color painting
Spray viscosity	18 - 20 secs at 20°C
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar

Application	Fixer additive
Layer thickness	max. 30 µm
Coat application	Wet on wet
Ventilation time	approx. 15 - 30 minutes

Maintain maximum layer thickness without fail.

Must always next be overpainted with clear lacquer.

Application	Drying accelerator
Use	Accelerates drying with only minimal reduction in working life
Working life	approx. 5 hours at 20°C
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 6 hours at 20°C
	approx. 25 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Cannot be used in all paints, read the manufacturer's instructions.

Particularly suitable for partial painting.

Application	Elastifier additive in primer material
Use	Elastifies the complete paint structure on plastics.
Addition	Up to 25%
Spray gun	HVLP 1.7 - 1.9 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 µm
Drying	approx. 4 hours at 20°C
	approx. 40 minutes at 60°C
	Short wavelength infrared approx. 8 minutes

DESCRIPTION AND OPERATION

Application	Elastifier additive in primer material
	Medium wavelength infrared approx. 10 - 15 minutes

Application	Elastifier additive in top coat
Use	Elastifies the complete paint structure on plastics.
Addition	Up to 25%
Spray gun	HVLP 1.7 - 1.9 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 60 µm
Drying	approx. 16 hours at 20°C
	approx. 45 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Application	Matting additive in solid paint
Use	Elastifies the complete paint structure on plastics.
Semi-gloss addition	Up to 25% in the paint without hardener and thinner
Silk gloss addition	Up to 35% in the paint without hardener and thinner
Silk matt addition	Up to 45% in the paint without hardener and thinner
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 8 hours at 20°C
	approx. 30 minutes at 60°C

Application	Matting additive in solid paint
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

CAUTION: Do not dry using infrared.

Application	Matting additive in clear lacquer
Use	Elastifies the complete paint structure on plastics.
Semi-gloss addition	Up to 25% in the paint without hardener and thinner
Silk gloss addition	Up to 35% in the paint without hardener and thinner
Silk matt addition	Up to 45% in the paint without hardener and thinner
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 8 hours at 20°C
	approx. 30 minutes at 60°C

Note:

- When mixing, first put in the matting additive, then the hardener and thinners.
- Stir immediately after adding the matting additive.
- Do not store after addition of the matting additive, storage will change the degree of gloss.
- Also suitable for use on plastics without addition of elastifier additive.

Application	Matting paste
Use	Matts, elasticizes and gives structure to solid paint and clear lacquer during painting of bumpers or hard plastic.

DESCRIPTION AND OPERATION

Application	Matting paste
Addition	1:1 or 2:1 depending on manufacturer in solid paint without hardener or thinners.
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 6 - 10 hours at 20°C
	approx. 30 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Note:

- **The paint must not be filtered.**

Application	Anti-silicone additive
Use	Prevents silicone craters
Addition	2% to maximum 5%

Note:

- Only add away from the paint cabin and immediately remove contaminated cloths.
- If anti-silicone additive is used in the first coat, then it must be used in the following coats, and in at least the same proportions.

Additive materials

Variety of adhesive tapes

For profile, fine and large area masking work.

Properties:

- Withstands heat.
- Withstands water-based paint.
- Accepts paint.
- Easily removed without leaving adhesive residues.

Masking film.

For masking of large areas on vehicles.

Properties:

- Accepts 2-component and water-based paints.
- Withstands heat.
- Withstands water spray and condensation.
- Withstands solvent.
- Easily cut.
- Environmentally friendly and can be recycled.

Polishing materials.

Polishing means microfine sanding. For this reason, polishes must only contain abrasives, and no silicones.

During polishing repair, a good shine is achieved through the step-by-step use of polishes, starting with a highly abrasive polish and ending with a polish having very slight abrasive action.

Polishes are available in graduations from coarse to fine.

Abrasives

Please refer to the "Tools" chapter for information on abrasives.

DESCRIPTION AND OPERATION

Paint Repairs

General information

There is a great difference between painting in production and repair painting.

In production, only the bodyshell is painted, it has no trim, upholstery or assemblies. Because of this, other paints, tools and processing techniques can be used.

In contrast to that used in production, paint used in the workshop must dry at low temperatures. Plastics and the vehicle electronics must not be subjected to temperatures greater than 70°C.

The painting process in the case of repair work consists of two phases:

- Pre-treatment of the surface for corrosion protection and the smoothing of irregularities.
- Top coat application.

The precondition for a professional paint finish on a vehicle is the permanently maintained cleanliness of work spaces, tools and equipment,

Original materials must be worked according to the manufacturer's instructions, so that no problems arise in the processing nor during drying.

The room temperature must be 20 - 25°C and the humidity must be low. Temperatures which are too low or too high can lead to porosity, poor flow and boiling. High humidity leads to paint damage such as tarnishing of the paint film (matt film), adhesion problems and craters.

Primer Surfacer Painting

Painting Procedures

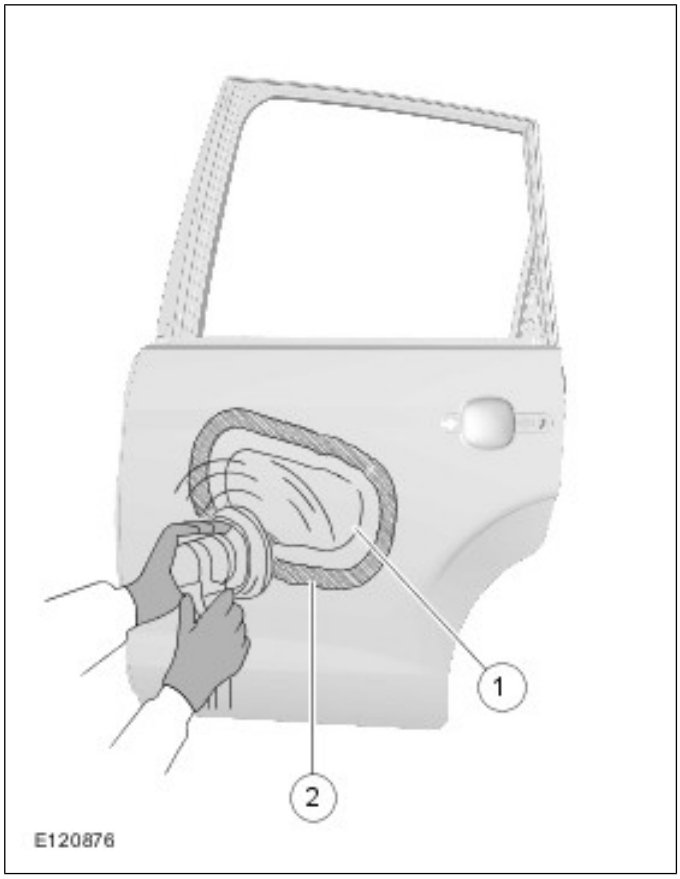
1. Check the painting surface.

- Before applying the primer surfacer, be sure to inspect the painting surface first. If the surface has a deep damage on it, it remains even after the primer surfacer is applied and, as the result, it becomes necessary to repair the damage after the primer surfacer process.
- When it is necessary to grind the deep damage, use a double action sander together with a P240 to P400 sandpaper. Where, however, a sander cannot be used because of space, use a hand file and then remove the damage with P400 to P600 sandpaper.

2. Grinding for better paint adherence (for primer surfacer painting).

- Grind off sandpaper scratches around the putty-applied surface with a double action sander using P320 sandpaper.
- Where it is impossible to use a sander because of space, use a hand file and then remove sandpaper scratches with a P600 sandpaper.
- Grind the puttied area and its surrounding range of about 100 mm (4.0 in) width from the brim of puttied area for better paint adherence.

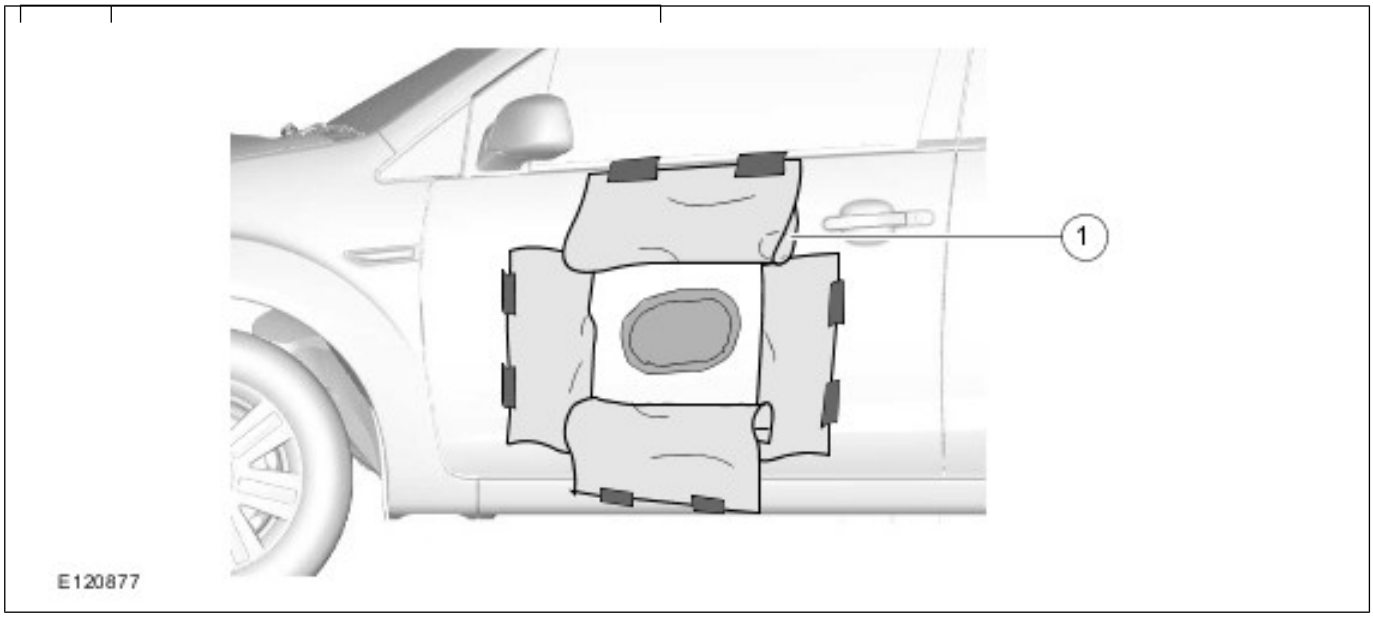
DESCRIPTION AND OPERATION



Item	Description
1	Putty
2	BRIM (edge)

3. Blow off all dust, dirt, and all foreign materials from the repaired surface.

4. Place masking sheet covering the primer surfacer painting area with a slight margin.



Item	Description
1	Reverse masking

5. Remove fat and oil and clean the primer surfacer painting area.

6. Preparation of primer surfacer (reference only).

Primer Surfacer Base:100+Hardener:10

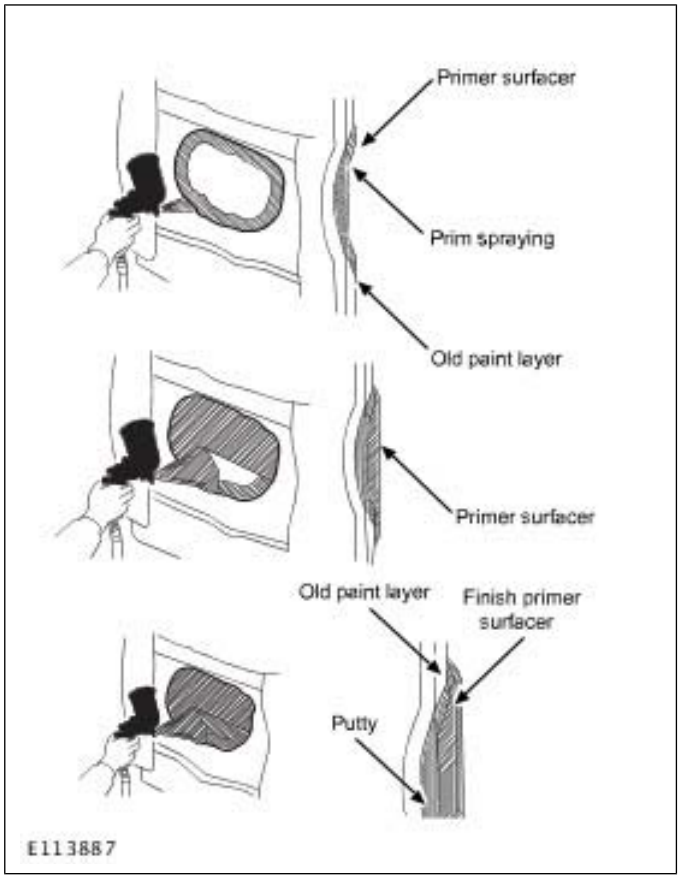
7. Primer surfacer spraying. The nozzle diameter of the spraying gun to be used for the primer surfacer painting should be about 1.5 mm (0.06 in).

- Spray the primer surfacer sparely around the bordering area between the puttied surface and the old painted surface to such an extent that

DESCRIPTION AND OPERATION

the sprayed surface looks half gloss. Take enough flash time.

- Spray the whole puttied area again in addition to the primer sprayed area to the half gloss extent.
- Take the flash time, and widen the painting area a little and spray once again for finishing.

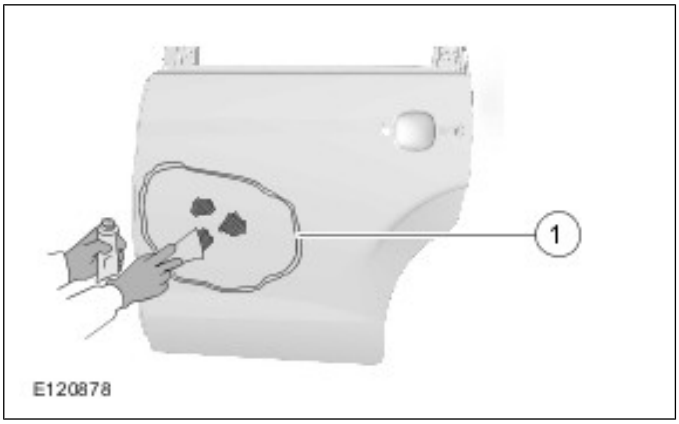


8. Drying primer surfacer. Take setting sufficient time and force-dry it.

NOTE: As for the drying time, follow the manufacturer's instructions.

9. Inspect the primer surfacer painted surface and, if necessary, repair partial defects with putty. Carefully inspect for paper scratches, cavities, etc. If any cavity or scratches are remain, fill them with putty.

- Polish the puttied surface with P400 to P600 sandpaper and, after that, clean with air blow and remove fat and oil from the surface.
- Apply putty with a spatula where necessary.
- Dry up the spots repaired later with putty.



Item	Description
1	Prime putty

10. Polish the last repaired areas with water or without to bring it to the finish.

NOTE: Be careful not to polish too much to expose the steel sheet.

Dry sanding:

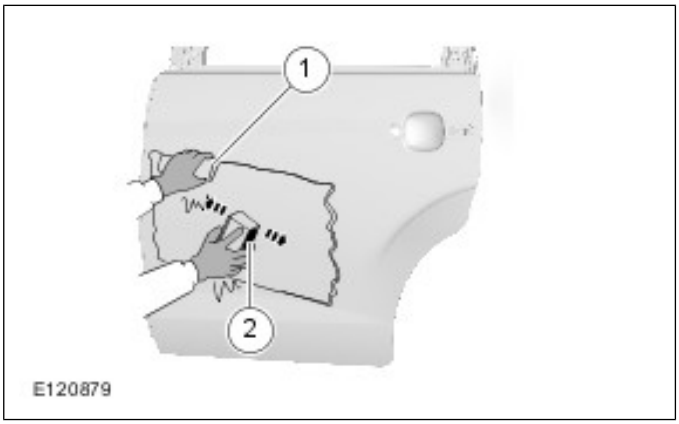
To polish by hand, use P400 to P600 sandpaper together with a rubber pad. Continue this work while removing abrasive powders to prevent clogging.

To polish with a double action sander, use a P240 to P400 sandpaper.

Wet sanding: (Generally not recommended

Use a sponge soaked with water.

To polish with water, use waterproof P400 to P600 sandpaper.



Item	Description
1	Sponge
2	Waterproof sand paper

11. Air blow and cleaning. After the painted surface is polished with water, air blow, the surface to

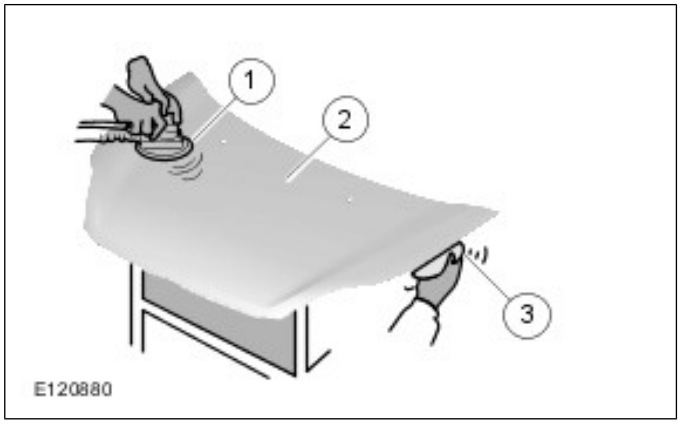
DESCRIPTION AND OPERATION

displace the water, after that, using an infrared light to dry it completely.

12. Inspection and repair after polishing. Inspect the state of the finished primer surfacer painted surface. If the surface is good without any defects, move to the top coat painting process. If any defect is found on the surface including unpainted spots, exposed putty or steel panel, repeat the primer surface painting and polishing processes.

Primer Surface Painting on a New Part

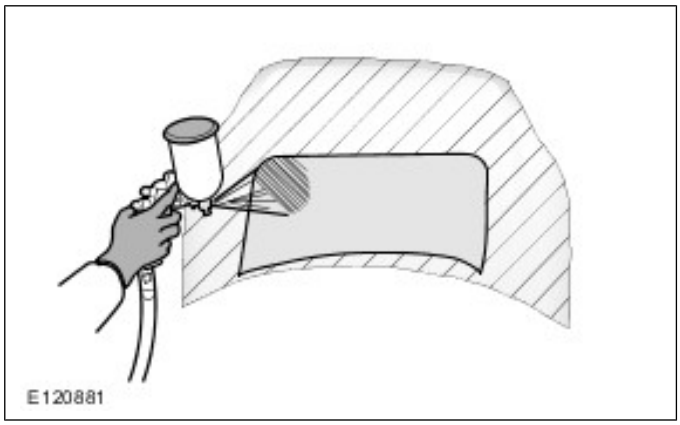
1. Polish with a double action sander attached with a P320 sandpaper. Where a sander cannot be used because of space, hand-polish it using a sandpaper brush.



Item	Description
1	Double action sander
2	New part
3	Sandpaper brush

2. Air blow, degrease and clean the surface.

3. Spray the primer surfacer (mist coat) over the whole panel to form a thin layer and inspect it for any defect such as unpainted spots.



4. After spraying, take enough flash time.

5. Do the final spraying so that the whole surface becomes even.

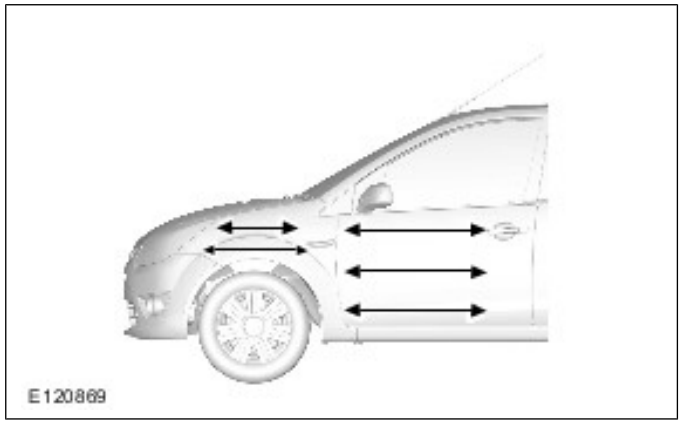
6. Polish the primer surfacer painted surface.

Sanding for Better Adherence to Top Coat Painting

This sanding work is done to increase adherence of the old paint layer to the top coat that is to be newly painted.

In a case that a block part or whole car is painted in the same color:

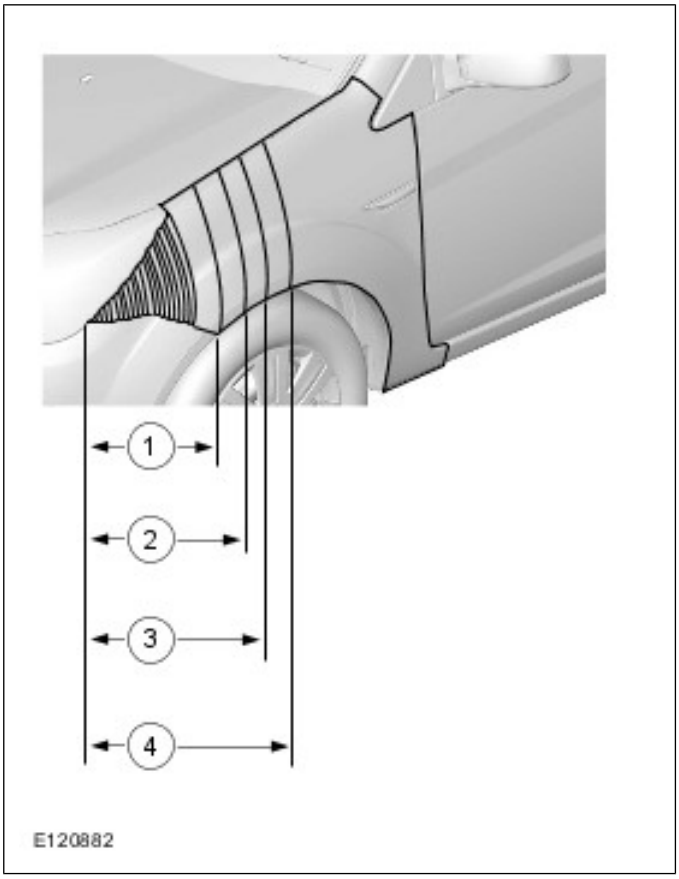
- Polish the area that is to be painted with top coat with a double action sander attached with a P320 to P400 sandpaper.
- Where the sander cannot be used because of space, handpolish with a P400 to P600 sandpaper. Be careful not to leave any spot unpolished.
- Polish only in a direction so as not to leave paper scratches.



In a case that only part of a panel is painted in gradation:

- Grind for better adherence the area to be painted in gradation and its surrounding border area.
- For a light solid colored surface, polish with an intermediate compound or with P1,000 waterproof sandpaper.
- For a metallic, pearl, or deep solid colored surface, polish with a fine compound or with P1,500 waterproof sandpaper.

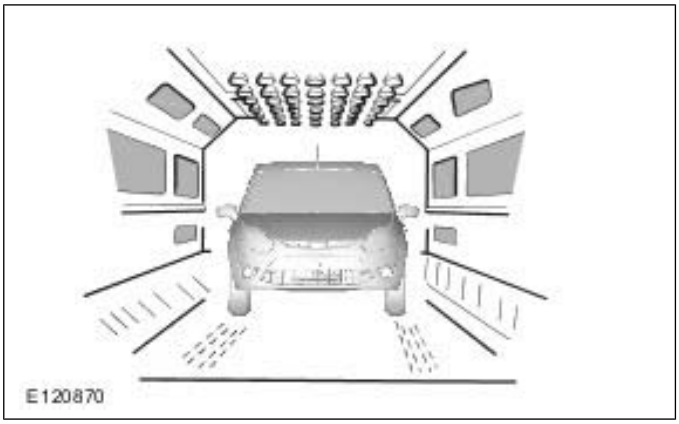
DESCRIPTION AND OPERATION



Item	Description
1	Decide on enamel colour
2	Enamel gradated
3	Clear coat sprayed
4	Clear coat gradated

Preparation for Top Coat Painting

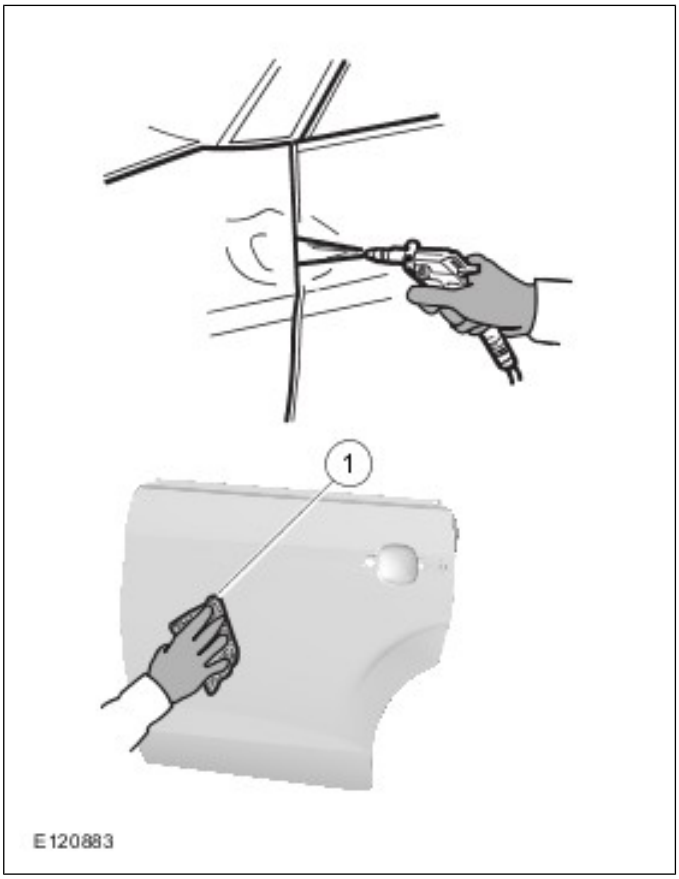
1. Clean and move. Clean the spray booth first. Sprinkle water over the floor and move the vehicle info the spray booth.



2. Clean the surface with air blow and degrease it.

- Degrease and clean the surface, check the lift or peel off of the masking paper. Using compressed air,blow off all dust and dirt from the gaps and recessed area of the panel.
- Just before top coat painting, wipe the whole painted area with a tack cloth. In doing this work, be careful not to press the cloth too much on the surface so that the varnish content of the cloth does not stick to the body surface.

NOTE: Do not touch the degreased surface with a ungloved hand.



Item	Description
1	Tack cloth

3. The technician will wear all safety gear and, in order to avoid dusts and dirt from adhering to the painted surface, will always wear a well washed work overall.

4. Paint mixing

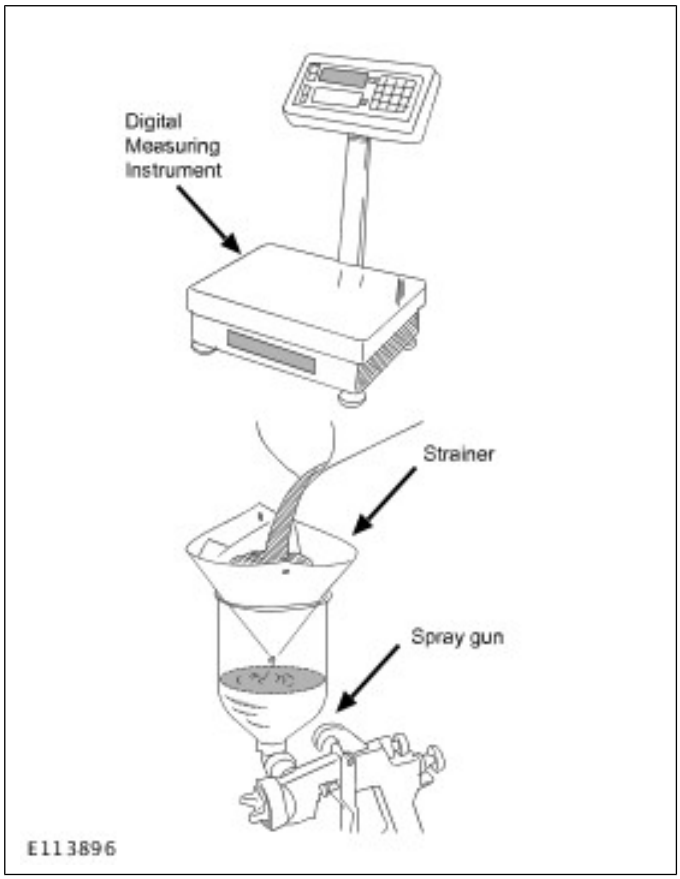
DESCRIPTION AND OPERATION

- Using a measuring instrument, mix the paint, hardener, and thinner to the correct ratio, according to the paint manufacturer's instructions. Avoid too much or too little of the hardener because it causes troubles after top coat painting. The use of a digital measuring instrument, which is so widely used, helps correct measurement problems.
- It is important to select the thinner depending upon the temperature in which it is to be used.

Use of thinner by temperature (Example):

Types of Thinner	Outdoor temperature °F (°C)
Ultra quick drying type (very cold season)	Less than 50 (10)
Quick drying type (cold season)	50 to 59 (10 to 15)
Normal type (warm season)	About 68 (20)
Slow drying type (hot season)	77 to 95 (25 to 35)
Ultra slow drying type (very hot season)	Over 95 (35)

- Mix the hardener and thinner to the paint, filter it with a strainer, and put it in a spray gun.

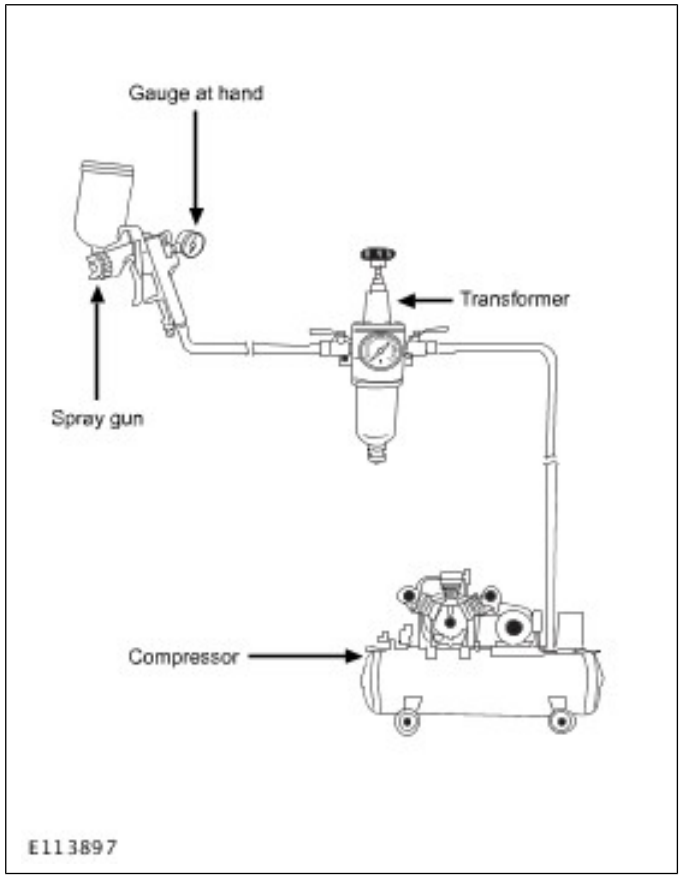


How to Use a Spray Gun

Check on Spraying Pressure

Set the most appropriate spraying pressure according to the type of paint and the range of spraying.

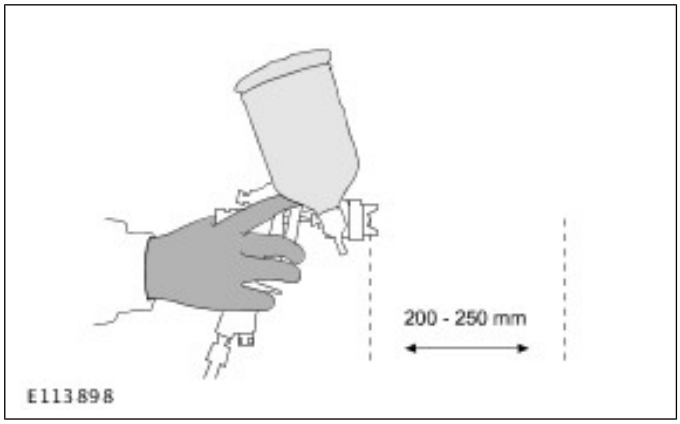
Generally, the spraying pressure is adjusted by the pressure gauge of a transformer. But, the pressure at hand varies according to the diameter and length of the hose. In order to measure the correct spraying pressure, install a hand gauge to the spray gun.



Spraying Distance

The longer the spraying distance is, the wider the spraying pattern, the thinner paint layer, and the less the paint loss become. Or if the distance is too short, unnecessary paint flows take place. Generally speaking, the spraying distance is about 200 mm (7.87 in.) for lacquer paints and 250 mm (9.84 in.) for acrylic urethane paints.

DESCRIPTION AND OPERATION

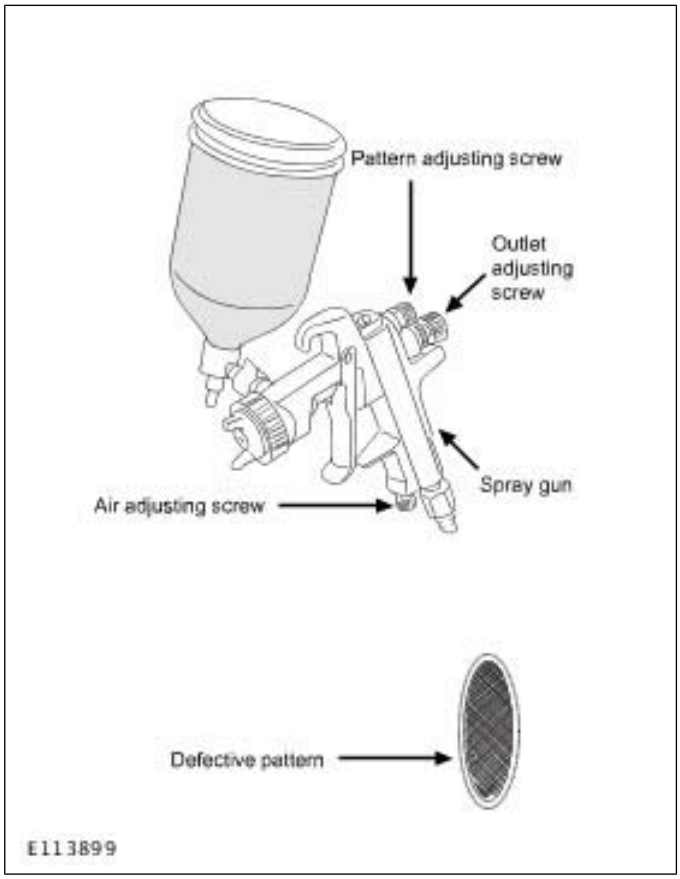


Adjustment of a Spraying Pattern

Adjust the spraying pattern with the spraying pattern adjusting screw and paint outlet adjusting screw.

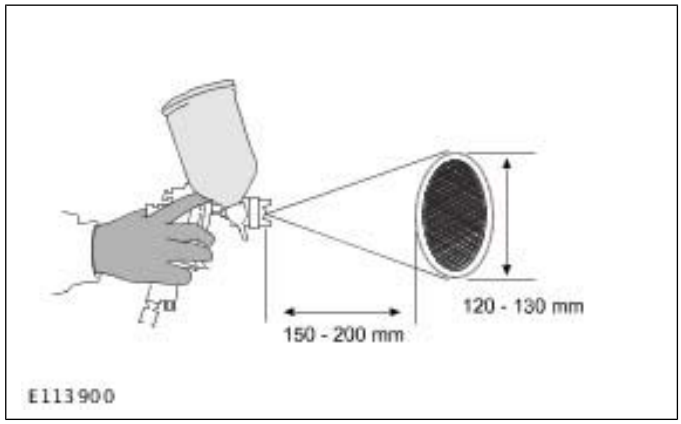
If the border of the spraying pattern becomes rough,increase the outlet by adjusting the outlet screw or decrease the amount of air by adjusting the air screw.

If flow marks appear on the painted surface, decrease the outlet. Also check the paint viscosity and the evaporation speed of the thinner.



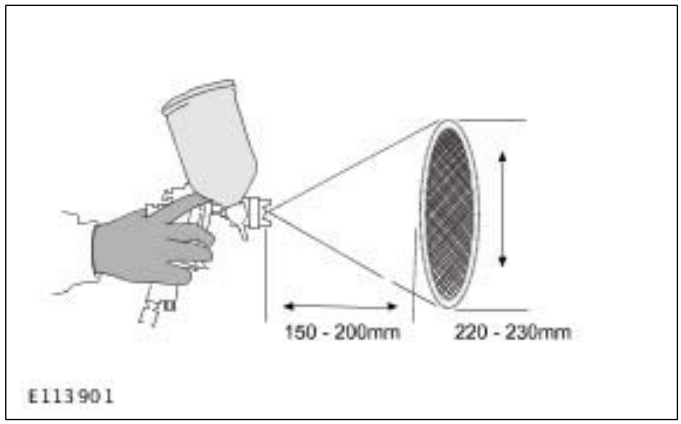
Pattern for partial painting:

Adjust the spraying pattern by turning the adjusting screw so that the spraying distance is 150 to 200 mm(5.91 to 7.87 in.), and the pattern width is 120 to 130 mm (4.72 to 5.12 in.) with no uneven painted surface and no paint flows.



Pattern for whole painting:

Adjust the spraying pattern by turning the adjusting screw so that the spraying distance is 150 to 200 mm (5.91 to 7.87 in.), and the pattern width is 220 to 230 mm (8.66 to 9.06 in.).



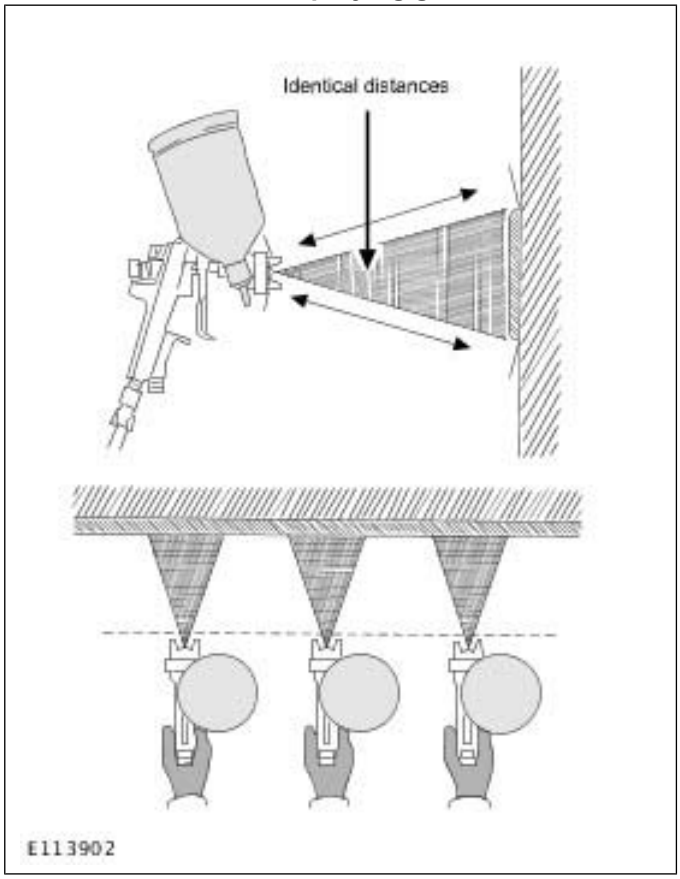
Movements of Spray Gun

Spraying Angle

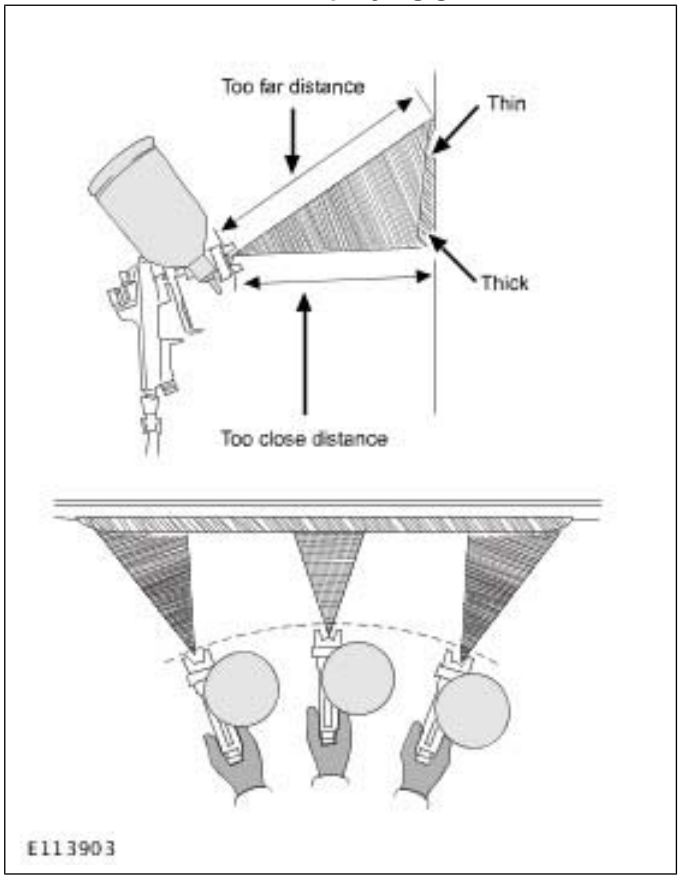
The generally gun moving speed is about 2 to 3 second per m. In order to form an even paint layer (identical thickness over the whole pattern), it is necessary to keep the same speed of moving the spray gun.

DESCRIPTION AND OPERATION

Correct movement of spraying gun:

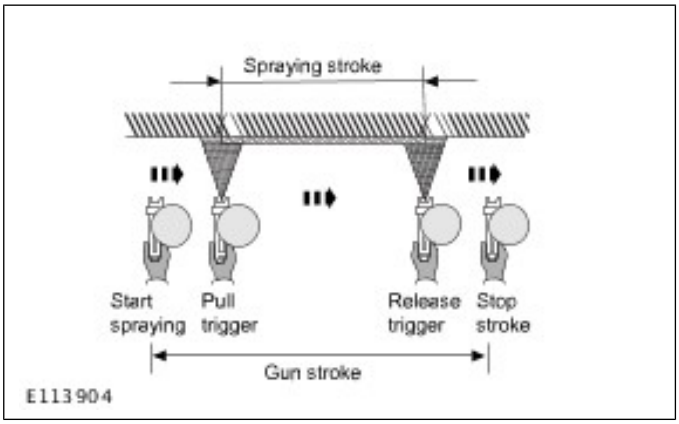


Incorrect movement of spraying gun:



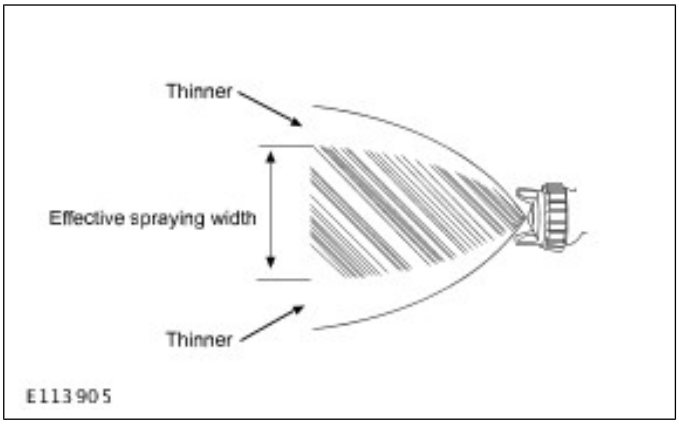
Gun Moving Speed

The generally gun moving speed is about 2 to 3 second per m. In order to form an even paint layer (identical thickness over the whole pattern), it is necessary to keep the same speed of moving the spray gun.



Double Spraying Width

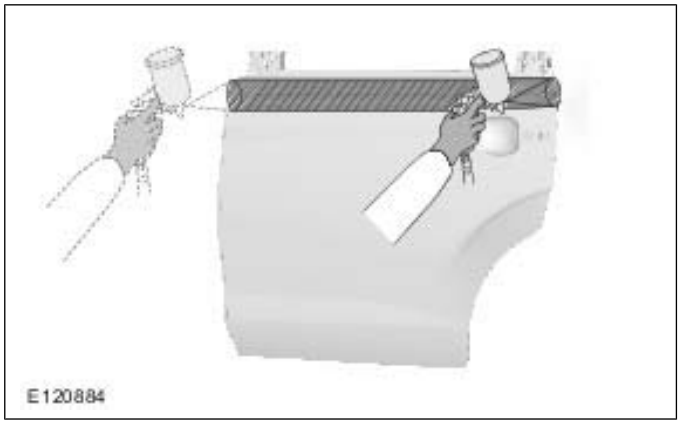
Within an effective spraying width of a spraying stroke, the thickness of paint is the same, but beyond the border, it becomes thinner. Therefore, in order to compensate for the difference and make the painted area have the same paint thickness, double painting is necessary.



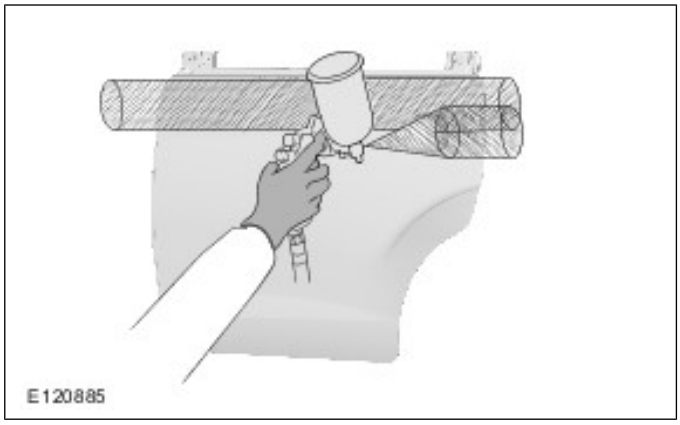
Single Coating and Double Coating

1. Facing the surface to be sprayed, hold and aim the gun toward 50 to 70% of the surface width beyond the left end of the panel. Move the gun from the left to the right beyond the right end.

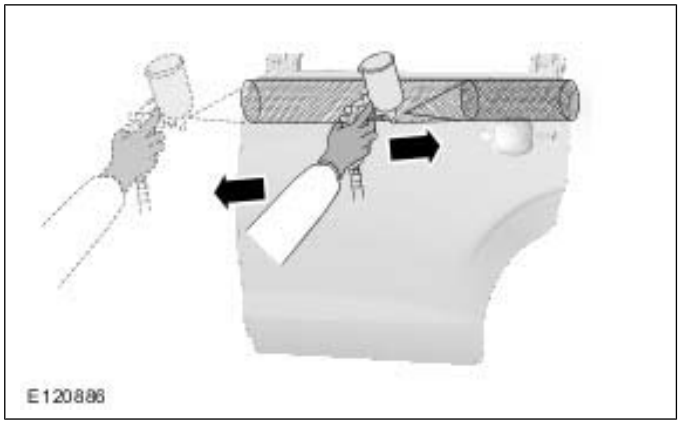
DESCRIPTION AND OPERATION



2. After moving the gun toward the right, shift the gun position down and move the gun to spray the same way from the right to the left while the spray pattern overlapping (50 to 70%) with the effective spraying width of the previous stroke. Repeat spraying until reaching the bottom. This way of spraying is called the single coating.

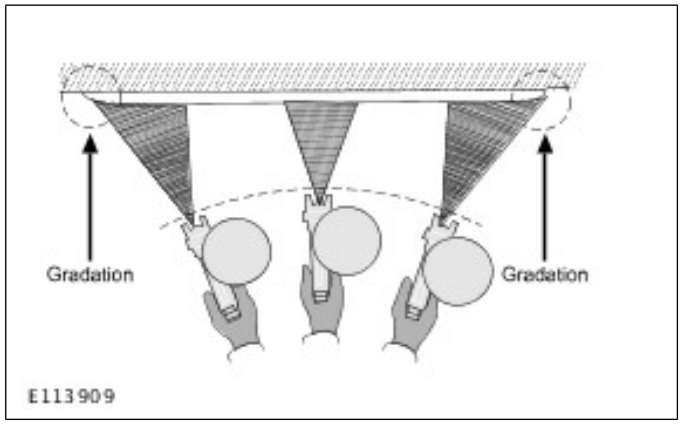


3. Spraying the same area repeatedly until it becomes finished without going to the next area is called the double coating.



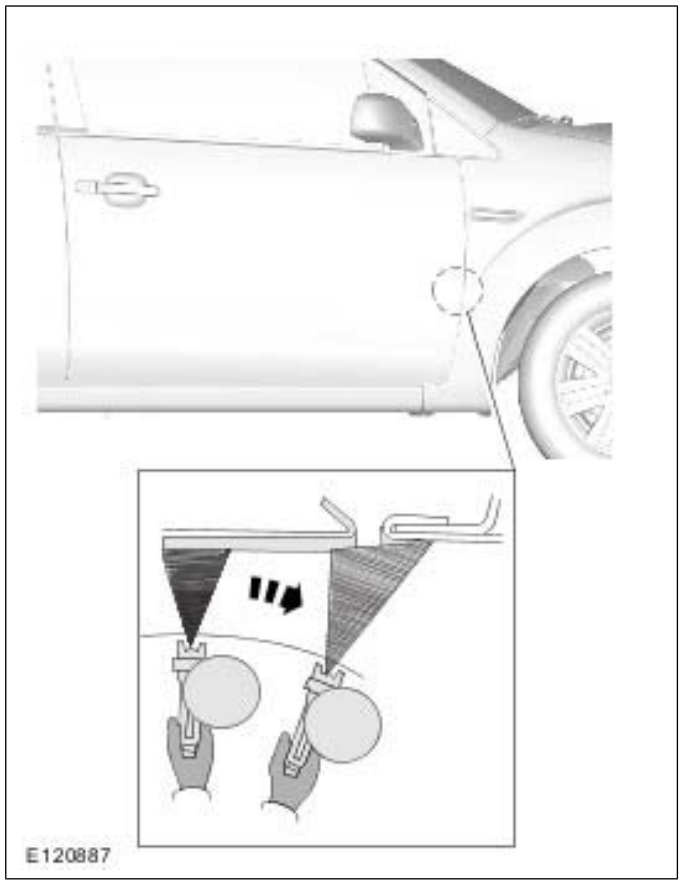
Gradation

Move the gun as if to draw a crescent as the direction of the gun is away from the repaired area by snapping the writ. By moving the gun this way, the paint layer thickness becomes gradually thinner as it moves away.



Overlapped Spraying

When a wide surface is sprayed, use the gradation method as described above so that the overlapped area becomes too thick in layer thickness.



Care of Spray Gun

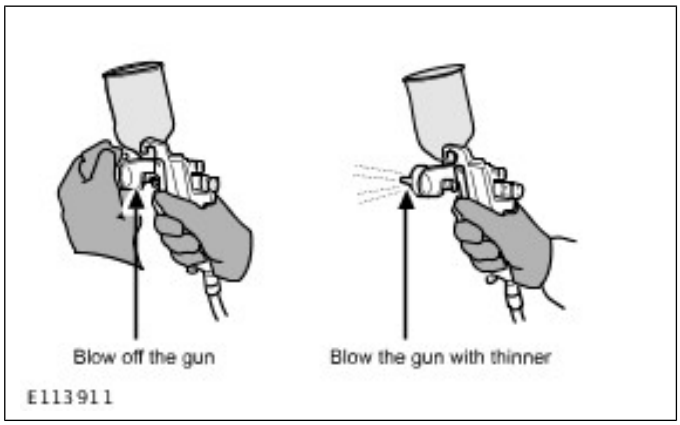
If a spraying gun is left as it is even for a short period of time after it has been used, it cannot be used again because the paint inside is hardened and clogs the mechanism inside.

DESCRIPTION AND OPERATION

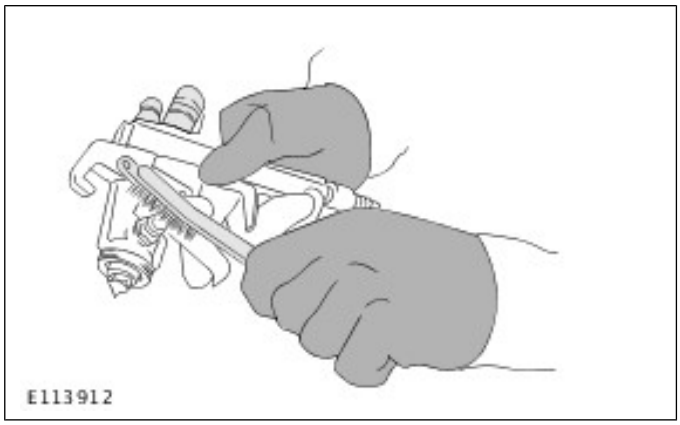
Washing Procedures

1. Cover the air cap with a cloth and pull the trigger. Then, the air that is blown out of the paint nozzle tip enters the paint passage thus cleaning the inside of the gun.

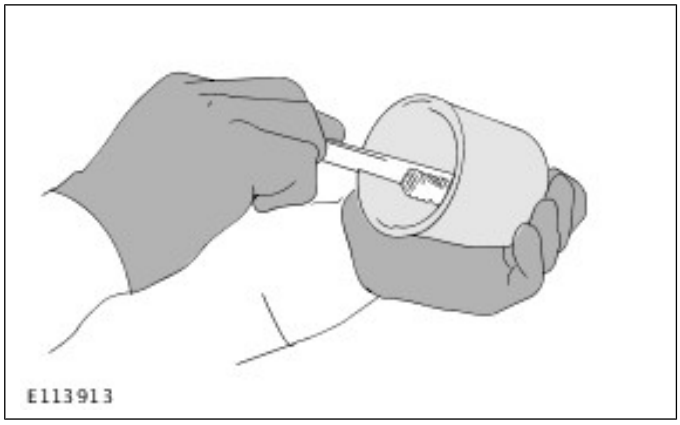
2. Discard the paint remaining in the cup and put some thinner in for washing and blow the gun out.



3. Clean the inside and outside of the spray gun with an attached hairbrush and clean it.



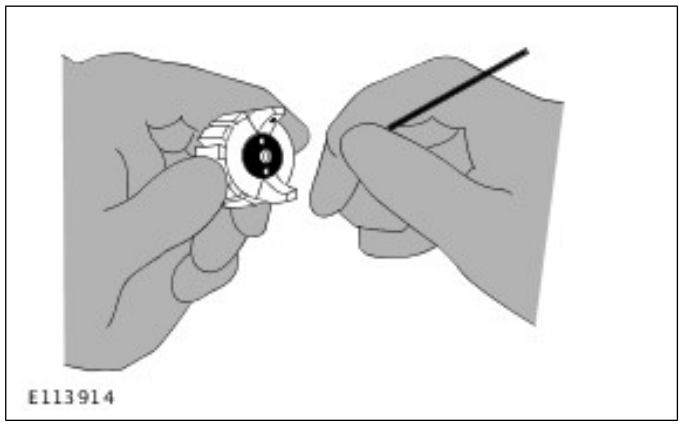
4. Clean the inside of the paint cup.



5. Remove the air cap and clean the inside and outside with an attached hairbrush soaked in thinner.

NOTE: When washing, be careful not to damage the air hole of the air cap because it affects the spraying pattern greatly. Never use a steel wire or wire brush for cleaning. When the air hole is clogged, clean it using a wood toothpick or something like that.

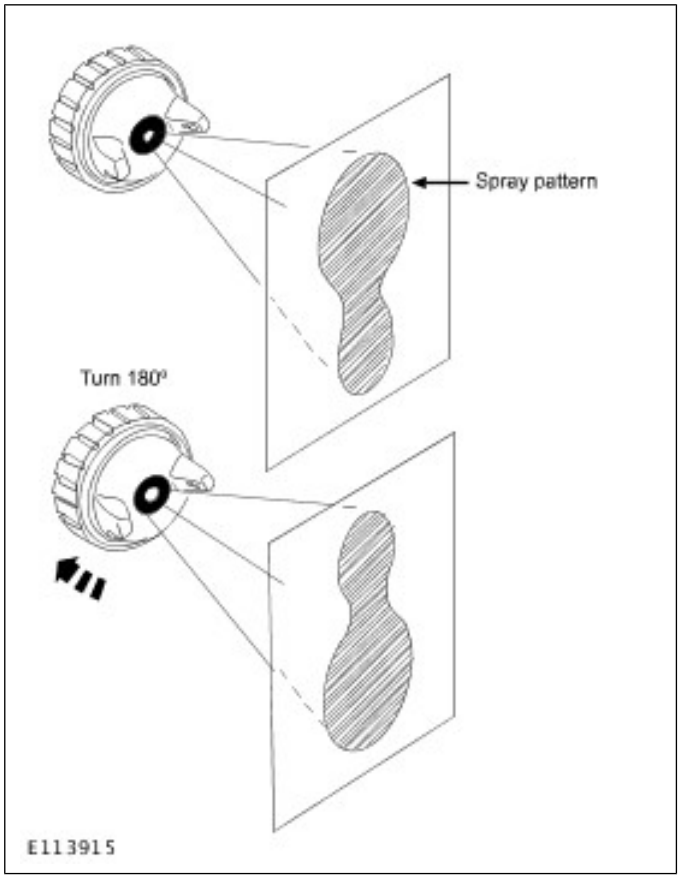
NOTE: When it is hard to get rid of the stuck paint, wash it after it has been submerged in lacquer thinner.

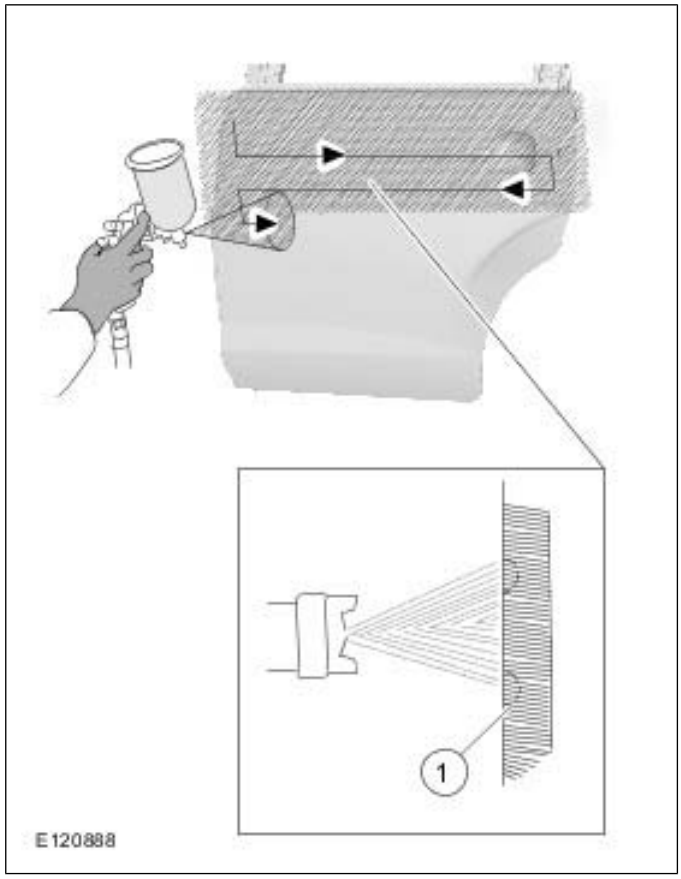


How to judge if incorrect pattern of spraying comes from air cap or spraying nozzle:

First, mark the pattern on a surface as shown in the figure below, turn the air cap 180° and mark the pattern once again. If the deformity of the pattern is the same, the cause of it is in the paint nozzle. If the deformity is in the reverse direction, the air cap is clogged with paint or dust or damaged. Remove the paint residue or dust completely from the air cap. If the damage is too much, replace the part with a new air cap.

DESCRIPTION AND OPERATION





Item	Description
1	Snapping defect

Top Coat Painting

Basic Process

Use of 2K paint and gradation agent . A gradation agent is a mixture of clear paint and thinner. Its viscosity is low and it evaporates almost completely leaving nothing. For metallic painting, it is used for the purpose of arranging aluminum flakes in the same direction.

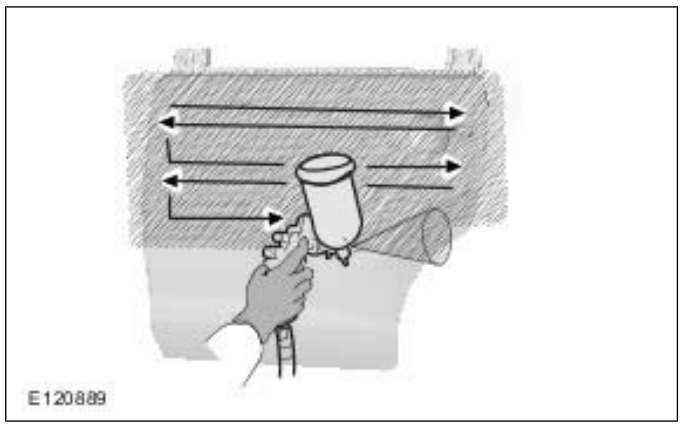
WARNING: Avoid contact with skin, wear a respirator, gloves, eye protection, and appropriate clothing when spraying.

1. Mist coat and spot coat.

- Use the single coating for mist coat. Spray as sparely as possible to detect where defective painted areas are.
- When there are snapping holes on the painted surface, fill the holes with dry coat.
- In order to hide the undercoat irregularity, spray the top coat paint over the repaired area (primer surfacer painted surface) one more time as final before the color fixing.

2. Color fixing.

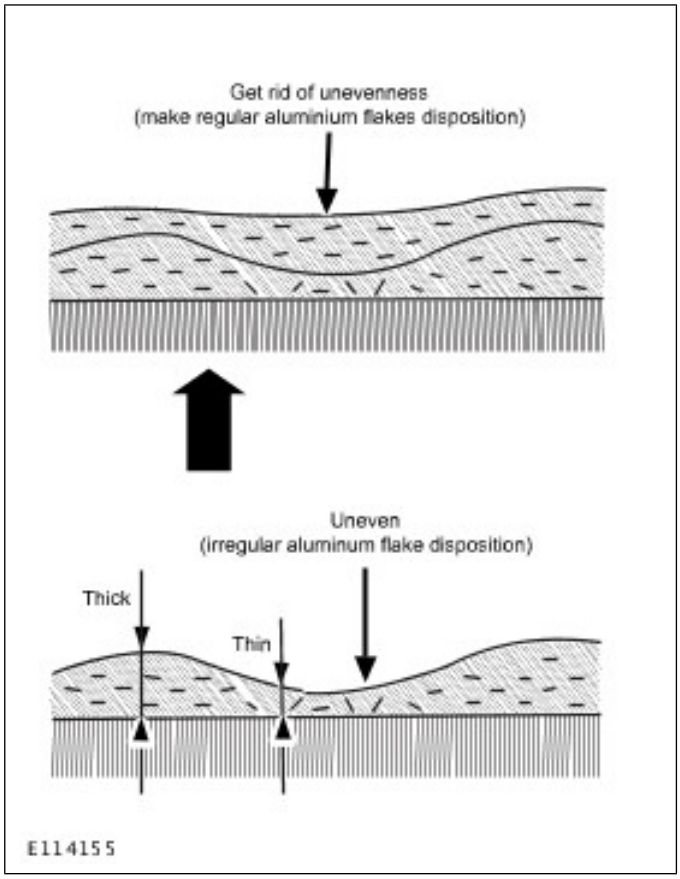
- Spray to the half gloss in a double coating way.
- Continue spraying until the undercoat is no longer visible.
- Do not attempt to spray thickly at one time but several thin coats with abundant flash times in between.
- For metallic colors, spray carefully so as not to create irregularity of color, taking care of pattern overlapping.



DESCRIPTION AND OPERATION

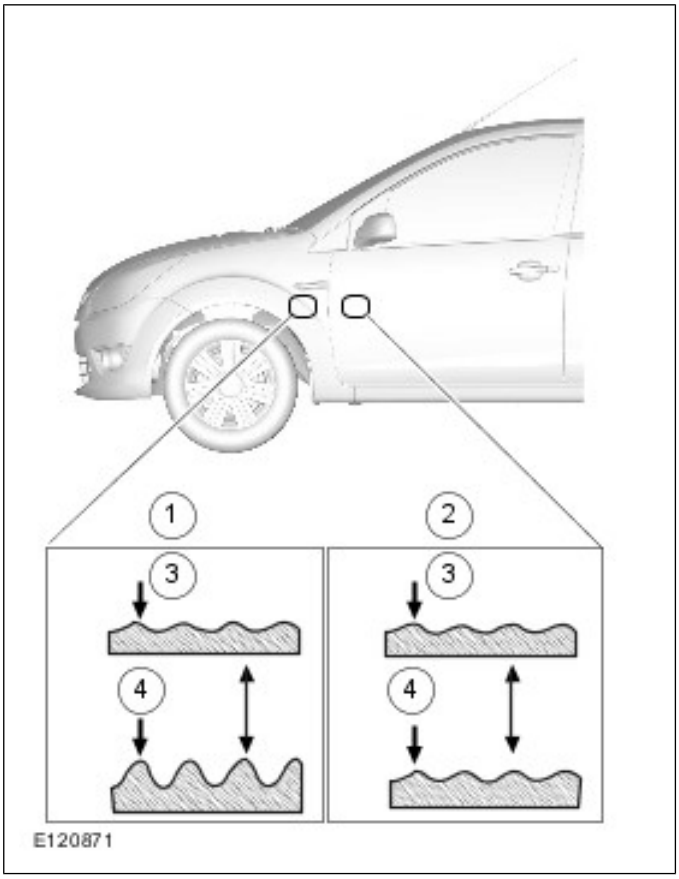
3. How to get rid of enamel base irregularity (metallic and pearl colors).

- Maintaining the same outlet as for the color fixing process and moving the gun slightly away from the painted surface, move the gun slower to leave the surface a little wet.
- By keeping the surface a little wet with paint, it is possible to let aluminum flakes arrange regularly.
- Overlap the spraying strokes repeatedly until the painted surface becomes even in color.



4. Finishing painting.

- Finish the painted surface smoothly and let it match the adjoining panel in the surface quality.
- For metallic and pearl colors, spray clear coat repeatedly several times for better luster and smoothness.



Item	Description
1	Incorrect
2	Correct
3	Old paint layer
4	New paint layer

Steps of Gradated Painting

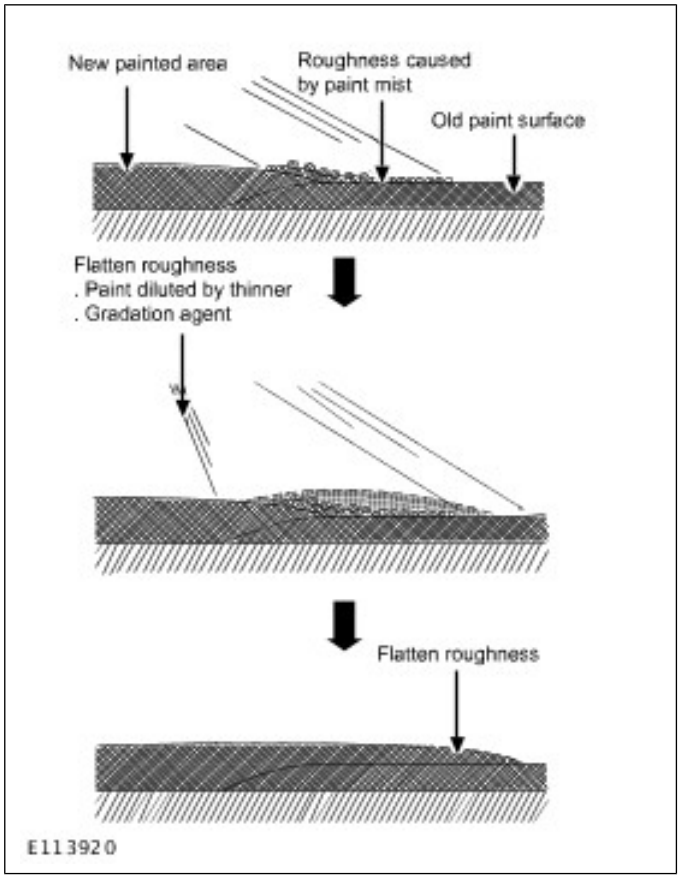
1. Spray so that the luster is even, while observing the state of the old paint surface.

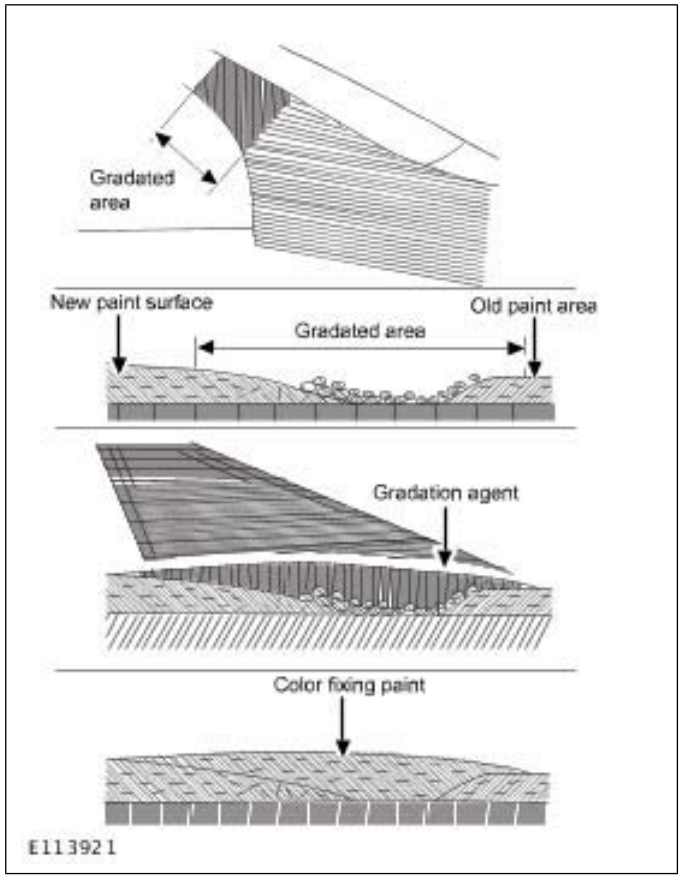
2. Dilute the finishing paint following the paint manufacturer’s instructions.

3. Spray the paint on the rough area due to the paint mist between the old and new painted surface so that the new and old surface are matched with each other.

4. Slightly decrease the paint outlet and spray to the half luster. Do not try to spray thickly the first time, but spray it a few times, taking an abundant flash time. A gradation agent can also be used to match the color and luster between the new and old painted areas.

DESCRIPTION AND OPERATION





Gradation Painting of Metallic and Pearl Paints

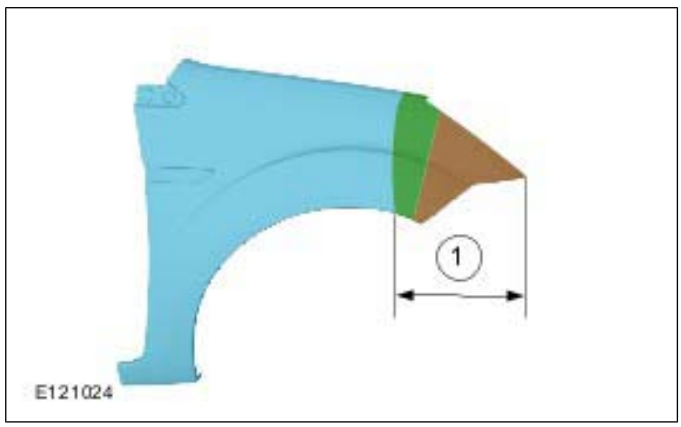
1. Spray gradation agent around the color fixed area.
2. With the state of the gradation agent sprayed in a half gloss, spray the color fixing paint between the color fixing area and the old paint surface in the same way to get rid of irregularity.
3. Repeat the above steps until the difference in color between the old and new paint is not visible.

Top Coat Partial Painting

Spot Gradation of Solid Color

Using a technique of gradation, match the color and luster with those of the surrounding paint surface.

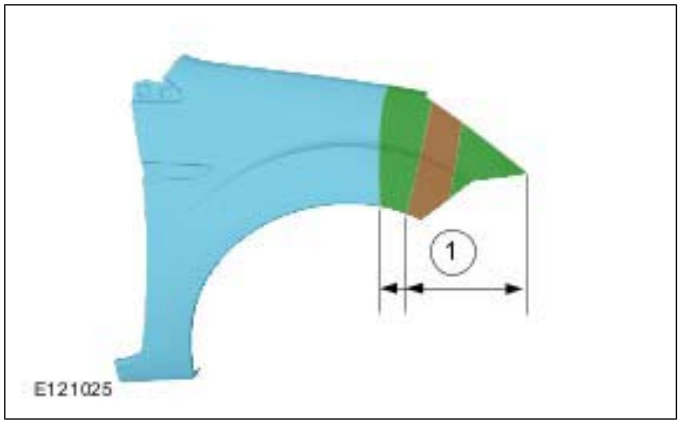
1. Mist coat and color fixing.



Item	Description
1	Mist coat/spray to obtain opacity area.

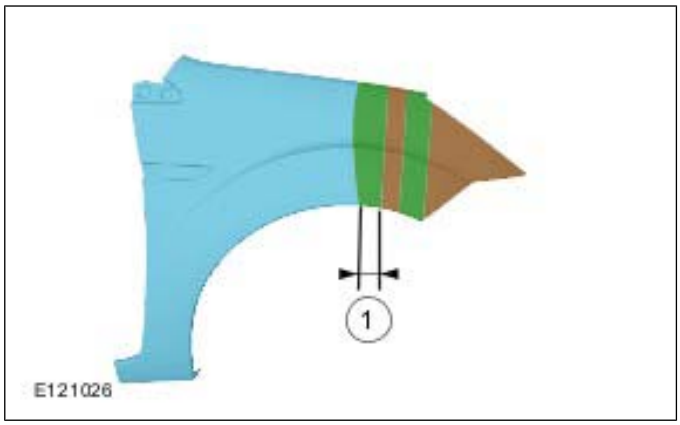
2. Finishing painting.

DESCRIPTION AND OPERATION



Item	Description
1	Finish coat area.

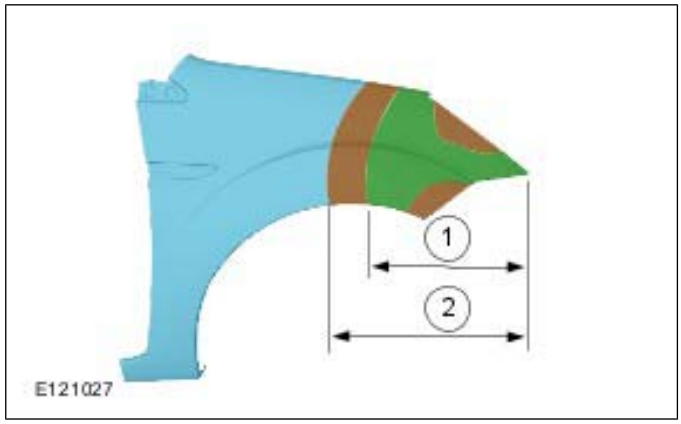
3. Gradation.



Item	Description
1	Gradation area.

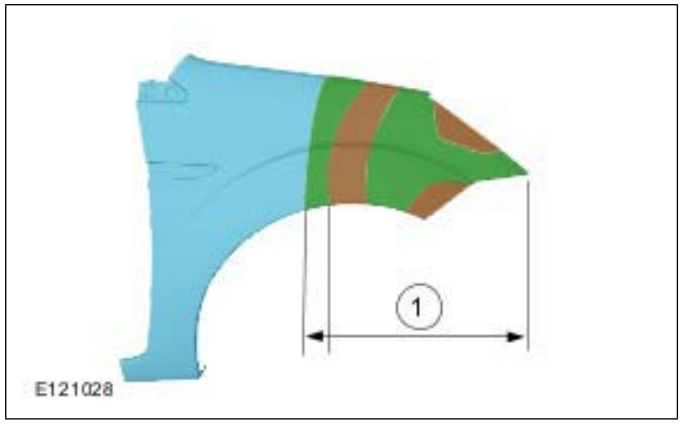
Spot Gradation of a Metallic Color

1. Mist coat and color fixing for enamel base (The same steps for solid color).
2. Get rid of irregularity in enamel base (Gradation).



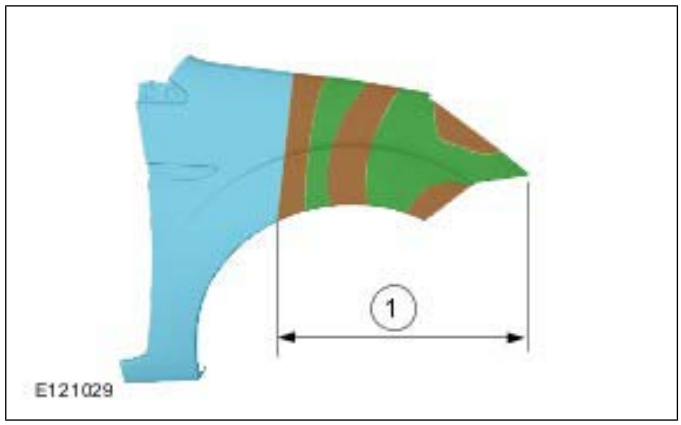
Item	Description
1	Get rid of irregularity area.
2	Gradation area.

3. Mist coat of clear coat.



Item	Description
1	Area of clear/mist coat.

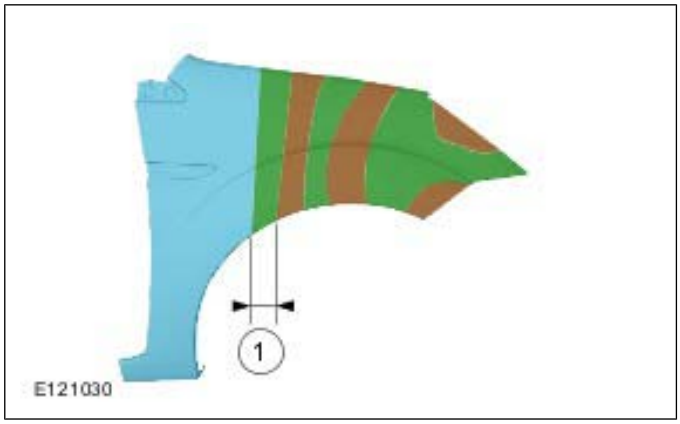
4. Finishing coat of clear coat.



Item	Description
1	Area of clear coat finish spraying.

5. Gradation of clear coat painting.

DESCRIPTION AND OPERATION



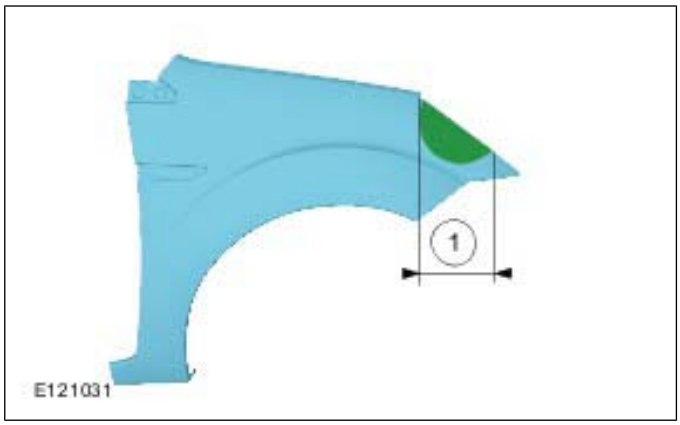
Item	Description
1	Clear coat gradation area.

6. Drying

Block Part Gradation of Solid Color

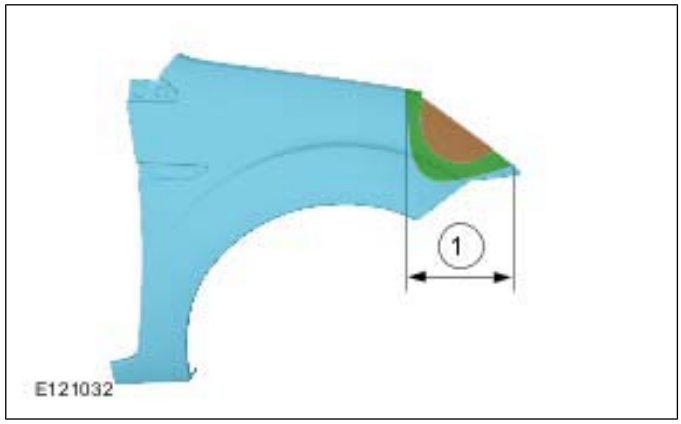
Basically paint the enamel base surface partially and paint the clear base as a whole block part. This gradation repair is also effective to prevent fading of deep solid colors

1. Mist coat.



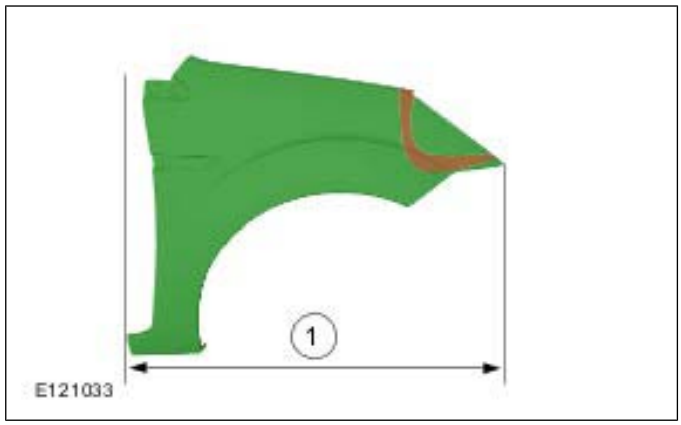
Item	Description
1	Area to be mist coated.

2. Color fixing and gradation.



Item	Description
1	Area to be clour fixed and gradated.

3. Mist coat of clear coat.



Item	Description
1	Area to be clear coat sprayed.

4. Finishing of Clear coat. For the same area as for clear mist coating.

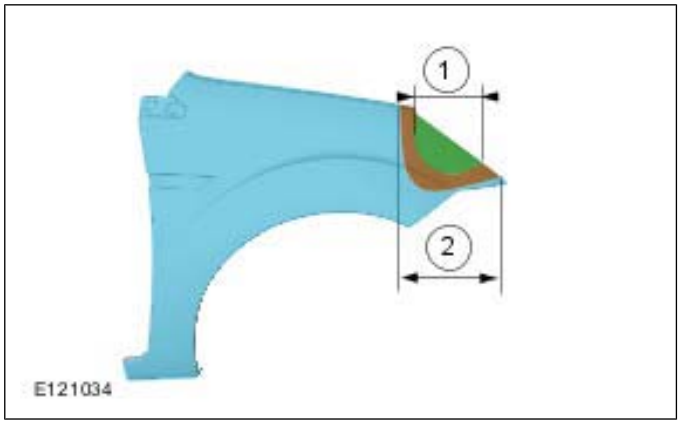
5. Drying.

Block Part Gradation of Metallic Color

1. Mist coat of enamel base For the same area as for solid color

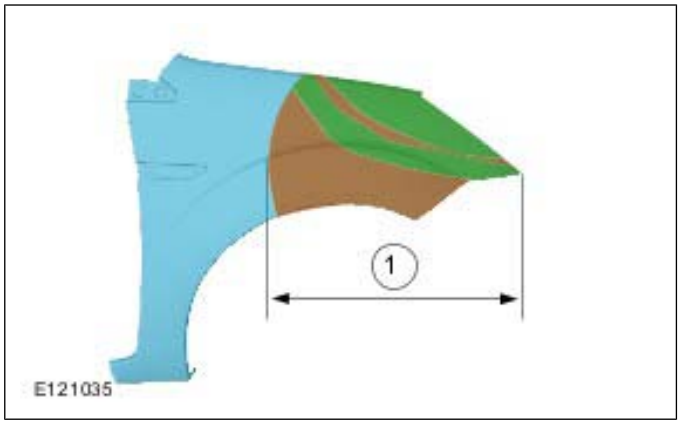
2. Color fixing of enamel base

DESCRIPTION AND OPERATION



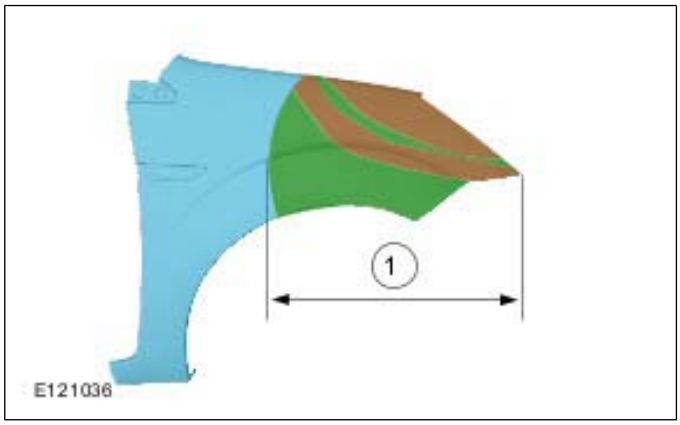
Item	Description
1	Area to be enamel mist coated.
2	Area to be colour fixed.

3. Getting rid of enamel base irregularity and gradation.



Item	Description
1	Area in which irregularity is gotten rid of and gradated.

4. Mist coat of clear coat.



Item	Description
1	Area to be mist coated.

5. Finishing of clear coat. For the same area clear mist coating

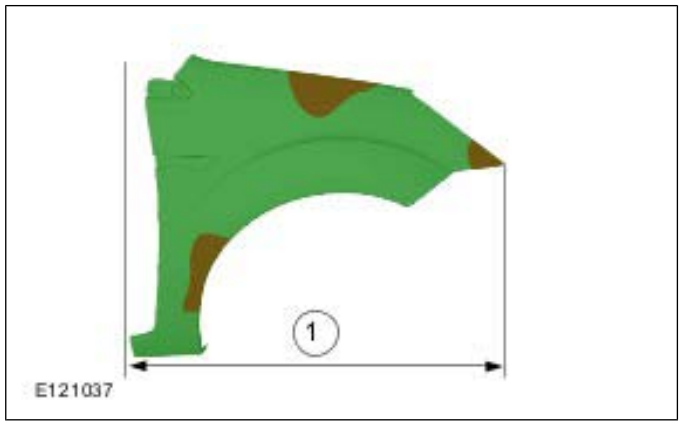
6. Drying.

Top Coat Block Painting

Divide the panel line in painting so that the painting work does not extend to the adjoining panel like the front fender or the door panel. Paint the panel as a whole without doing any partial repair. However, as for the roof panel and the panel space between the rear pillars, it is possible to repair the color locally.

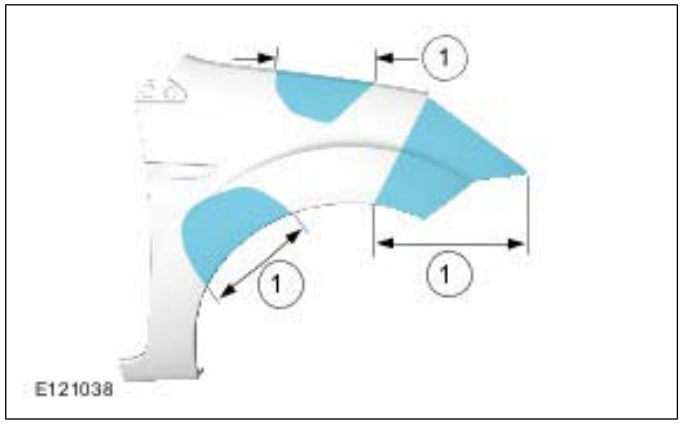
Solid Color

1. Mist coat.



Item	Description
1	Area to be mist coated.

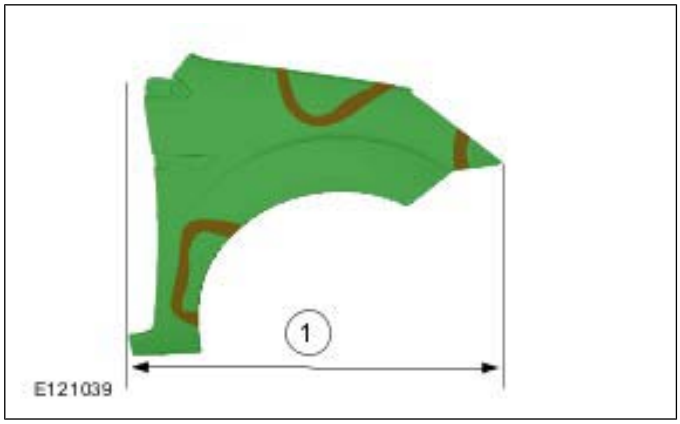
2. Partial spot spraying of repaired areas.



Item	Description
1	Area to be spot sprayed.

3. Color fixing.

DESCRIPTION AND OPERATION



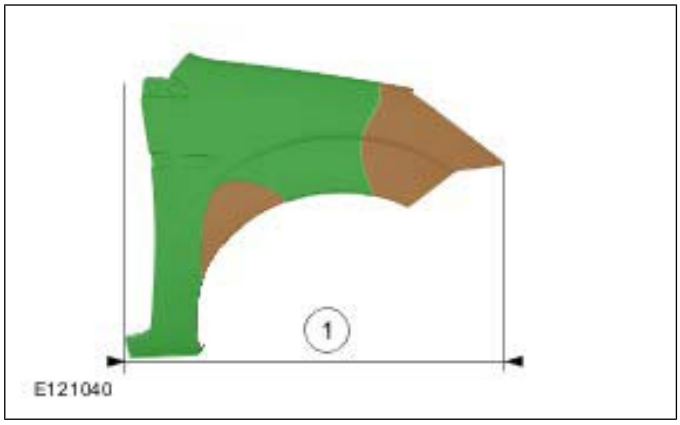
Item	Description
1	Area to be colour fixed.

4. Finishing. The same area as for color fixed.

5. Drying.

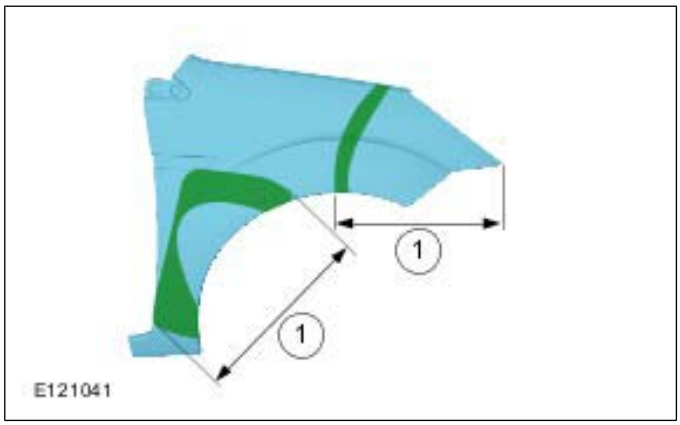
Metallic Color

1. Mist coat of enamel base.



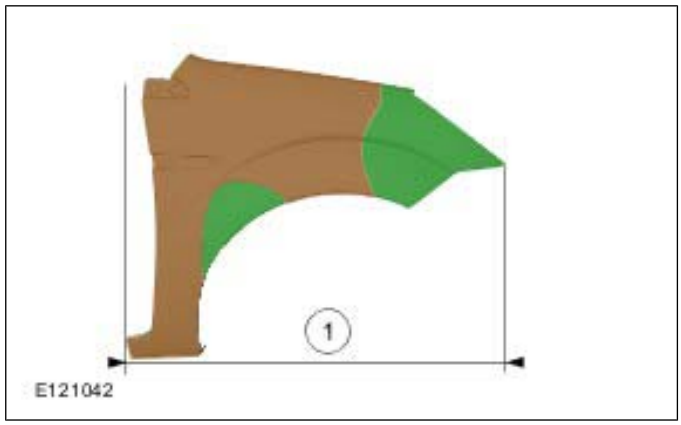
Item	Description
1	Area to be mist coated.

2. Spot spray of repaired areas.



Item	Description
1	Area to be colour fixed.

3. Color fixing of enamel base.



Item	Description
1	Area to be spot sprayed.

4. Getting rid of irregularity of enamel base. The same area as for color fixing.

5. Mist coat of clear coat. The same area as for color fixing.

6. Finishing of clear coat. The same area as for color fixing.

7. Drying.

Drying of Top Coat Painting

1. Allow enough setting time. After painting, leave the surface as is for about 10 to 20 minute, in order to let the solvent evaporate and prevent defects from occurring during the forced drying time.

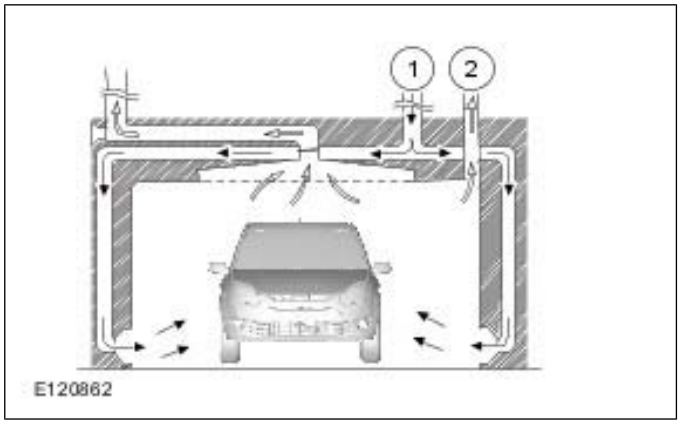
NOTE: As the setting time changes according to temperature or paint layer thickness, check the paint manufacturer's instructions.

2. Forced drying of top coat paint

- Force dry the surface for approximately 30 minutes at a temperature of 140°F (60°C).
- If polished without being well dried, partial lack of luster or white marks occurs. If dried excessively, the paint layer becomes too hard to be easily polished losing its workability.

NOTE: Always refer to the paint manufacture's instructions.

DESCRIPTION AND OPERATION



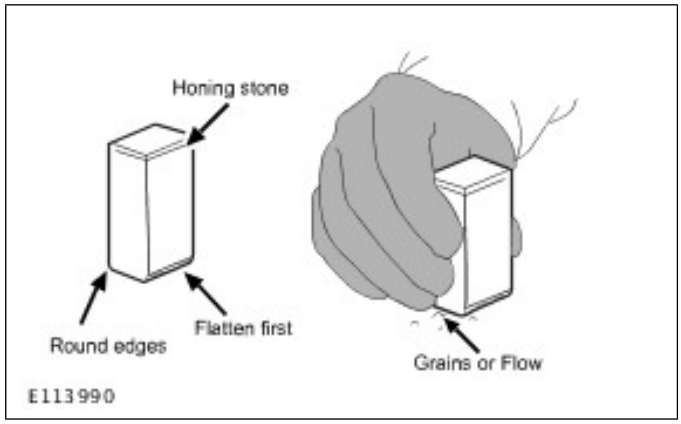
Item	Description
1	Hot air
2	Exhaust duct

Top Coat Polishing

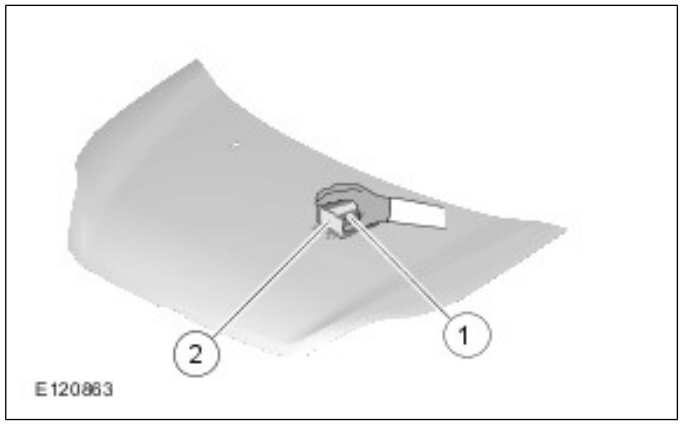
Polishing Procedures

1. Take out small cavities or paint grains.

- Remove small cavities and paint grains with a honing stone or waterproof sandpaper.
- First flatten the honing surface and round the edges.
- Hone the surface with a rough stone and finish with a fine P2000 to P3000 stone.
- If the paint flow or grains is high, scrape it out with a knife first before honing it.

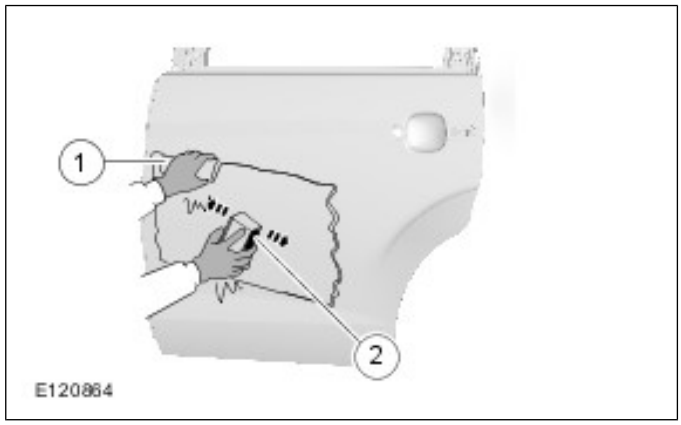


- If the waterproof sandpaper, using a sanding block with a P1500 to P2000 sandpaper.



Item	Description
1	Waterproof sandpaper
2	Sanding block

2. Finishing of painted surface. Using a waterproof P1200 to P2000 sandpaper hone the surface together with soap and water or water in a fixed direction. After the surface becomes flat and smooth. Wipe off the remaining particles.



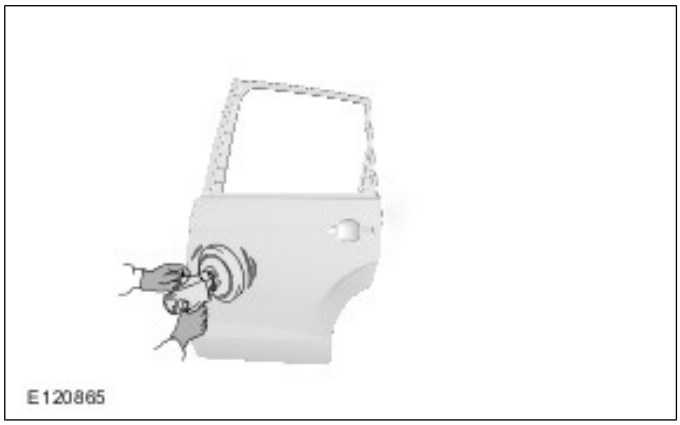
Item	Description
1	Sponge
2	Waterproof sandpaper

DESCRIPTION AND OPERATION

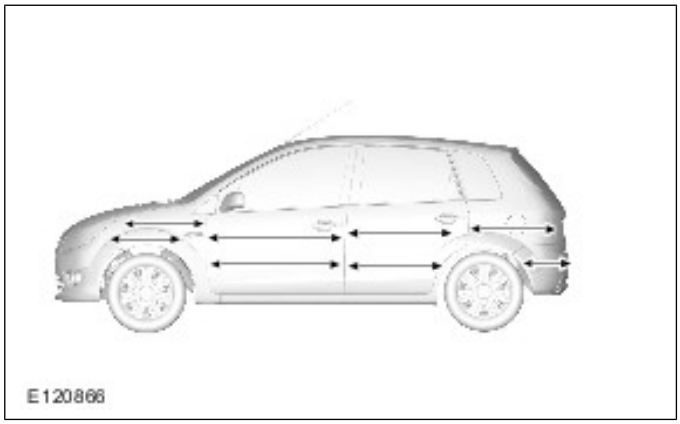
3. Final polishing.

- With fine compound, polish the surface with a polisher set with a towel buff or intermediate sponge buff to take off honing or sandpaper marks. And finally, polish it out with finer compound.
- In polishing, remove honing powders frequently to avoid damaging the paint surface.

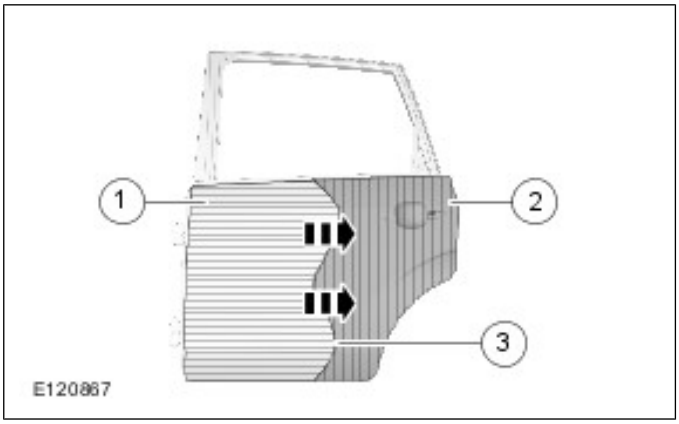
NOTE: Turn on the polisher power switch after it has been in touch with the polished surface.



4. Move the polisher along the panel surface in a fore and aft direction.



5. Where the paint is repaired in gradation, move the polisher from the new painted area to the old painted area.



Item	Description
1	New top coat
2	Old top coat
3	Colour gradated

6. Hand-polish the press lined or mold lined parts of the surface because these parts of the panel tend to be overly polished. Polish the surface with a cloth with finer compound, moving it fore and aft.

7. Glossing.

- Using slender buff with ultra fine compound, polish the painted surface.
- Press the polisher very lightly on the surface to be polished.

DESCRIPTION AND OPERATION

Color Clear Painting

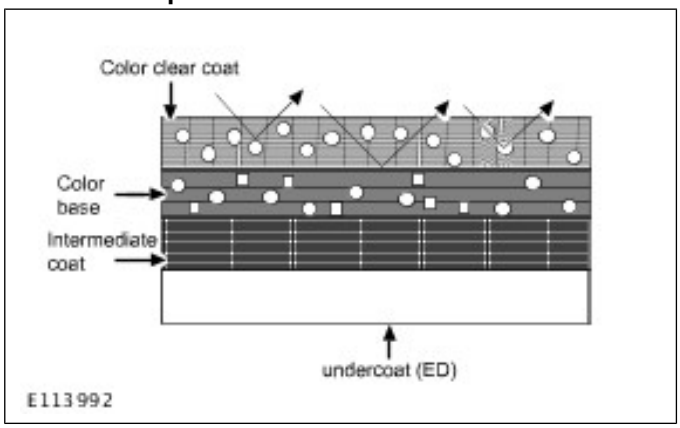
Color clear paint is a mixture of clear coat used for top coat for metallic painting and transparent pigment and dyes. The use of this paint provides vivid, deep and transparent colors.

Its paint layer is made up from top half-transparent color clear layer and lower color based layer.

NOTE: As color clear paint is half-transparent, its color looks different according to the thickness of the layer. It is, therefore, necessary to prepare several color test pieces that have a different paint layer thickness for comparing the color the same way as for the three-coat pearl

NOTE: If the paint used as color base is inferior in hiding the undercoat color, paint the color that is good in hiding the lower coat first before painting color base.

Color clear paint:



Minor Paint Repair Working Exercise

Pre-treatment of the surface

Perfect preparation of the subsurface is the precondition for a brilliant paintwork result. Faults in the preliminary stages delay completion and cause unnecessary extra work. The working steps described here demonstrate how important it is to follow these instructions step by step.

NOTE: Thorough cleaning of the vehicle and especially of the area being repaired is particularly important because of the danger of contamination of the paint.

Clean the area of the damage

Clean the damaged surface thoroughly, to allow the extent of the damage to be seen. Use silicone remover to produce a grease-free surface.

NOTE: The treated surface must be rubbed with a clean dry cloth before the solvent evaporates, otherwise there will be no cleaning effect.

Effective de-greasing is important not only before the application of paint, but also before all sanding stages, for two reasons:

- During sanding of grease contaminated surfaces, globules may form with the sanding dust. Sanding marks will occur and the sanding medium quickly becomes unuseable.
- Oil and grease are embedded by the action of the abrasive particles, and are then very difficult to remove.

Establish the area of damage and the repair stages. In doing so, establish how much disassembly work must be undertaken. Perform a color test at this stage.

Mask off the area of the repair ready for preparatory work.

Sand out the damage location

When sanding, produce smooth transitions from the painted area to the bare metal.

DESCRIPTION AND OPERATION

Use an eccentric sander and P80 or P120 abrasive sheets. Finish off sanding with P150 or P180. The remaining adhering sanding dust must be completely removed.

Cleaning, de-greasing

Use silicone remover to thoroughly clean the surface in order to remove grease residues, sweat from the hands and other contamination.

NOTE: Use a solvent test to establish whether the old paint can be etched. Apply 2-component thinners to the damaged area using a clean cloth and rub lightly for about 1 minute. If the subsurface can be etched away, special pre-treatment is necessary. See "Tips and Tricks"

Apply primer filler

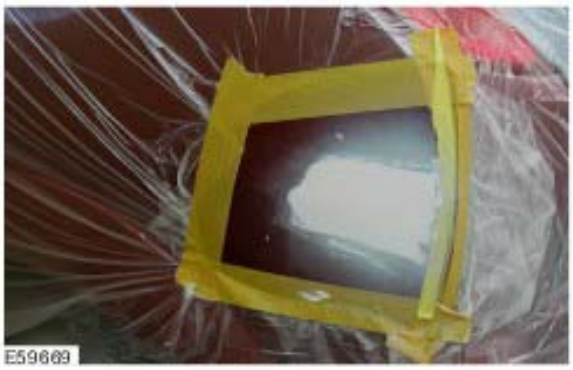
Before applying stopper, apply primer to the sanded and bare surface.

Allow the primer to dry and then lightly sand by hand using P220 - P400 dry.

NOTE: Most stopper can be applied directly to bare metal. But application of a primer filler provides better corrosion protection.

NOTE: Avoid sanding through to the bare metal. Points which are sanded through must be retreated with primer filler.

Stopper application

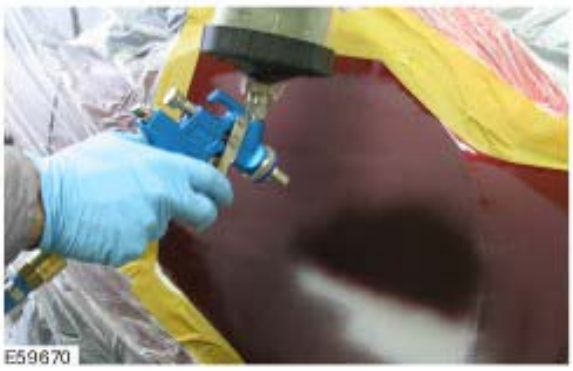


Pre-sand the hardened stopper using an eccentric sander and P80 dry, then final-sand using P120 - P140 dry. Clean the sanded surface using silicone remover.

Apply 2-component stopper to the filled surface. The stopper compound must only be applied thinly.

NOTE: Use of a testing powder is recommended so that the sanding process can be more easily checked.

Apply filler



Filler can now be applied to the dried repair area. Choose the correctly toned filler according to the manufacturer's instructions.

NOTE: Alternatively, filler with the correct tone can be mixed with the aid of colour matching cards.

DESCRIPTION AND OPERATION

Sand the filler.

The working area is expanded by applying new masking. This makes it possible to even out the transition from the damage area to the vehicle paintwork.

NOTE: The primer filler must be carefully sanded. Faults in the primer filler layer will be visible in the top coat.

The sanding process consists of two stages. Coarse sanding levels out the surface of the filler primer. Fine sanding ensures the necessary surface structure which allows the top coat to adhere well and cover sanding marks.

Sand the filler using the eccentric sander and P400 - P500 used dry. Clean the sanded filler finished surface using silicone remover.

The painted area is matted using a fine matting sponge, and then thoroughly cleaned.

Surface ready for paint

The surface which has been repaired and then prepared according to the manufacturer's instructions is now ready for basic paint application.

Top coat application

It is important for a good paint result that the recommended process data is adhered to, i.e. mixture proportions, layer thickness, viscosity, drying time etc.

First of all the work area is carefully masked ready for paint application. The correct adhesive materials and techniques must be used so that no hard transitions and edges are created during painting.

NOTE: The chapter "Tips and Tricks" gives in-depth information on masking work.

Thoroughly check the surface once more and rub-off with a dust-bonding cloth.

NOTE: Once more check the paint material and that the spray gun is correctly adjusted before applying the paint.

Paint application

The base paint is applied in two or three steps. First of all only the repair area is painted with the first paint application.

Flash off

Allow the paint application to flash off until the surface has a matt appearance. So that the transition to the original paint is optimally created, the next paint application is applied to a wider area.

After the base paint has dried for the specified time, the clear lacquer is applied. Next the transitions to the original paintwork are treated with fade-out

DESCRIPTION AND OPERATION

remover. This removes the spray mist and forms an ideal paint surface.

Repair stages for repair painting

The required time and material data is divided into four painting levels for calculations concerning repair painting. Proceed according to these divisions for every calculation.

Level 1 - Painting of new components

On new components, all inner surfaces, seams and edges which will no longer be seen after assembly must be primed and pre-painted.

NOTE: The cathodic dip primer must not be sanded away. Cleaning with silicone remover or light sanding of the primer is all that is required.

Job steps:

- Wash off, prime and pre-paint inner surfaces, seams and edges which cannot be reached at all or only partly after the component is installed.
- Sand new component with P280 - P320 or a fine sanding pad.
- Clean subsurface with silicone remover.
- Carry out masking work (when painting an installed component).
- Apply one spray run of filler, dry.
- Sand the filler. P1200 wet or P500 dry.
- Clean filler application with silicone remover.

Then the prepared surface can be painted with solid or 2-component paint.

If the new part has mild transport damage, this must be rectified beforehand.

To do so, add the following steps:

- Grind out the scratch.
- Finely sand the surrounding surfaces.
- Use a steel cleaning agent to thoroughly clean and then rub dry.
- Apply corrosion protection primer to the bare areas.

Level II - Top surface painting (color tone matching)

Complete bodywork surfaces which are to be painted without the need to apply stopper belong to this group. In addition, surfaces with faults in the top coat surface which cannot be removed by polishing.

The following faults are included:

- Loss of gloss.
- Sanding scores.
- Heavy paint runs.
- Large dust and dirt inclusions.

The scope of the work is as follows:

- Sand the surface.
- Sand out paint damage and faults.
- Treatment of small areas which have been sanded through.
- Masking work (when painting an installed component).
- Apply top coat according to the painting process (one or several coat process).
- Dry the top coat and perform finishing work.

Level III - Repair painting with stopper applied to up to 50% of the surface.

If in addition to painting, work with stopper application must be performed, then the repair levels III or IV must be used.

In repair level III, apart from painting the complete bodywork surface, partial stopper work is carried out on up to 50% of the surface to be painted. The necessary primer and filler work are also included.

The following damage must be rectified in this level:

- Slight panel unevenness.
- Damage due to corrosion.
- Dented body surfaces.
- Weld locations.
- Deep scores or scratches.

The scope of the work is as follows:

- Fine sand pre-treated bodywork surfaces (e.g. lead-loaded areas).
- Sand out existing damage.
- Perform all necessary masking operations on the vehicle.
- Apply primer.
- Partial stopper application on up to 50% of the surface to be painted (two to a maximum of three stopper applications).
- Fill the repair area.
- Apply stone chip protection (when present in production).
- Apply top coat according to the painting process (one or several coat process).
- Dry the top coat and perform finishing work.

DESCRIPTION AND OPERATION

Level IV - Repair painting with stopper applied to more than 50% of the surface.

In repair level IV, apart from painting the complete bodywork surface, partial stopper work is carried out on more than 50% of the surface to be painted. The necessary primer and filler work are also included.

The following damage must be rectified in this level:

- Damage due to hail.
- More extensive stone chip damage.
- Extensively dented body panels.
- Sectional repairs with large weld seams.
- Surfaces with severe corrosion damage.

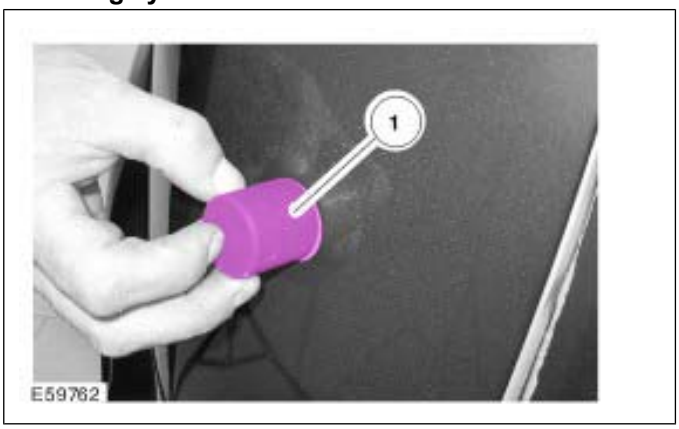
The scope of the work is different to level III because of the partial application of stopper to more than 50% of the area to be painted. In addition, more extensive sanding work is usually required.

Polish

In order to achieve faultless quality, it is sometimes necessary afterwards to polish a newly painted surface.

Even after the most careful painting, it sometimes happens that dirt inclusions and paint runs occur in work with top coat or clear lacquer. Before polishing, such paint faults must be removed with the sanding cylinder ("Finiball") and hand sanding or eccentric sander in a wet sanding process.

Sanding cylinder



The special sanding compound **-1-** (sanding bloom) for the sanding cylinder is self-adhering and available in grades from P1000 to P2500.

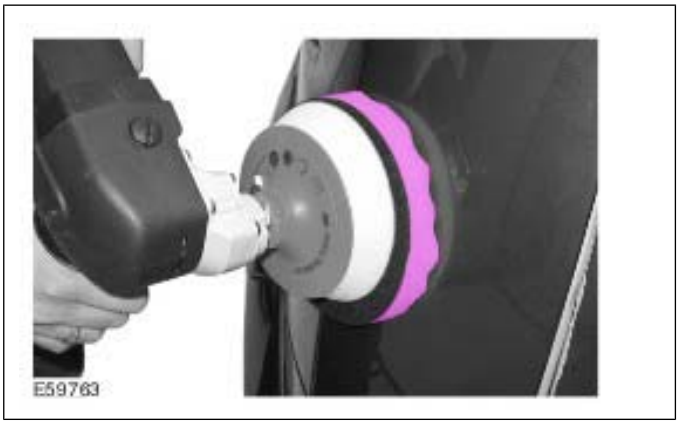
- P1000 - P1500 for pre-sanding of runs and large imperfections in the paint.
- P1500 - P3000 for subsequent sanding of runs and sanding out of dust inclusions.

A small eccentric sander can be used for more extensive working areas. When doing so, first of all put the eccentric sander in place and then switch it on, so that the danger of sanding through on edge is reduced.

Finally polish the sanded area to a high gloss with suitable polish. To this end the various manufacturers recommend materials and process techniques which are specially suited to their products.

NOTE: The polishing is to be done in the same way as that used to remove swirl marks.

Polish



NOTE: Before using the nap sponge for the first time and after any long pauses in working, dampen the nap sponge with polish.

Job steps:

- Clean and degrease the area to be polished using silicone remover.
- Apply the polish to the polishing disc and spread it.
- Place the polishing machine down flat on the area to be polished and before switching it on, gently distribute the polish over the underlying surface.
- Polish out the location for 10 - 15 seconds with the edge, working with a criss-cross motion.
- Subsequently polish the location for about 10 seconds with the machine laid down flat.
- Wash off and clean the polished location using the professional polishing cloth and then clean the polished surface.
- It is absolutely vital to carry out a visual check after finishing the polishing procedure. If any swirl marks are not completely removed by the first polishing procedure, then process must be repeated.

DESCRIPTION AND OPERATION

Aids

Cleaning putty

Cleaning putty allows deposits on the paint surface to be removed easily and gently. The following paint faults can be removed using cleaning putty:

- Metal deposits and iron dust.
- Paint or color mist.
- Tree resin and tar.
- Insect residues.

The surface to be worked must be thoroughly cleaned before the cleaning putty can be applied. Then the surface is sprayed with soapy water. Now the cleaning putty can be slid over the surface until all unevenness is removed.

DESCRIPTION AND OPERATION

Painting Plastic Parts

General

Although these days plastics can be produced in all colors and with a matt or gloss surface, painting is often necessary.

NOTE: Manufacturer's limitations concerning the feasibility of painting certain components must always be observed.

Reasons in favor of applying paint to plastic are:

- Individual coloring, matching the body paint.
- More gloss and color brilliance through painting.
- Removal of production imperfections.
- Protection from atmospheric exposure.

Nowadays painting plastic presents no problems because the materials are known and matched to the paint. In order that the painter can use the correct painting materials, the type of plastic must first be correctly determined.

To allow this, plastics are marked on the rear in accordance with the recommendations of the Association of Vehicle Manufacturers.

Once the type of plastic is determined it is an easy matter to assign special paint recommendations, matched to that particular plastic. Unmarked plastics require knowledge of materials so that a correct choice of paint materials can be made and the component can be reliably painted.

Plastic groups

Thermoplastics

When warmed these undergo a reversible transformation into a plastic deformable state and once cooled they maintain their shape. They consist of string-like (linear) or only slightly branched molecular chains.

Thermosets

Thermosets are hard and have the form of a close-meshed network in all directions. They do not undergo plastic deformation, are especially resistant to chemicals, are difficult to swell and are insoluble. At normal temperatures they are hard to brittle. At first the material does not undergo any change when heated, but when it reaches a critical point, the thermoset is totally destroyed.

Elastomers

Elastomers are characterized by high elasticity over a wide temperature range. They have properties like rubber or a sponge and after compression or distension they return to their original state.

Types of plastic

The plastics used in the automotive area:

- ABS - Acrylonitrile butadiene styrene (polymer)
- PA - Polyamide
- PC - Polycarbonate
- PE - Polyethylene
- PP - Polypropylene
- PP/EPDM - Polypropylene/ethylene propylene diene copolymer
- PC/PBT - Polycarbonate/Polybutylene terephthalate
- PBT/PC - Polybutylene terephthalate/Polycarbonate
- PUR - Polyurethane
- GRP - Glass reinforced plastic

NOTE: PE and PP are plastics which cannot be painted, or can only be painted using special techniques.

As well as the pure plastics, so-called 'blends' are also used. This means combinations of different plastics. If we were dealing with metals they would be called alloys.

Plastic identification

Normally the identifier is marked on the plastic components used in vehicle construction.

One method to determine the plastic group is the sanding test. In this a place is chosen which will not be visible later, and the finger belt sander is used to sand the plastic.

The plastic group can be determined using the pattern left by the sanding and the dust:

- Thermosets produce a white dust.
- Thermoplastics smear and do not produce dust.

The plastic group can be determined by a sound test:

DESCRIPTION AND OPERATION

- Degree of hardness - the higher-pitched the sound, the harder the plastic.
- Elasticity - the more muffled the sound, the higher the elasticity of the plastic.

Cleaning plastic

Plastic components are manufactured using complicated moulds and presses or other highly engineered tools, mostly using an injection moulding process or reactive injection moulding process.

In order to be able to remove the component from a particular tool, a separating agent is used, which in some cases adheres very strongly to the plastic.

This separating agent on the plastic components must be completely removed before any surface coating is applied.

Warm storage (tempering) before actual cleaning brings the following advantages:

- The separating agent sweats out of the plastic.
- Tensions in the plastic are released.
- Air inclusions can be recognized and removed.

Intensively clean the item several times using a pad and fresh cleaning agent.

NOTE: A single wipe, even with cleaning agent, is not usually sufficient in most cases. Clean textured components with the aid of a soft brush.

After cleaning, it is absolutely vital that cleaning agent absorbed by the plastic should be expelled by tempering again. If the ventilation is good and the room temperature is about 20°C the solvent can be evaporated away by overnight storage.

Painting new components

It is absolutely vital that the substrate of an unpainted new component is free of separating agent. Paint can only be applied directly to very few plastics. The plastic must first be identified exactly and then worked with a repair system which is matched to the type of plastic. In most cases a plastic etch primer must be applied as adhesion base to all plastics which can be painted.

NOTE: Plastics have a tendency to become electrostatically charged. This can easily cause contamination during painting. Special antistatic cleaning cloths prevent electrostatic charging.

Work process for thermoplastics:

- Thoroughly clean the surface.
- Temper the plastic.
- Afterwards clean with antistatic cleaner or antistatic cloths.
- Apply the bonding agent.
- Apply elastic filler. After it has dried, sand and clean.
- Apply one coat Uni-paint with elasticizer additive. For two layer painting the elasticizer additive is in the clear lacquer.

NOTE: Follow the paint manufacturer's guidelines during all work.

Work process for thermosets:

- As a rule, thermosets can be handled in the same way as normal body components.

Work process for PUR soft foam:

- The work process is the same as for thermoplastic.
- Instead of using bonding agent, a filler wash is applied to close the pores of the PUR soft foam.

The primer which has been applied to a primed new component can vary greatly. If no manufacturer's data is available, the composition and suitability for further working must be tested.

Painted components with an already ascertained and intact paint coat present no problems for possible repainting. After sanding and careful cleaning with plastic cleaner or thinners, painting can be done directly.

Unknown primer

When dealing with unknown substrates it is important to carry out an adhesion test on the existing paint before any repainting is attempted. First of all a mechanical test must be carried out, for instance using a lattice cut and tear-off band. If the adhesion of the old paint is not acceptable, it must be mechanically removed and new paint finish applied.

If the adhesion is acceptable, then an etch test is performed using 2-component thinners. If no etching can be detected in this test, application of the the paint finish can be started directly. Otherwise the old paint must be removed and a new paint finish created.

With the help of universal or special plastic primers and with only a few materials complementary to those previously present anyway, the painter can now apply a long-lasting paint finish to all popular vehicle attachments made of plastic.

DESCRIPTION AND OPERATION

Paint faults on plastic substrates

NOTE: Paint faults are fully described in the chapter Paint Defects and Damage.

The most common paint faults which can occur when painting plastic components and the methods of repair are briefly described.

Discoloration

Cause/damage pattern:
- Plastic material is not suitable for painting.
- Incorrect bonding agent.
- Paint used not solvent resistant.

Repair of damage:
- Repaint using suitable materials.
- Install a new unpainted component.

Softening

Cause/damage pattern:
- Substrate not carefully cleaned.
- Air humidity too high or working temperature too low.
- Drying time incorrect (too short).
- Materials for substrate not correctly matched to each other or not mixed correctly.

Repair of damage:
- Dry out, sand, re-isolate and paint.
- Sand away faulty paint coats and re-apply paint finish.

Paint damage caused by detachment, poor adhesion

Cause/damage pattern:
- Insufficient paint adhesion between top coat and filler. The whole of the paint finish detaches from the plastic.
- Plastic not cleaned sufficiently, not or inadequately tempered.
- Unsuitable cleaning agent or materials used.
- Poor or lack of intermediate sanding.
- Paint finish underbaked or overbaked.

Repair of damage:
- Sand away faulty paint coats and re-apply paint finish.

Paint damage caused by blisters, craters, sink holes

Cause/damage pattern:
- Painting on PUR plastic which was not painted in production.
- Surface of the plastic material too porous.
- Flash-off time not adhered to.
- Drying temperature too high.
- Moisture in plastic material.
- Layers too thick.

Repair of damage:
- Clean the damaged area, sand, re-isolate and paint.
- Remove the paint layers and re-paint.

Crack formation

Cause/damage pattern:
- Overexpansion of painted PUR plastic components.
- Use of unsuitable paint materials.
- Paint materials not suited to each other or incorrect mixture ratio.

Repair of damage:
- It is not possible to repair overexpanded PUR plastic components.
- On other plastics, sand away damaged layers, isolate and repaint.

Paint Repair Process

The resin parts to be repaired according to the following repairing process are mostly large ones in size and PP, ABS, PC or PA materials.

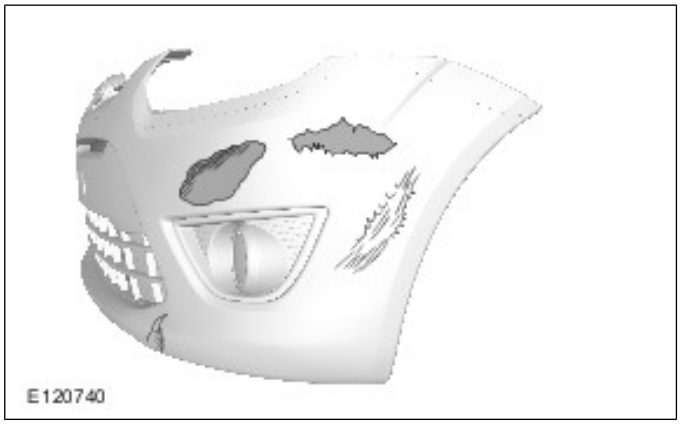
It is extremely important to confirm the plastic material of the part and select the appropriate repair materials. In repairing, pay particular attention not to cause deformation or other damages to the part due to drying heat and other conditions.

Basically, the repair process for resin parts can be divided into two. One is for PP and “ ABS+PA” resin parts and another is for the other types of plastic materials.

NOTE: The states of damage and their way of repair are described below. Since the repair methods are different according to the repair

DESCRIPTION AND OPERATION

materials, always check the paint manufacturer's instructions.



Steps of Repair Painting

The following are the steps taken for paint repair after the undercoat process has been completed.

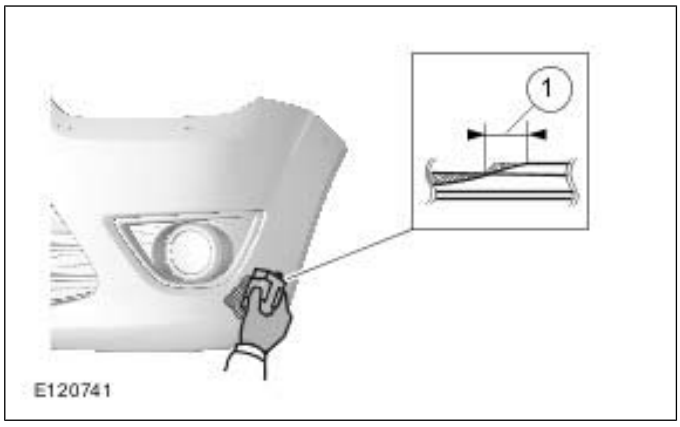
For filling and reforming, refer to the Body Repair Manual Body Basic.

Example of repair materials.

- Primer surfacer: Two-liquid mixing type (Bumper primer surfacer gray)
- Top coat paint: Two-liquid polyester urethane (2K type).

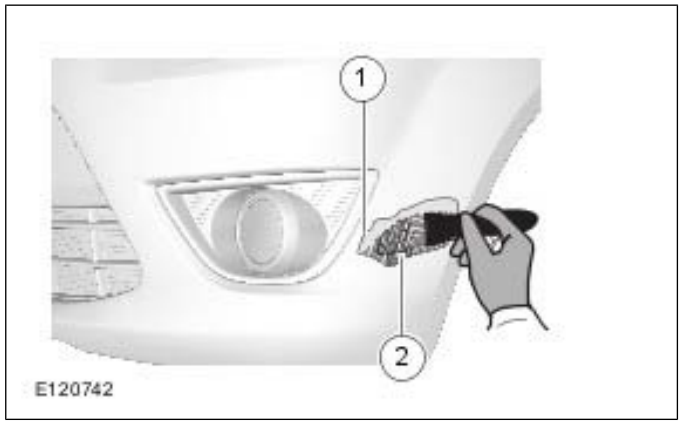
NOTE: Follow the paint manufacturer's instructions.

1. Grinding for better adherence (for primer surfacer painting). Grind the old paint surface around the area to be repaired with P200 to P400 sandpaper to form featheredge.



Item	Description
1	Feather edge

2. Paint PP primer (Raw surface exposed area). As the PP bumper cannot be painted directly on the raw surface, be sure to paint the PP primer on the raw surface first to secure tight adherence to the top coat.



Item	Description
1	Exposed surface
2	Bumper primer

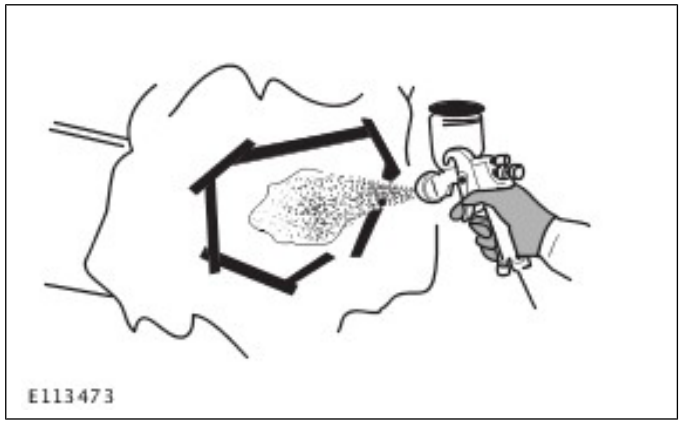
3. Clean the surface by air blow and wipe off all fat, oil and grease.

4. Paint primer surfacer and dry it.

WARNING: Avoid contact with skin, wear a respirator, gloves, eye protection, and appropriate clothing when spraying.

Spray the PP primer over the area a little wider than the painted area with a spraying gun. The paint thickness is aimed to be 20 to 30 m at 2 to 3 double coating sprayings.

NOTE: Follow the primer surfacer manufacturer's instructions for drying time.



5. Polish with P600 sandpaper with water. Do not use a sandpaper lower than P600.

6. Clean by air blow and wipe off all fat, oil and grease.

7. Masking (in case of a partial repair).

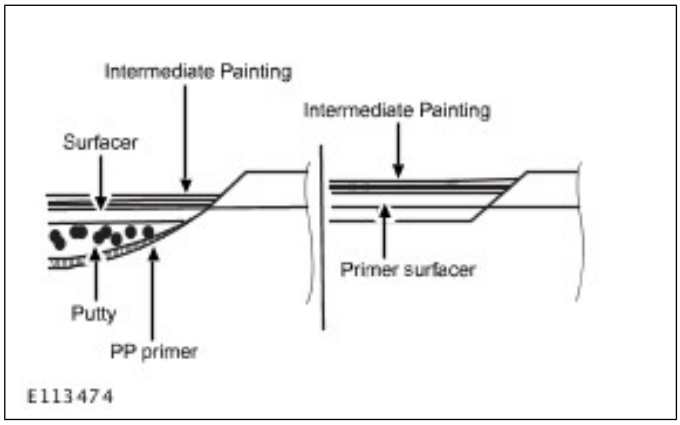
8. Painting of intermediate coat and drying.

DESCRIPTION AND OPERATION

- On PP plastic parts (bumper, side sill, garnish etc.), paint the intermediated paint to match the color.
- For the paint, use the top coat enamel paint.

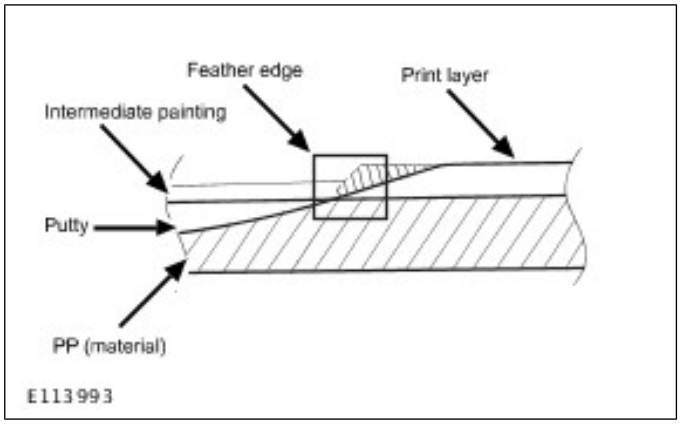
NOTE: Mix it with thinner and softener or hardener according to the paint manufacturer's instructions on mixing ratio and dry it according to the instructions.

- Before painting, clean the entire surface to be painted with a tack cloth.
- The paint thickness is aimed to be 20 to 30 m at 2 to 3 double coating sprayings to hide the primer surfacer paint color.



9. Sanding for better adherence (for top coating).

- After drying the painted surface, polish the surface with P600, P800, or P1000 sandpaper with or without water.
- Take care not to expose the intermediate or primary surfacer layer.
- To paint in gradation, form a featheredge around the area to be top coated with P1500 sandpaper.

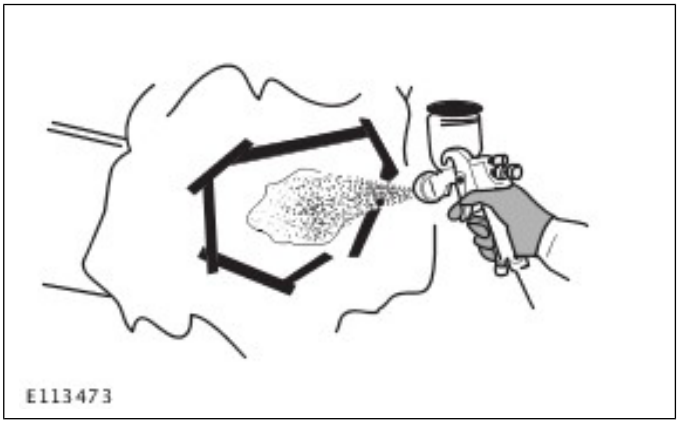


10. Clean the surface by air blow and wipe off all oil, fat, and grease with grease remover.

11. Masking (for top coating).

12. Top coating

- Follow the paint manufacturer's instructions about the mixing of softener, hardener and thinner.
- Immediately before painting, clean the entire surface with a tack cloth.
- Without trying to paint at one time, take flash time and spray several times, hide the intermediate and primer surfacer paint color.
- After spraying the top coat enamel paint, leave it for 5 to 10 minutes and spray clear coat on it.

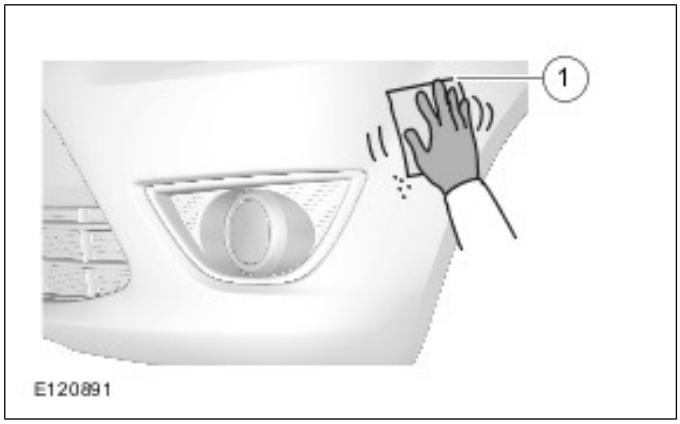


After painting the clear coat, take about 5 to 10 minutes setting time, while taking care of the deformation of the part, force dry it.

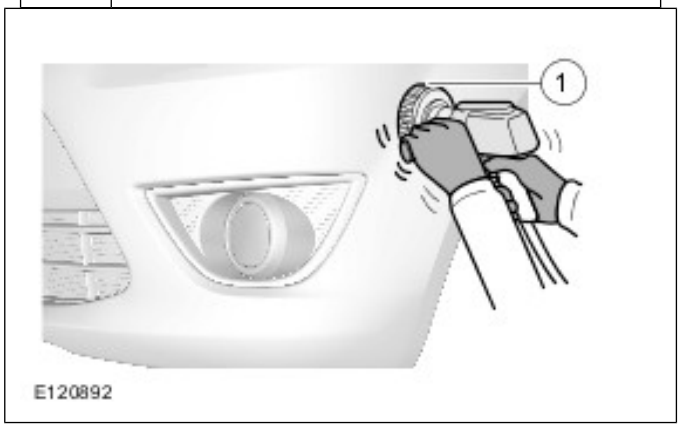
13. Final polishing.

- Confirm that the top coat layer has been completely dried.
- Polish with a waterproof P2000 sand paper with soap water.
- Wipe off water and clean the surface by air blow.
- Put some fine or ultra fine compound on the painting surface and wool buff. Press the wool buff lightly against the surface and take off sandpaper hair scratches.
- Make sure viewing from a low angle that there are no sandpaper hair scratches.
- Polish the surface very lightly with an electric polisher with a sponge buff with ultra fine compound.
- Finish the paint surface by polishing with wax.

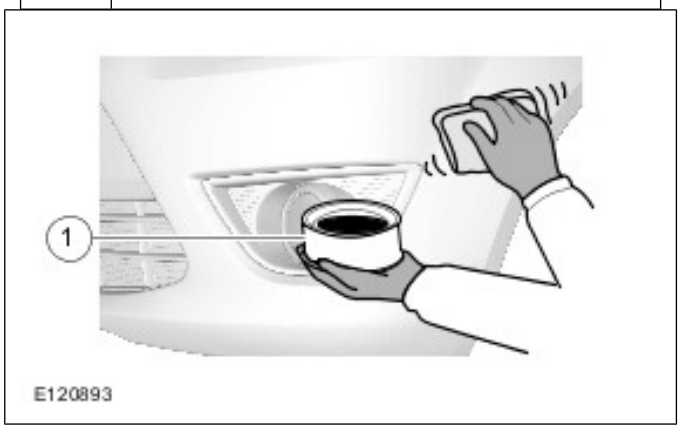
DESCRIPTION AND OPERATION



Item	Description
1	Sandpaper



Item	Description
1	Wool buff



Item	Description
1	Wax

DESCRIPTION AND OPERATION

Spot Repairs

General

In general, partial surface painting at a point is called a spot repair. Using this technique, minor paint damage can be resolved economically and to time.

Advantage of this method

Because this application remains confined to the area of the damage, it is often unnecessary to remove components or color match against neighboring components. The material used is very much reduced because only a part of the repair area is coated.

Practical application areas

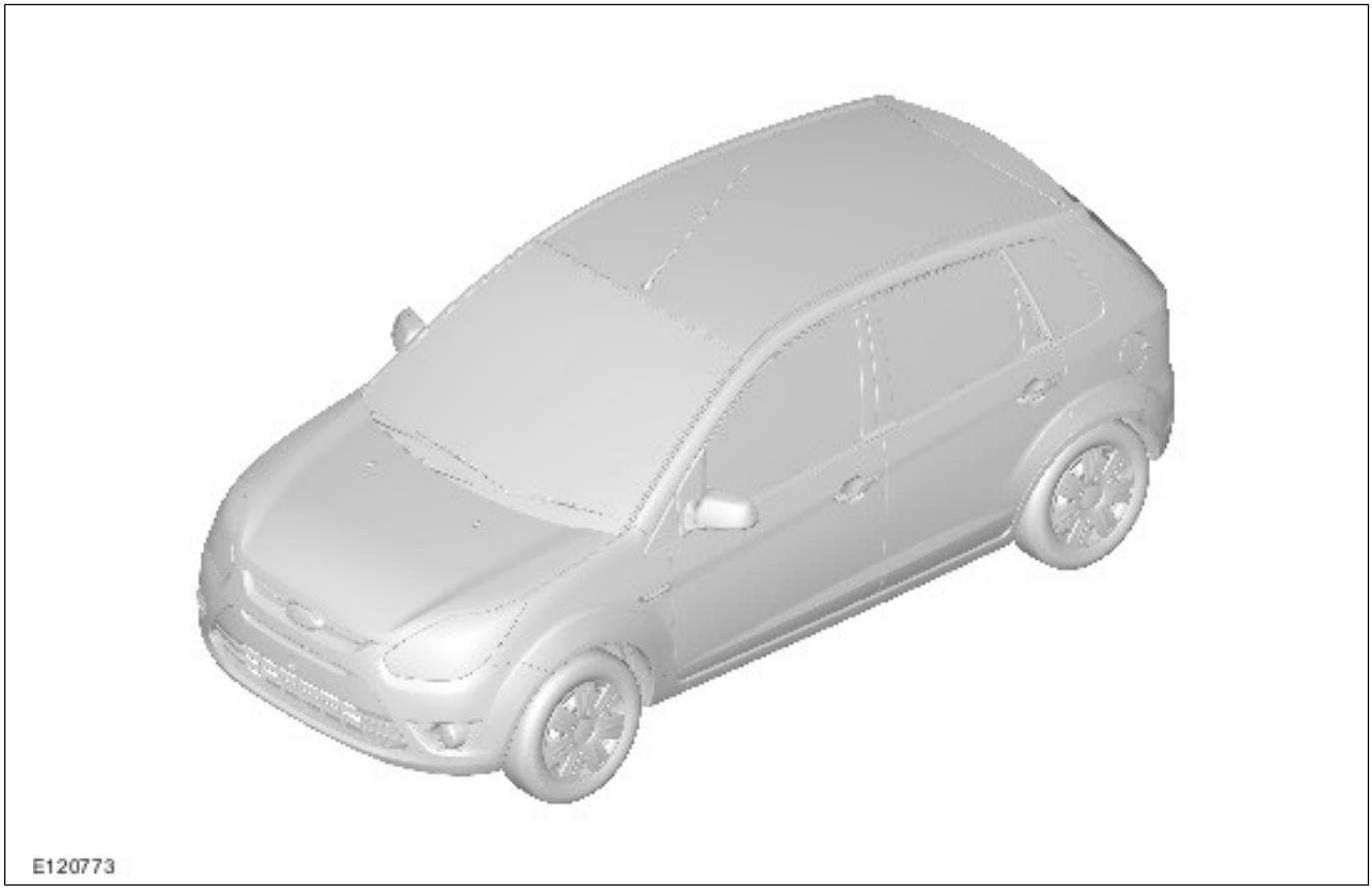
Only occasionally can satisfactory results be achieved in the centre of larger surfaces and/or on difficult colors. In addition, unprofessional application may cause tear-off edges to appear in clear lacquer. Only certain application areas are recommended.

NOTE: The final decision on whether to spot repair or paint the component must be made by an expert.

Application areas:

- 2-layer paint.
- Depending on the damage zone, paint damage up to a diameter of 3.5 cm or a length of 10 cm.
- Scratches.
- Clear lacquer application up to an area of DIN A4 max.
- Smaller areas which are optically broken up by other components such as trim strip, tail lights, swage lines and edges.
- Boundary zones and edge areas of larger components.

The best application areas have proven to be optical break lines such as corners, narrow surfaces, fenders and wheel arches.



Because of their locations, the violet colored areas are the most suitable for spot repair painting. The turquoise areas are only marginally suitable and the rest of the areas are not suitable for spot repairs.

DESCRIPTION AND OPERATION

Before Starting Paint Repair

Work Processes and Work Descriptions

Generally, paint repair on a vehicle body is carried out in the following steps.

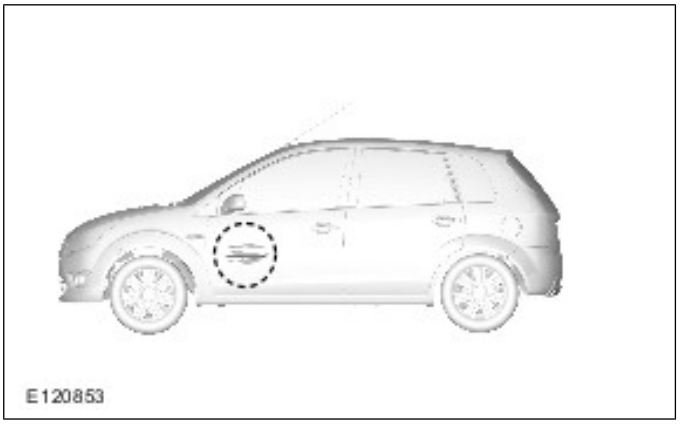
1. Inspection of body repairing processes
2. Confirm the range of repair. Inspect the grade of the damage and decide on whether to repair or replace the part with a new one.
3. Evaluate the state of the old paint layer. Check the type of the old paint layer and the state of deterioration.
4. Decide on the painting specification and estimation. Decide on the type of paints to be used and work processes.
5. Preliminary processes before painting. Vehicle washing, removal of attached parts, separation of the old paint layers, and polishing.
6. Treatment of metal surface. Wash primer painting, putty application and polishing.
7. Inspection of after treatment.
8. Masking for undercoat painting.
9. Undercoat painting. Primer surfacer painting, putty application and polishing.
10. Masking for top coating.
11. Top coating. Color matching and top coat painting.
12. Inspection of after top coating.
13. Drying and final polishing. Final polishing installment of attached parts, and cleaning.
14. Inspection of paint after repair completion.

Range of Damage and Types of Repair

Decide on the range to be repaired.

Minor Repair

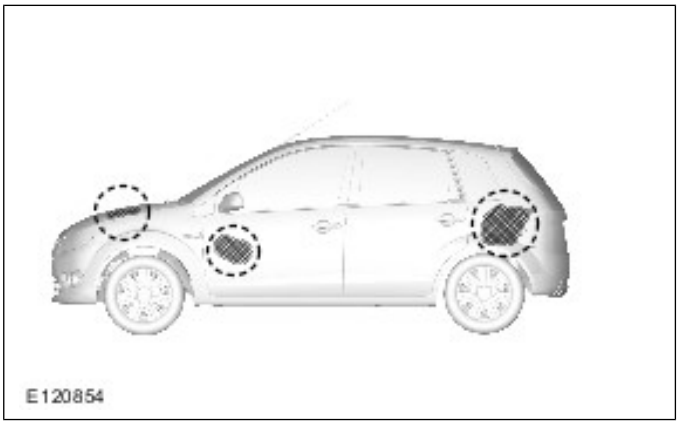
A repair method to be applied for a minor damage involving only the top coat paint layer such as slight scratches, dents, paint grain or flow. Repair is conducted only with a pen-like paintbrush and polisher without using a spray gun.



Partial Repair

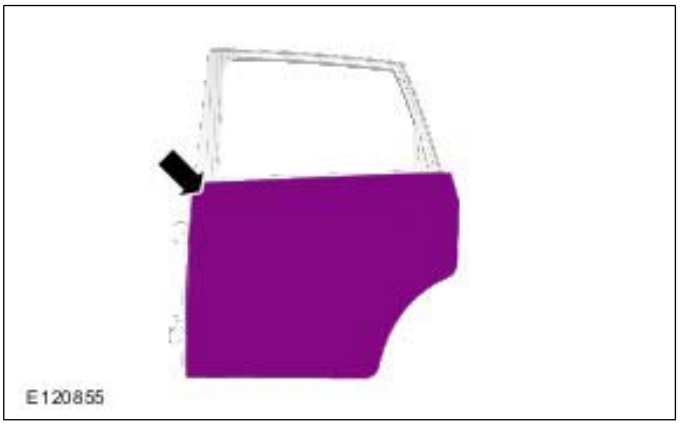
Spot gradation painting:

A repair method to be used for a narrow range of the damage. In order for the differences in color and surface appearances between the repainted area and the surrounding panel to be inconspicuous, gradation is utilized.



Block gradation painting:

Repair with gradation only the damaged part of a panel part with an enamel base paint and paint the whole panel part with clear coat. Solid color, instead, may be used depending upon the situation.



Block painting:

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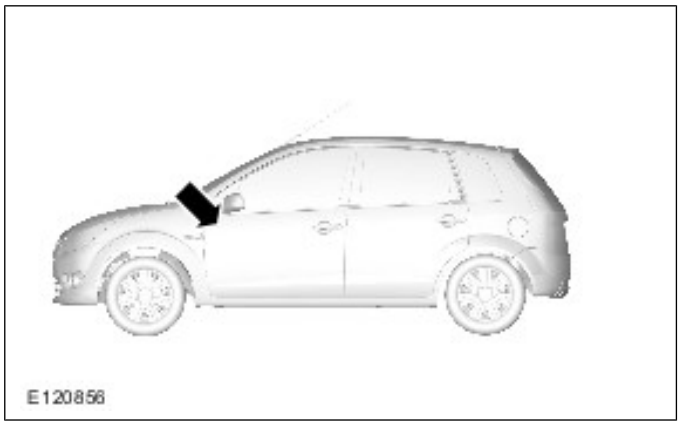
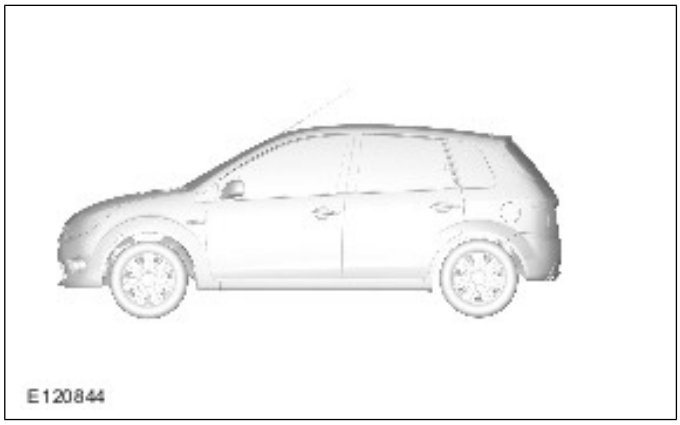
Body panels are divided into individual blocks such as a door, engine hood, etc. and termed as a block. Painting is conducted as a unit of a whole block. The whole panel block is painted without resorting to a gradation painting. But, for a roof panel and a panel between the rear pillars, depending upon the situation, gradation painting is used.



Whole Painting

Paint the whole vehicle panels with the original color or a new color. In a case that numerous damaged spots spread over the vehicle body, the whole painting is much better than the partial color repairing.

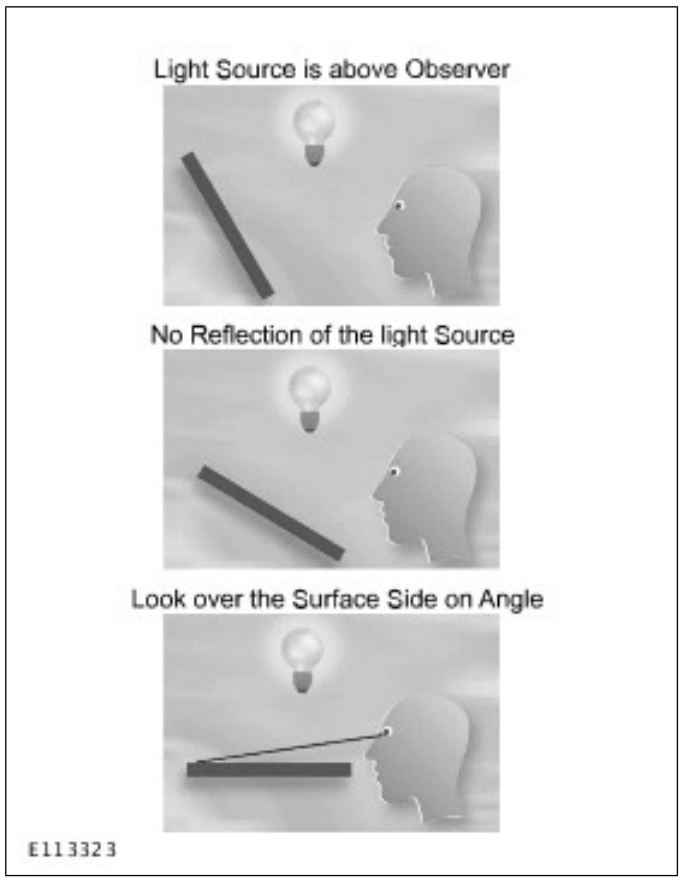


Judgement of Paint Layer and Selection of Repair

In paint repair, it is vitally important to know well the type of the old paint layers and the state of deterioration. To correctly evaluate the old paint layer and decide on the type of paints to be used, follow any of the methods described bellow.

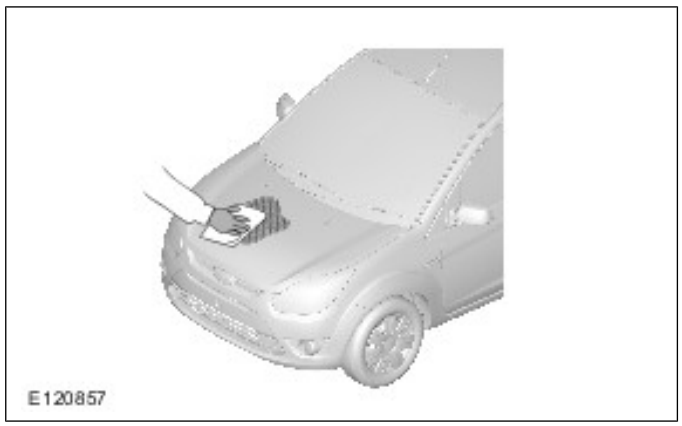
Visual method:

Check the surface of the paint and its state of polishing visually with your eyes.



Solvent Method

Wipe the surface with a cloth wetted with lacquer thinner.



Thermal method

Polish with P800 to P1,000 sandpaper, and heat it with an infrared lamp to over 176°F (80°C).

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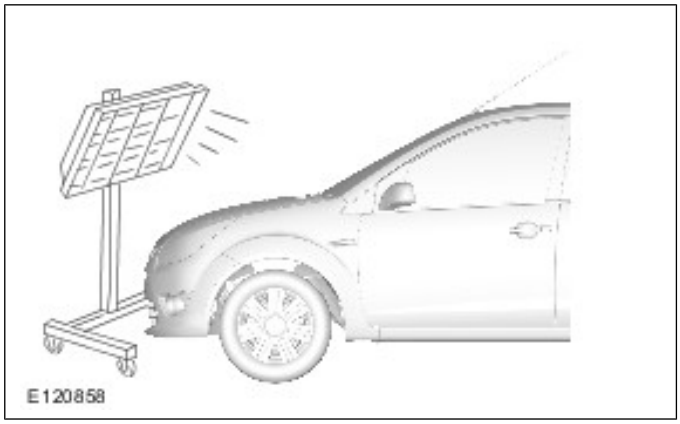


Selection of Repair Paints

Relationships between paint layer evaluation methods and states of paint layers:

Kinds of Paint layer	Visual Check Method	Solvent Method	Thermal Method
Melamine baking type	Granulated	Insoluble	No Change
Acrylic baking type	Finely granulated	Insoluble	No Change
Baking primer type	-	Insoluble	No Change
NC Lacquer type	Polished	Soluble	No Change
NC denatured acrylic lacquer type	Polished	Soluble	A little softened
CAB straight acrylic lacquer type	Polished	Soluble	Softened
Acrylic urethane type	Mirrored	Insoluble	No Change
Quick drying acrylic urethane type	Mirrored	hard to be soluble	No Change

Selection of Repair Paints

Note that all paints cannot be used as paint for repair.

In a case that the old paint layer is a baking type or an acrylic urethane type that is not dissolved by lacquer thinner or if the old paint layer is totally removed including the undercoat, rifting hardly happens, but if the old paint layer is of a lacquer type that is dissolved by lacquer thinner, rifting often happens during paint repair. For this reason, the types of paint that can be used for paint repair are limited.

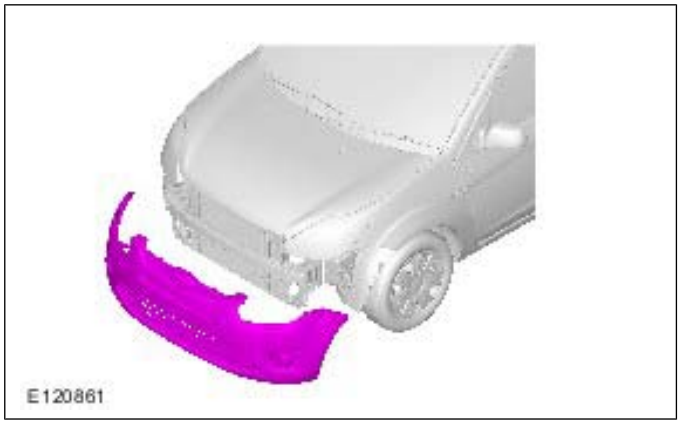
Repair Painting

Removal of Attached Parts

1. Wash vehicle. Start the vehicle washing from the roof to the engine hood, trunk lid, and the side panel in this order. Remove wax and other fat on the paint with neutral washing agent. Never bring dust and dirt into the painting room.

2. Remove attached parts. Refer to the Shop Manual. Where necessary, remove attached parts, get rid of dust and dirt with air blowing and wipe off water on the paint surface. When a heater is used for drying, be sure to remove heat-sensitive resin parts from the heated area.

DESCRIPTION AND OPERATION



Separation of Old Paint layer

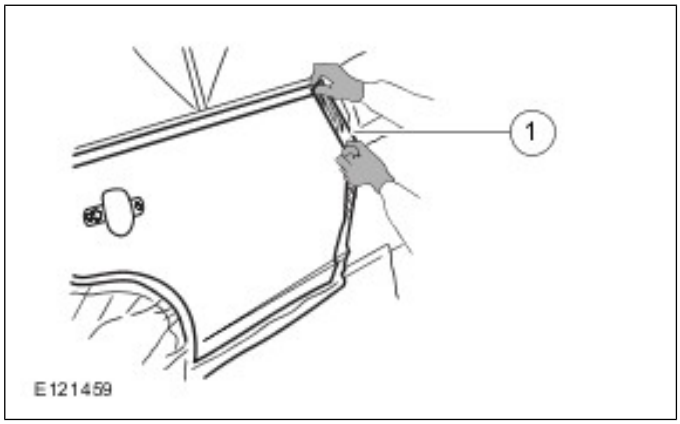
Removal

Use a paint remover to remove the old paint layer if the damage is too deep or its deterioration is extensive. If the area that needs repair is wide, also used the paint remover.

WARNING: Avoid contact with skin, wear a respirator, gloves, eye protection, and appropriate clothing when applying the paint remover.

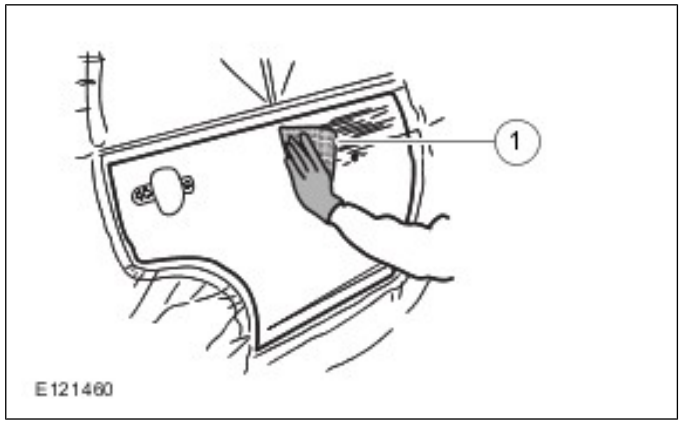
NOTE: Be sure to read the manufacturer's instructions.

1. Place the masking tape about 10 to 20 mm (0.4 to 0.8 in.) inside from the edge of the area to be separated. Place masking tape over the whole surface where the old paint should remain as it is.



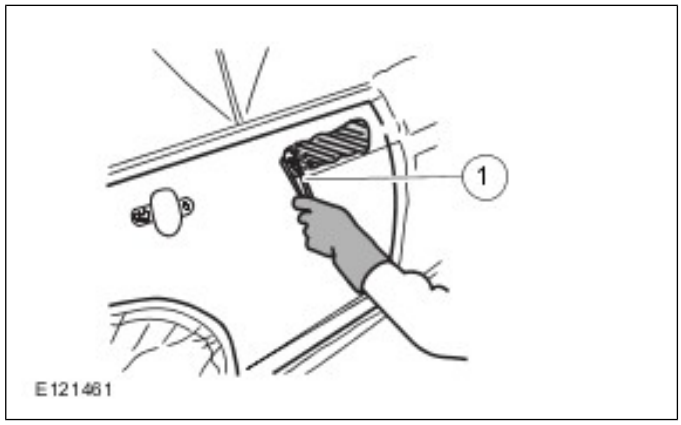
Item	Description
1	Masking tape

2. Polish the surface to be removed with P60 to P80 sandpaper to facilitate penetration of the paint remover.



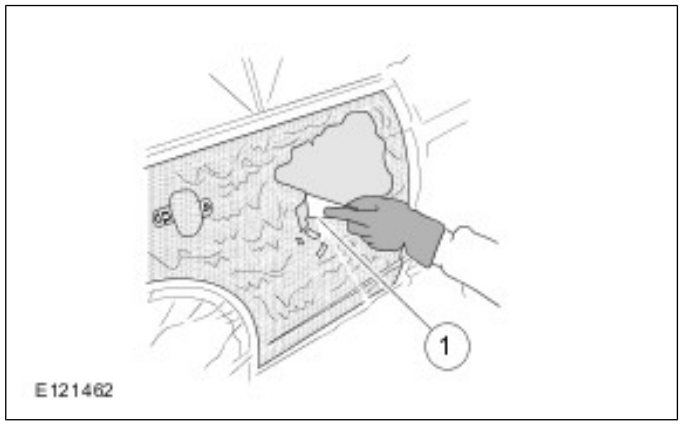
Item	Description
1	Sand paper

3. Heap up the paint remover on the surface with a brush.



Item	Description
1	Paint remover

4. When the paint layer becomes soft and comes off easily, remove it with a scraper or spatula. If it cannot be taken off all at a time, repeat the work until it is removed completely.



Item	Description
1	Scrapper

DESCRIPTION AND OPERATION

5. Get rid of the remaining paint remover and other residues. Rinse thoroughly with water.

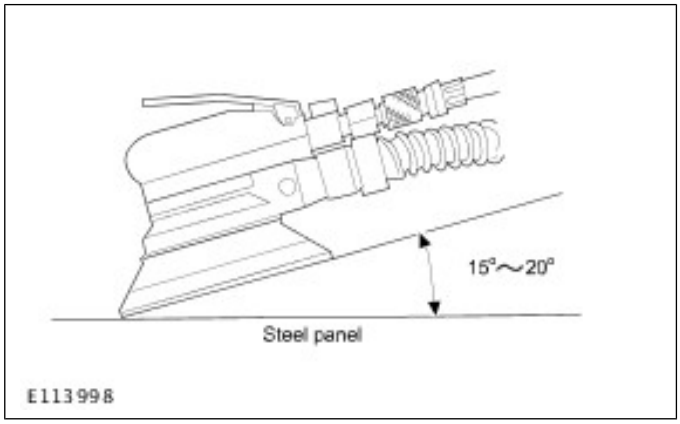
6. If some of the paint and the masking tape marks are still left on the surface even after being removed by the paint remover, polish them off with P40 to P80 sandpaper again and clean and take off all fat with the degreaser.

Removal with a disc sander :

WARNING: To prevent eye injury, wear goggles or safety glasses whenever sanding.

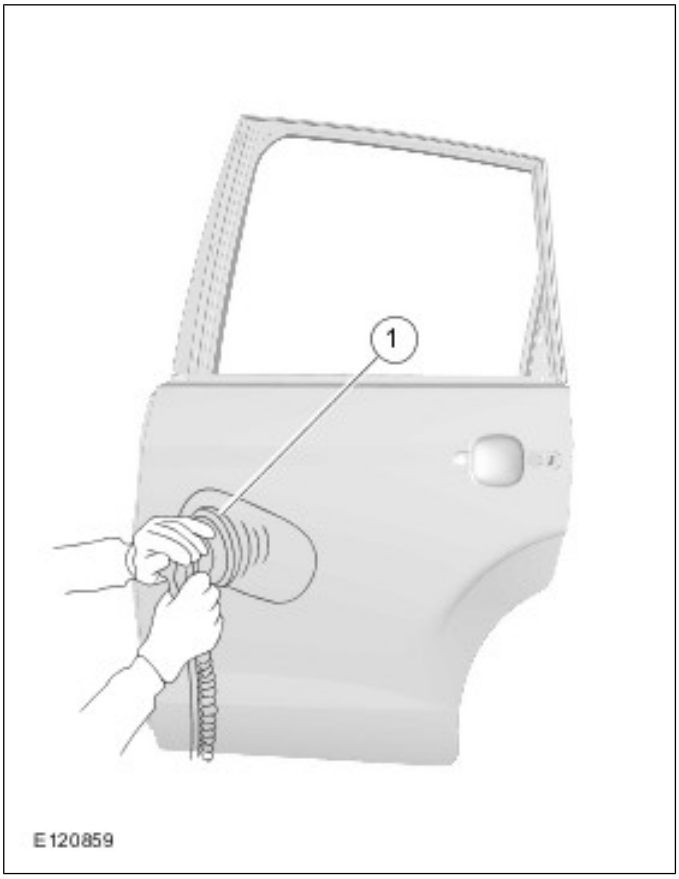
If the area that needs repair is small, it is better to remove the old paint layer with a disc sander.

NOTE: Do not press the sander too hard. Use the disc sander with the front of it touching the surface as shown below.



Attach P40 to P60 sandpaper to the disk to polish the damaged or deteriorated area.

NOTE: Remove the sideliner attaching tape and stickers using a razor blade or scraper and if their glue vestiges remain, use a degreaser to remove them completely.



Item	Description
1	Sander

Setting of Reference Surface

Featheredge

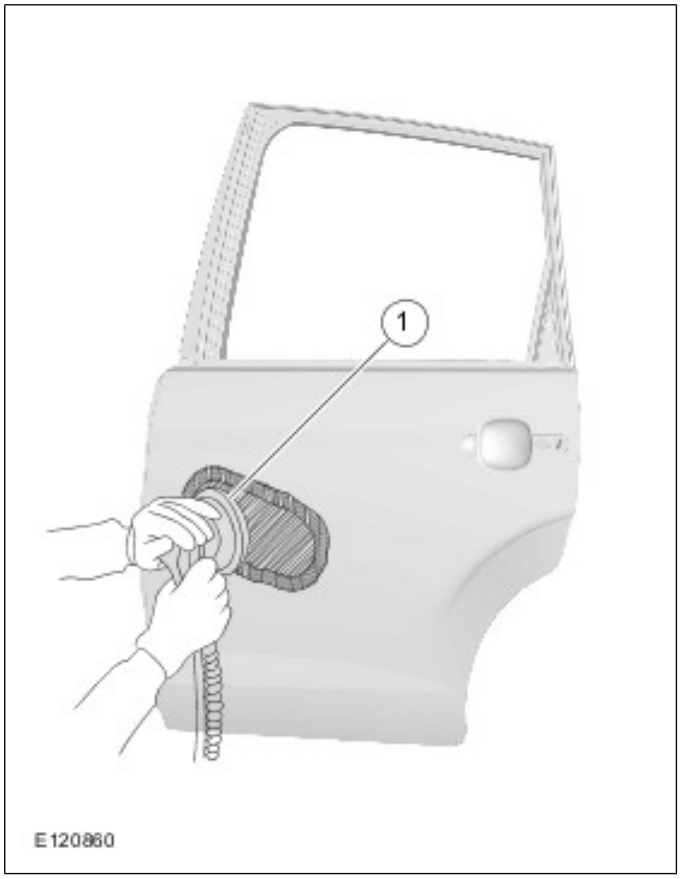
Set a reference surface on the old paint layer.

NOTE: How well the reference surface is set affects the final result of the repair greatly.

Using a double action sander attached with a P40 to P80 and P240 sandpapers, make featheredge match well with the state of the damage on the paint layer surrounding the damaged area.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever sanding.

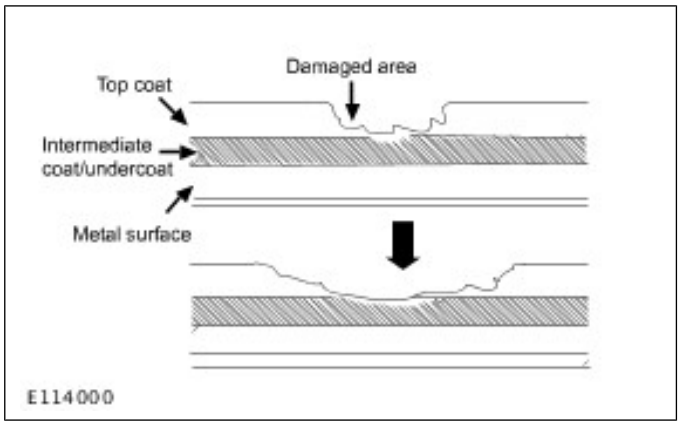
DESCRIPTION AND OPERATION



Item	Description
1	Double action sander

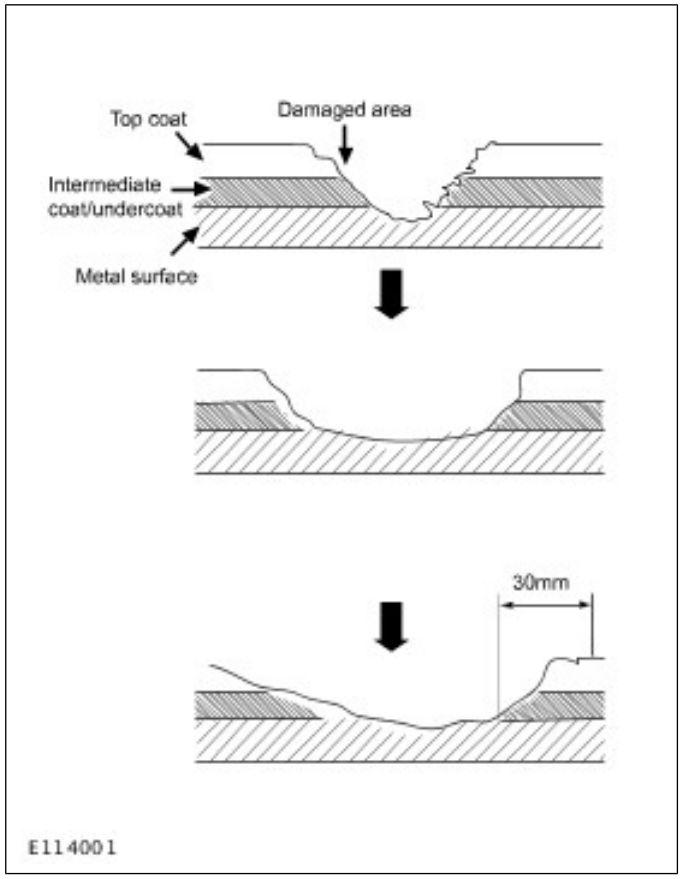
If the damage is not deep:

Flatten and make smooth the edge of the damaged area with a double action sander with P240 paper.



If the damage is extensive:

Attach a P40 paper to a double action sander and grind off the paint layer roughly. Then, attach a P80 paper and polish the surface until the paper scratch is eliminated. Further, carefully polish off the paint around the damaged area in a width of 30 mm (1.2 in.) to form a featheredge.



Treatment of Metal Surface

Treatment Procedures

1. Wash primer painting. If the metal surface remains exposed to the air after being polished, rust will grow quickly. In order to prevent rust from growing and, at the same time, to improve adherence to the paint, apply wash primer to the surface.

WARNING: Avoid contact with skin, wear a respirator, gloves, eye protection, and appropriate clothing when applying.

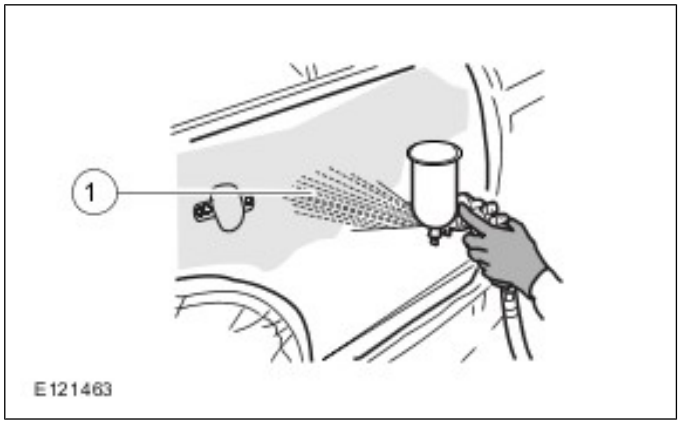
NOTE: Before using the wash primer, be sure to read and follow the manufacturer's instructions carefully.

a. Mix the main agent with its additives and dilute it with the thinner exclusively for it.

b. Apply it at one or two layers with a spraying or brush. The layer thickness should be 3 to 5 m to such an extent that its color is then yellow green.

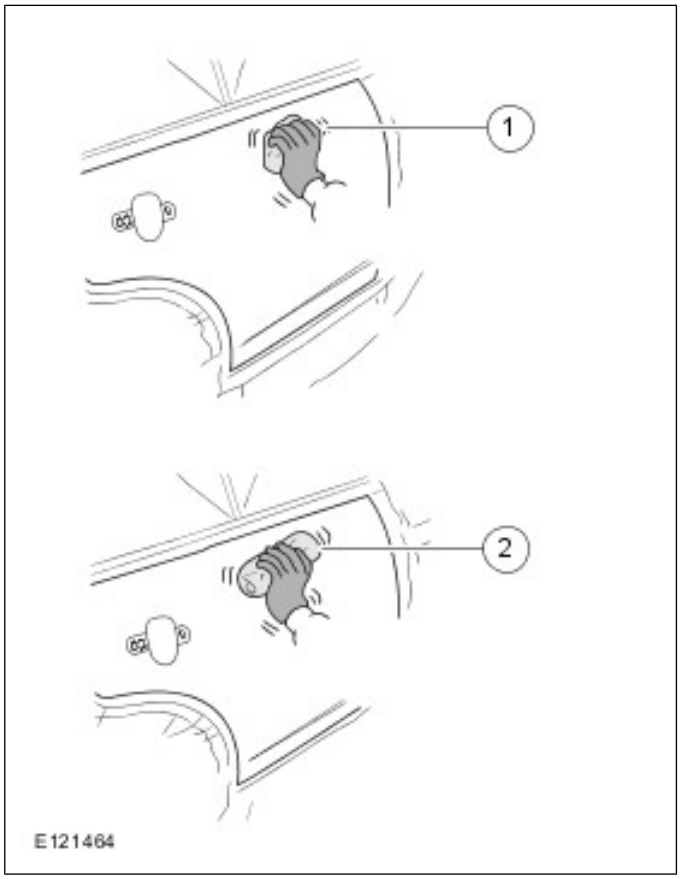
c. The drying time should be around about 60 minutes at 68°F (20°C). If force-dried, the quality of the paint is improved.

DESCRIPTION AND OPERATION



Item	Description
1	Wash primer

2. Clean the puttied surface with air blow and remove grease from the metal surface.



Item	Description
1	Grease remover
2	Wipe off with dry cloth

3. Select the putty. There are different kinds of putty. Some putty is good for lightweight panel repair because of its polishing quality. Some are called polyester putty and have good in the qualities of quick drying and polishing qualities, and some are with other features. In this case study, intermediate putty is to be used as an example that has characteristics of both panel repair and polyester-putties.

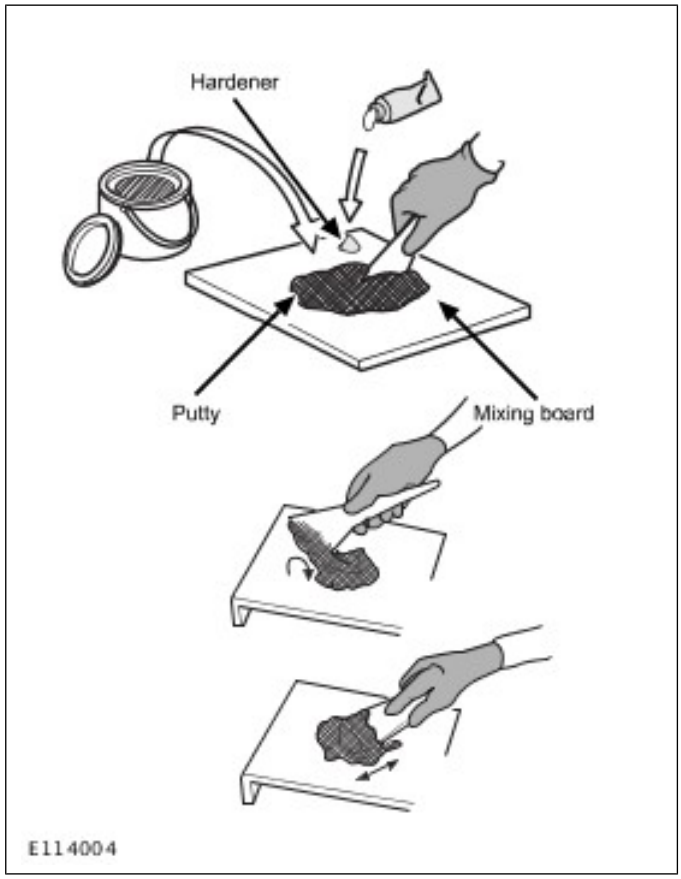
4. Preparation of intermediate putty.

NOTE: Carefully read and follow the manufacturer's instructions.

a. Stir the putty until it becomes even.

b. Take out the necessary amount of putty and place it on the mixing board. Add 25% of hardener to it and mix it.

c. Knead it with a spatula until the color becomes even taking care not to entrap air in it.

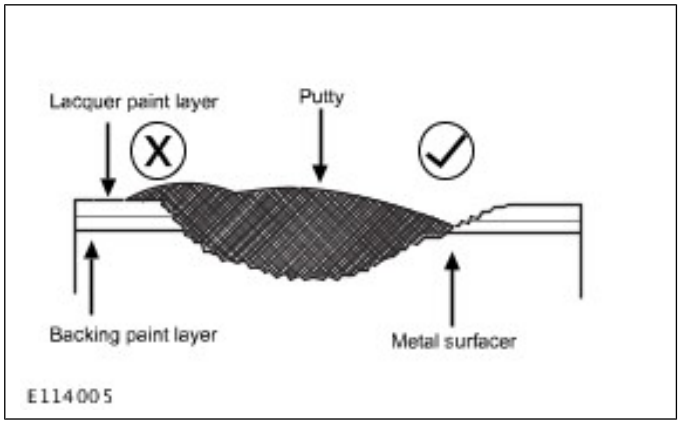


5. Apply intermediate putty with a spatula in the recess of the damaged area.

WARNING: Wear an approved gloves, when applying the putty.

NOTE: When the old paint layer is of a lacquer type, be careful not to put the putty on the old paint surface. If it is put on the old paint surface. The putty mark may remain on the surface when the top coat is painted.

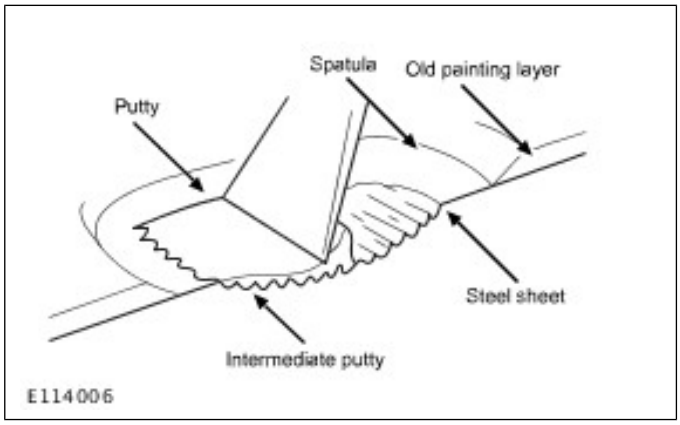
DESCRIPTION AND OPERATION



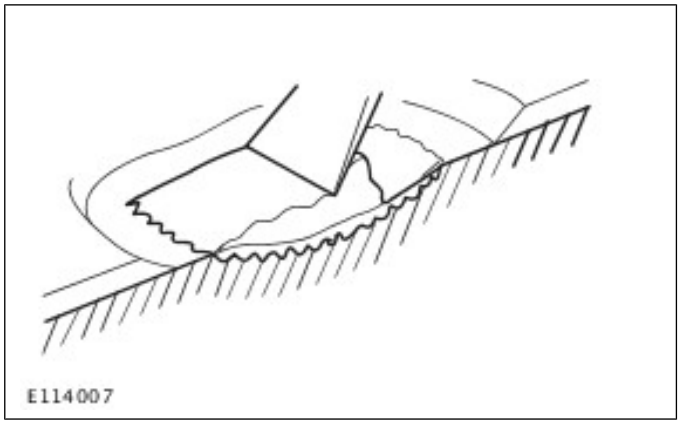
Basic technique in putty application:

In applying putty, do not try to heap up all at a time but do it in several layers.

6. At the first application of the putty, stand the spatula nearly on end to apply the putty very thinly so that the putty penetrates into hair scratches caused by sand-paper polishing.

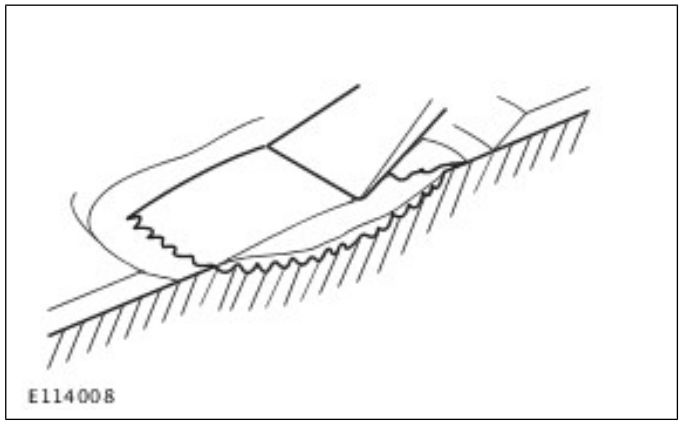


7. Heap up the putty thickly with a spatula holding it a little sideways.



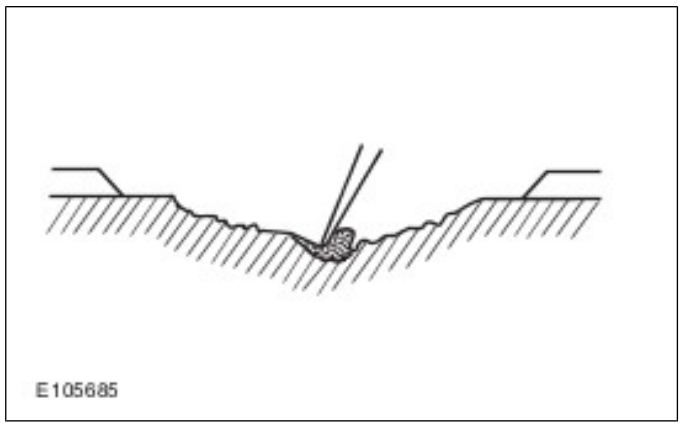
8. Make the putty surface flat. If the spatula's unevenness remains on the putty, take it out using the spatula in a flat way. Complete this process of making the putty surface flat before the putty starts to dry.

NOTE: If a large amount of putty is applied at a time, air may be entrapped in the putty.

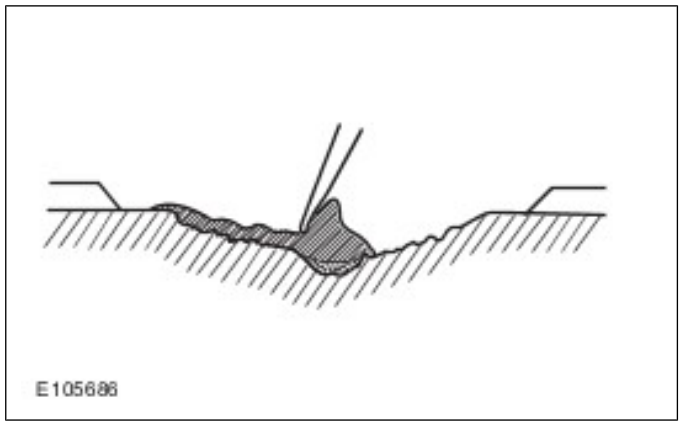


Apply putty on the uneven panel:

Apply putty into a partially deep dented area of the damage.

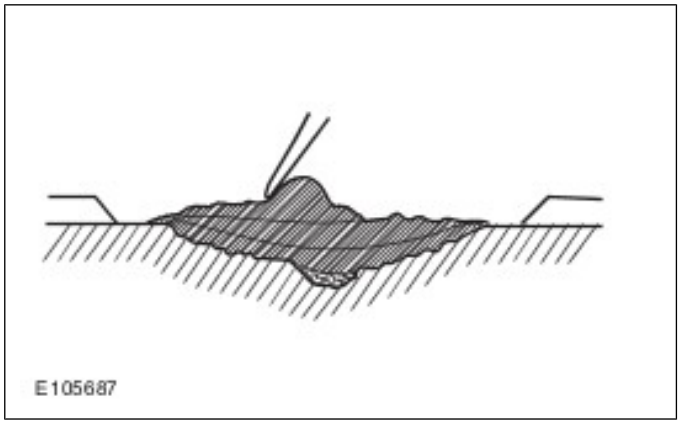


Apply over the whole area of the damage.

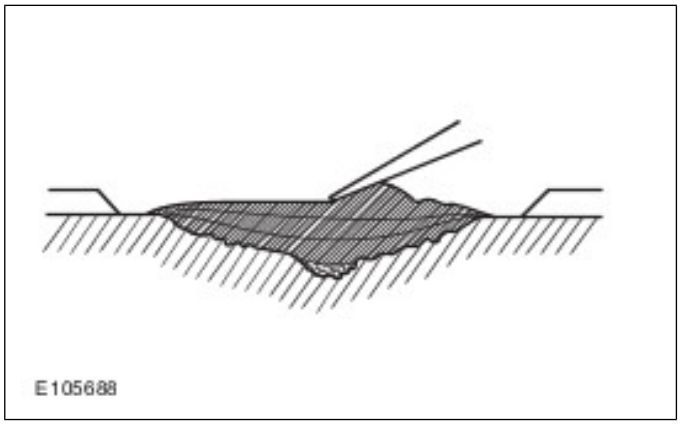


Take a slightly larger amount of putty on the spatula, heap up it over the whole area of the damage holding the spatula in an inclined way.

DESCRIPTION AND OPERATION



Holding the spatula in a flattened way, flatten the surface taking out all irregular spots.

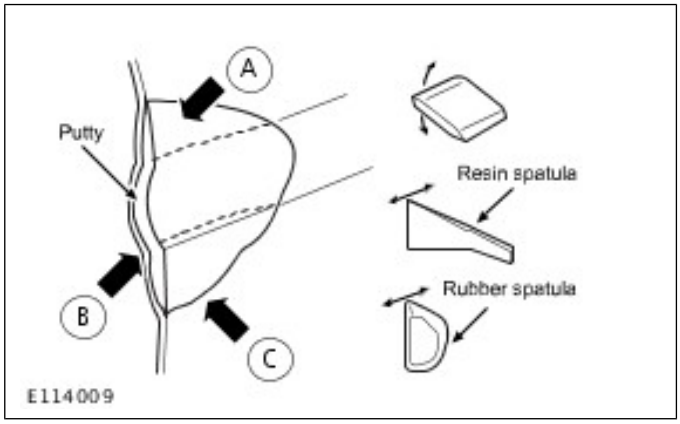


Apply putty on a curved surface:

Apply putty using a spatula normally used for the damaged area (A).

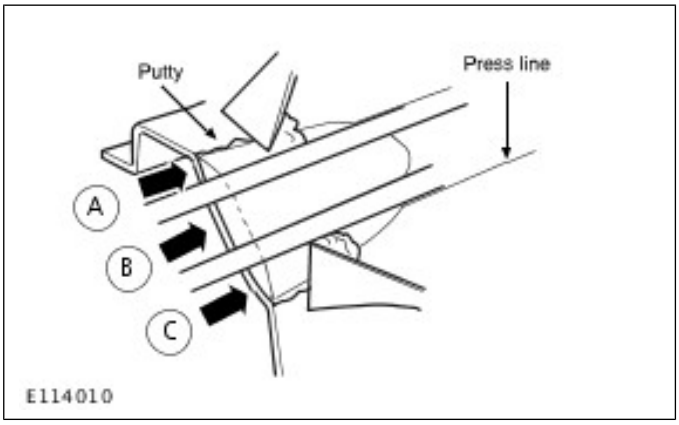
Apply putty on the damaged area ©) using a rubber spatula.

Apply putty along the line on the reverse curved surface of the damaged area (B).



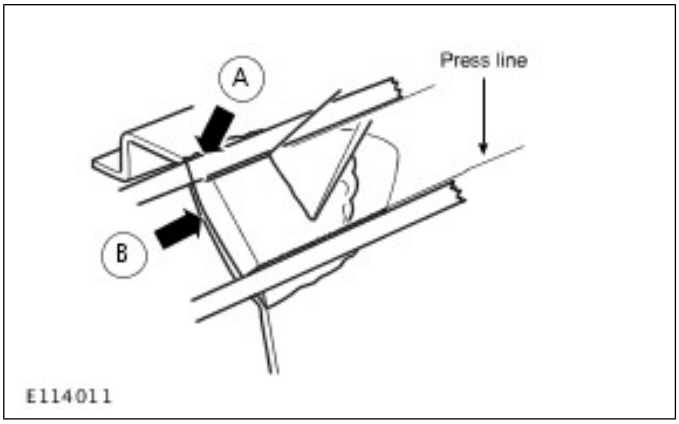
Apply putty on the press line area:

For applying putty on the straight-line area like the press line, make use of a masking tape. Place the masking tape along the top and lower lines of the damaged area (B). Apply putty on (A) and ©) surfaces of the damaged area.



Apply the putty on the (A) and ©) surfaces of the damaged area has dried, peel off the tape and then paste the masking tape along the lines of (A) and ©) surfaces of the damaged area.

Apply putty on the (B) surface of the damaged area.



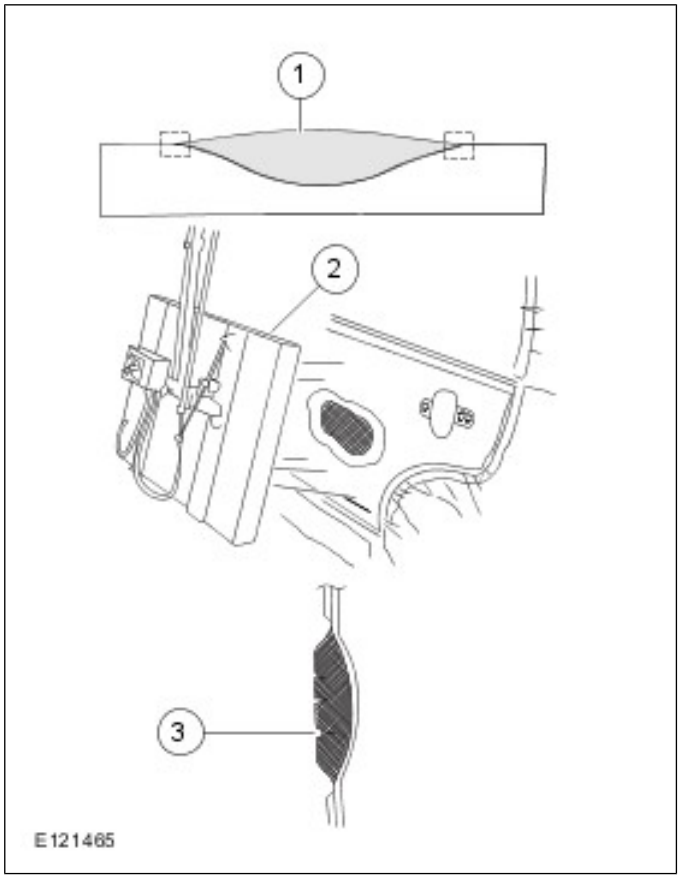
9. Dry-up of intermediate putty. The dry-up time depends greatly upon the ambient temperature. The thickness of the putty also affects the drying time because the thermal reaction takes place while the putty is drying. Where the putty is thick, more heat is produced causing a shorter drying time than where it is not as thick.

NOTE: Check to see the manufacturer's instructions on the drying time.

NOTE: Before starting forced drying, take sufficient setting time. Carry out the forced drying at 122 to 140°F (50 to 60°C). Making the temperature too high may cause degradation of the hardener.

NOTE: Avoid too quick or too slow heating or cooling, because it is likely to cause distortion to the steel sheet, which causes cracking or peeling of the putty.

DESCRIPTION AND OPERATION

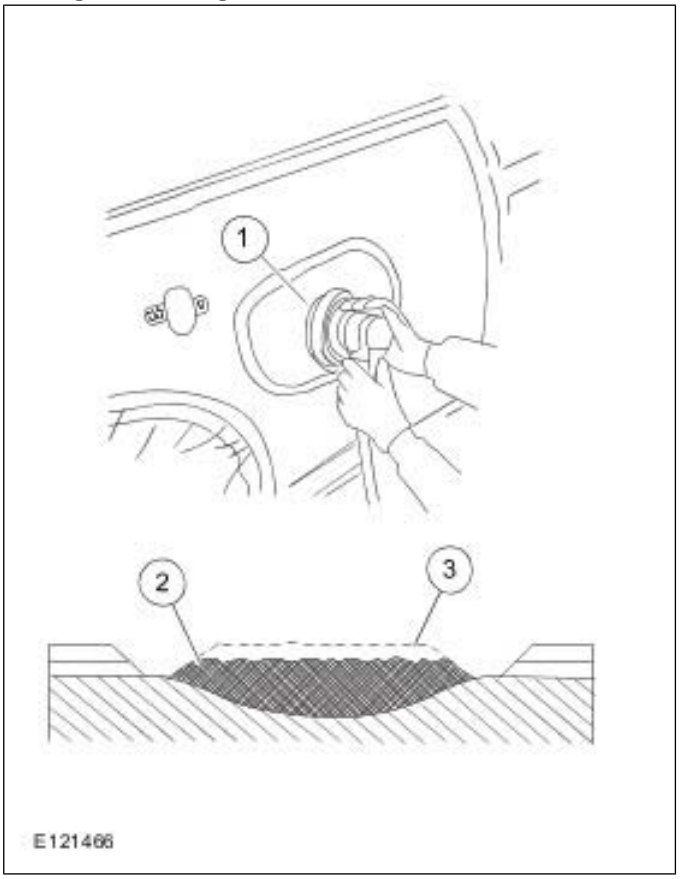


Item	Description
1	Drying time shorter
2	Infrared lamp
3	Putty

10. Intermediate putty polishing.

WARNING: Wear an approved respirator, gloves, eye protection, when putty polishing.

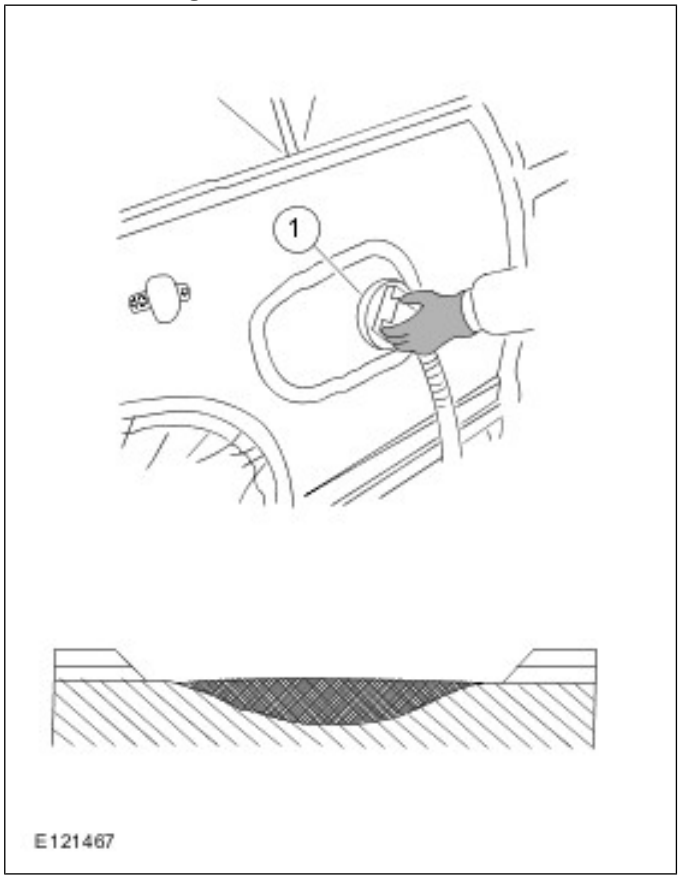
Rough Polishing



Item	Description
1	Orbital sander
2	Putty
3	Rough polishing

DESCRIPTION AND OPERATION

Fine Polishing



Item	Description
1	File

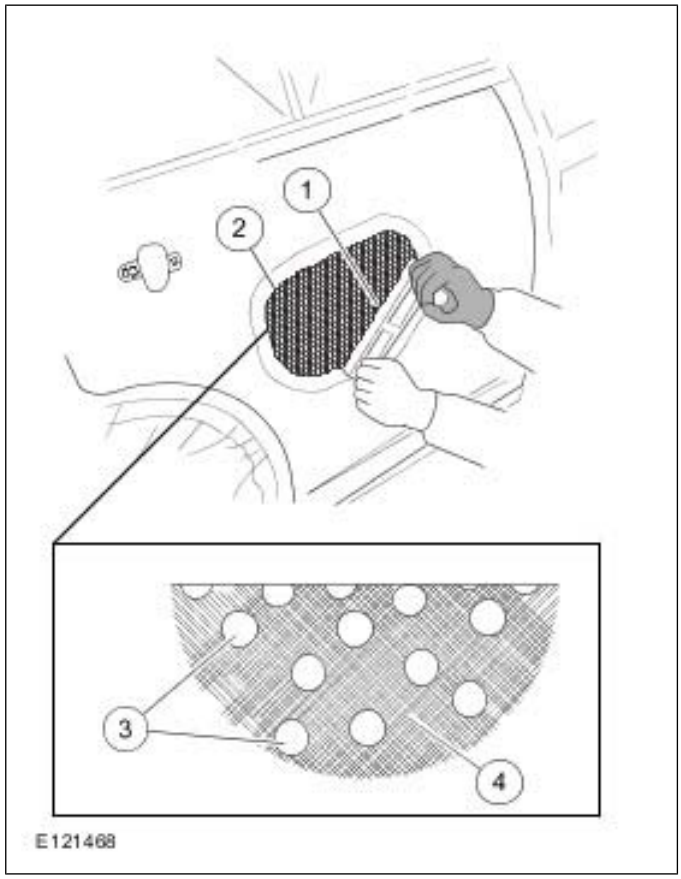
11. Verify the surface after applying intermediate putty. After the surface is formed, check it by feeling with your fingertips so no cavities or hair-line scratches are found; move to the primary surfacer process. If a dent could not be filled with putty the first time or the part of the surface is polished too far below the reference surface, apply putty again to correct it. Use polyester putty in this case.

Sheet panel putty (wax type):

When a panel putty is used that is a sticky wax type and hard to dry, grind off the surface because it is inferior in polishing.

If it has been hardened too much, it is difficult to grind off the surface, so, grind off the surface about 2 to 10 minutes after it starts to dry in a half hardened state. In grinding off, move the surface former from the center toward the edge in a radial direction because the adherence along the edge is not strong enough.

NOTE: After a puttied (body filler) surface is polished, a number of hollow cavities remain on its surface. As it is difficult to fill tiny air cavities with a primer surfacer, use polyester putty or lacquer putty instead.



Item	Description
1	Surface former
2	Panel putty
3	Hollow cavities
4	Resin and pigment

12. Blow air on the puttied surface and remove fat with solvent.

WARNING: To prevent eye injury, wear goggles or safety glasses whenever blowing.

NOTE: Blow out polishing residues from cavity holes.

13. Preparation for polyester putty application.

NOTE: Before applying the putty, be sure to read the manufacturer's instructions.

NOTE: Mix the putty with its necessary amount of hardener and knead it until its color becomes identical.

14. Apply polyester putty. Apply the polyester putty sparely on the scratches, cavity holes or dents.

15. Dry up polyester putty.

DESCRIPTION AND OPERATION

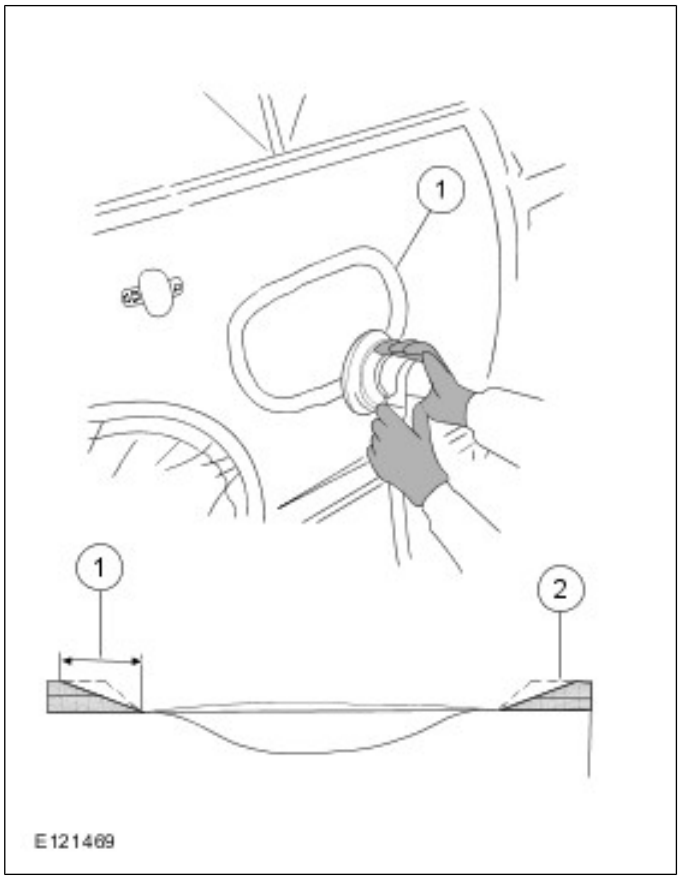
NOTE: For the drying time, refer to the manufacturer's instructions.

16. Polyester putty polishing and finishing. To polish by hand, use P180 to P240 sandpaper. To use a double action sander, use P120 to P180 sandpaper.

17. Featheredge (Undercoat roughing for better adherence).

WARNING: Wear an approved respirator, gloves, eye protection when putty polishing.

- Using a double action sander with a P240 sandpaper.
- Depending upon the situation, make the polished old paint layer sloping without steps.
- For the old paint layer on which primer surfacer is to be applied, polish it with sandpaper for better adherence to the new paint.



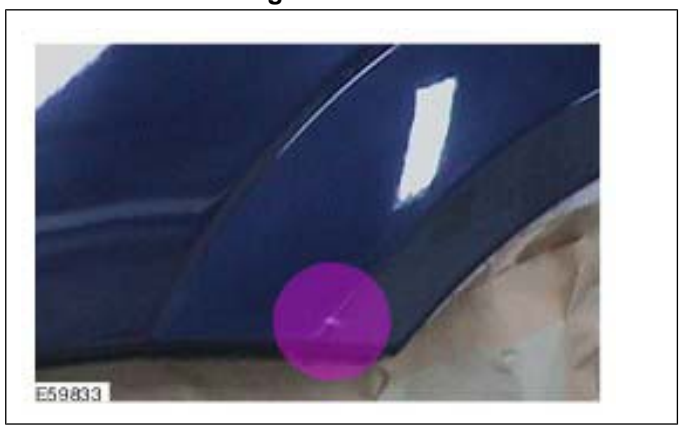
Item	Description
1	Feather edge
2	Old paint layer

Perfect preparation of the subsurface is the precondition for a brilliant paintwork result. Faults in the preliminary stages delay completion and cause unnecessary extra work. The working steps described here demonstrate how important it is to follow these instructions step by step.

Repair process

Perfect preparation of the subsurface is the precondition for a brilliant paintwork result. Faults in the preliminary stages delay completion and cause unnecessary extra work. The working steps described here demonstrate how important it is to follow these instructions step by step.

Illustration of damage



A typical case for spot repair is a small stone chip on the fender.

Cleaning

First of all the component is thoroughly cleaned using silicone remover and refurbished using abrading and polishing paste. This re-creates the original degree of shine and ensures exact color matching on the touch-up surface.

DESCRIPTION AND OPERATION

Sand out

Sand out the damaged location using P180 - P320. Only small sanding blocks and small sanding machines must be used, so that the area of the repair remains as small as possible.

Sanding is completed by rubbing down the surrounding surface with a fine sanding pad or P1000 paper. Remove sanding residues and clean the repair area with silicone remover. The peripheral zone must then be masked for application of the filler.

NOTE: The size of the repair area must be kept as small as possible (maximum size DIN A4).

Filling

The filler layer is applied in stages. First of all, filler is only applied to the location which has been sanded away. After a wait time for flashing off, the second coat is applied so that it spreads over onto the existing paintwork.

The filler must be dried according to the instructions of the material supplier.

Rubbing down

The repair location is now rubbed down with P400 - P500 and the bordering surface with P2000 - P4000. Remove sanding residues and clean the repair area with silicone remover.

Paint

Before painting, clean the area for the final time using a dust-bonding cloth. Then apply the basic paint in thin layers using a spray gun until enough coverage is achieved.

After drying, apply clear lacquer in 1 or 2 coats (depending on product). In doing so, spray so that only the newly applied basic paint is completely covered. Finally a touch-up thinners is sprayed over the edge of the clear lacquer to dissolve the clear lacquer spray mist.

DESCRIPTION AND OPERATION

Dry

Now dry the clear lacquer according to the manufacturer's instructions using an infrared gun.

Polish

Polish the component using a polisher and polish and check the polished area for any swirl marks which may be present. Polish away any swirl marks which are present.

Dirt inclusions

Sand out

Minor damage can be removed with a small sanding machine or preferably with an eccentric sander with P1500 - P2000. Very fine spray mist can be removed using P2000 - P4000 paper and a larger eccentric sander.

DESCRIPTION AND OPERATION

Corrosion Prevention

General

Although corrosion protection measures and painting processes in production have reached a very high technical standard and will be continuously developed further, in the long term corrosion on a vehicle cannot be totally avoided. Further demands are therefore made of the paint specialist besides his knowledge of normal repainting of vehicles which have been repaired after an accident, in addition specialist knowledge is required for assessing and rectifying damage due to corrosion.

During repair painting, take care over the maintenance and re-creation of the corrosion protection applied in production, in view of the long-term warranty on Ford vehicles. Only those repair materials which are approved by Ford may be used for body repair work and repair painting.

For detailed information on corrosion protection measures during body repairs, please refer to chapter 501-25.

Furthermore, information on corrosion protection measures is repeated in individual chapters of the paint manual.

In particular, pay attention that the layer thicknesses specified in production are maintained. The complete system of solid one-layer on galvanized steel panels must equal at least 90 µm and the total system of two-layer on galvanized steel panels must equal at least 105 µm.

It is important that sealing operations, as far as they are necessary, should be undertaken after the application of the paint to specification, in order to ensure the best corrosion protection. All components which form hollow cavities such as pillars, rails, side components etc. must be provided with a coating of cavity protection wax.

Causes of corrosion

Corrosion of steel is an electrochemical process during which the steel combines with oxygen. The following factors lead to corrosion:

- Acidic compounds contained in the air, such as carbonic acid and sulphur dioxide, combined with oxygen from the air and/or water. Salts such as sodium chloride used as road salt accelerate the corrosion process.
- Mechanical damage such as stone chips and scratches which penetrate through to the steel panel.
- Lack of care by the vehicle owner of the painted and corrosion proofed surfaces or areas on the vehicle.
- Unfavorable weather or environmental conditions, as may occur in areas with high humidity, high salt content in the air or serious air pollution due to aggressive gases and dusts.

In the case of mechanical damage, formation of rust can often be seen, beginning to spread into the painted surface from a point (stone chip) or from a line (scratch). If these faults are not professionally rectified in good time, the result is rusting through from the outside to the inside. Rusting penetration from the inside to the outside occurs when for instance the cavity protection was inadequate.

Operations after painting

NOTE: The manufacturer's instructions must be followed when working with the various corrosion protection materials.

- After painting, treat all cavities in the repair area with cavity protection wax. In doing so, pay particular attention to the weld seams. In dead-end applications with a panel insert, the cavity protection wax must be applied so that it also reaches the area of the panel insert.
- Seals which were applied in production and not over painted must be reapplied. Seals protect vulnerable parts of the bodywork, keep moisture away, reduce wind and road noise and dampen vibrations.
- Apply transparent wax.

Definition of the degree of rust

In workshop practice, in order to be able to carry out a consistent and objective evaluation of the scope of the damage, a degree of rust on the scale of 1 to 5 is determined by the DIN 53 210 standard. The main criterion here is the extent to which rust exists under the paint structure. It is determined in millimeters (mm).

DESCRIPTION AND OPERATION

Underlying rust grade: R1 < 1 mm

Corrosion starting with up to 1 mm of rust underlying (in the form of a spot or a line).

The damage can be rectified by cleaning the defective location and mechanically removing the underlying rust. For a small extent, apply a primer using a brush and allow it to dry. Touch-up the location with a paint pen or provide a new paint coating.

Underlying rust grade R2 < 1 - 2 mm

Advanced corrosion with up to 2 mm underlying rust.

Rectifying the damage:

- Clean the defective location.
- Remove the underlying rust mechanically down to the paintwork carrier.
- Apply 1-component filler and then 2-component "Vario" filler.
- Provide the damage location with new paint coat on visible outer surfaces. Only locally touch-up areas which are not optically conspicuous.

Underlying rust grade R3 < 2 - 4 mm

More advanced corrosion with up to 4 mm underlying rust. The damage must be rectified in the same way as for R2. A permanent cure of this type of damage pattern is still just possible

Underlying rust grade R4 < 4 - 5 mm

Notably advanced corrosion with up to 5 mm underlying rust. The damage must be rectified in the same way as for R2. If it is found that for whole areas this is only possible with a great deal of work, or is not possible at all, then a new component must be used.

Underlying rust grade R5 > 5 mm

Extreme corrosion, with more than 5mm underlying rust (panels, flanges or load-bearing components partially rusted or rusted through).

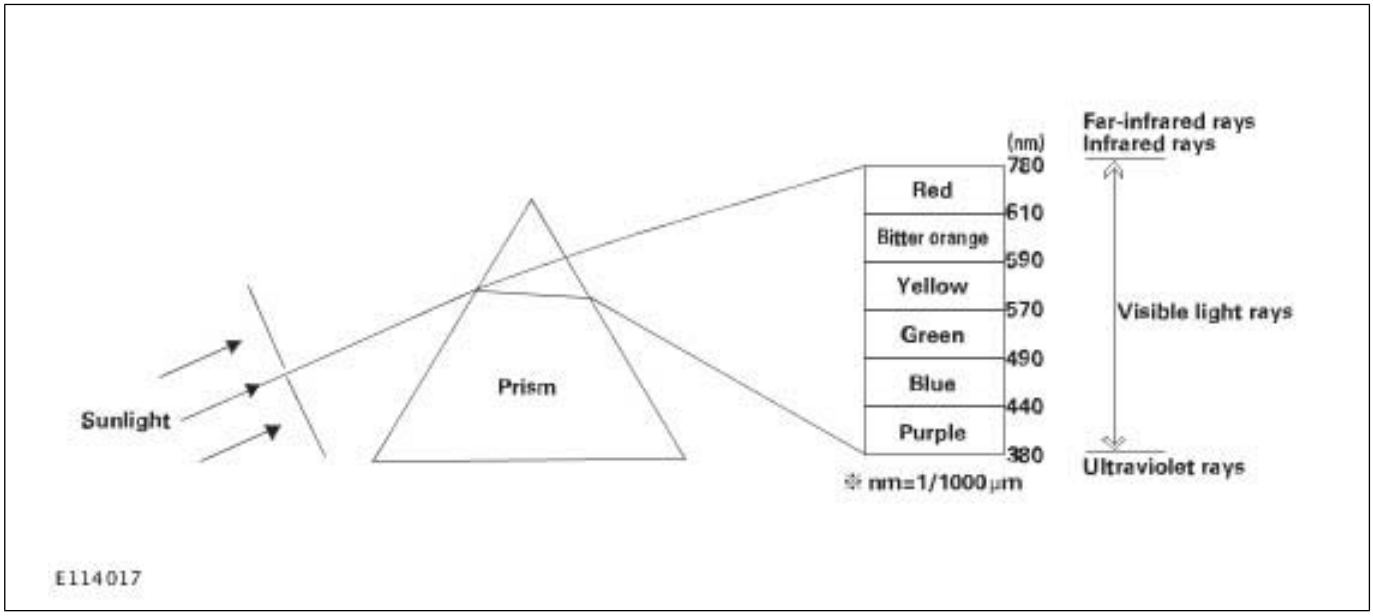
Such damage can no longer be repaired because in many cases the constructional strength of the component can no longer be produced. The risk in making a repair is too great. Install a new component and paint it.

DESCRIPTION AND OPERATION

Color Identification and Chromatics

Basic color theory

In order to achieve optically perfect painting results it is vital to understand the physical principles of the origin of color impression.



Out of all light rays coming from the sun, what human eyes can see are only visible rays within a wavelength range of 380 nm to 780 nm. The rays of which wavelength is shorter than 380 nm are called ultraviolet rays. The deterioration of a paint layer and the change or fade of a color is caused by these ultraviolet rays. On the contrary, the rays that have wavelengths longer than 780 nm are termed infrared rays. The rays that have much longer wavelengths are called a far-infrared ray. Both of these infrared and farinfrared rays are called heat rays, which are used for the heat sources of dryers and room heaters.

Visible rays in the sunlight look white. However, as is easily understood if the sunlight is passed through a prism, the sunlight is a combination of different wavelengths that have different colors ranging from red to violet.

Color

Color itself is a sensory perception.

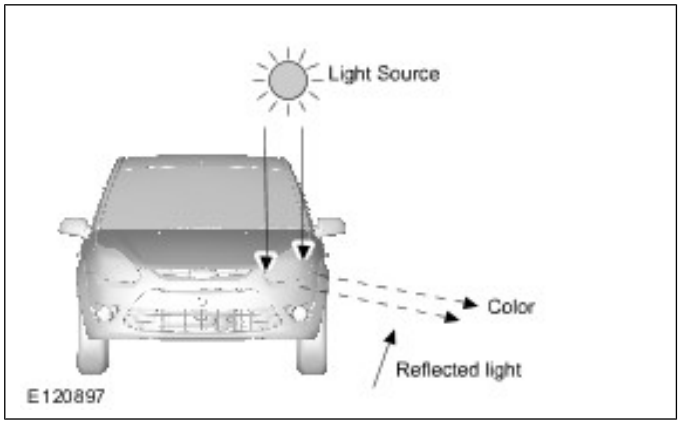
Only when a visible light ray comes to an object and its reflected light ray reaches the human eye, its color is recognized by the human eye. If only light rays of long wavelengths are reflected, their red color is visible and, if only light rays of short wavelengths are reflected, human can see its blue color.

Colors can be generally divided into two groups, chromatic colors and non-chromatic colors.
Chromatic colors: [Red] / [Blue] / [Yellow] : colors that have, in other words, hue or tint.
Non-chromatic colors [White] / [Gray] / [Black] : colors that have no hue or tint.

This perception arises through the combined effect of the following components:

- Light (sunlight or artificial light irradiates the object).
- Surface of the object (reflection from the object of certain constituent parts of the light).
- Eye (perception of the reflections from the object).

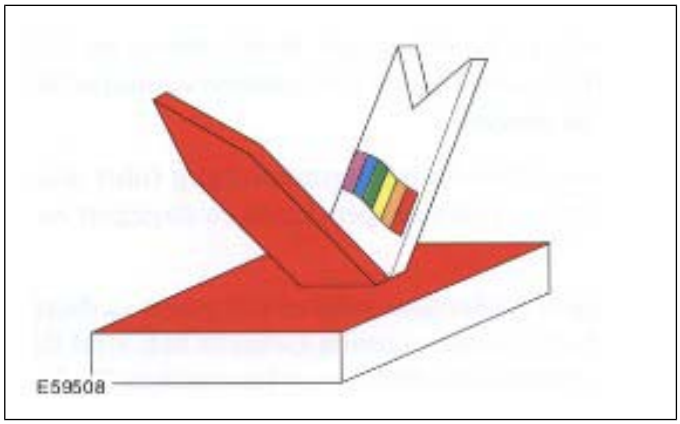
DESCRIPTION AND OPERATION



Because the sensory impression of color is produced by all three of these components, it is dependent on the type, quality and function of the individual components. Practical examples make this clear:

- If a particular article is subjected to artificial light, then it gives a different impression of color to that which it gives in sunlight.
- An object with uniform color but different surface textures appears to have different colors (grained or ungrained dashboard).
- A person with perception disorder (color blindness) cannot recognize certain colors or distinguish between them e.g. red-green weakness).

In turn the type of color is determined by the light absorption ability of an object. Light shines with all color components (spectral colors) onto an object, certain components of the light are absorbed (taken in) and other components are reflected (sent on). The components which are reflected produce the specific color impression.



The colors as we see them are the result of a combination of reflected colors from the spectrum. Physically speaking, these are electromagnetic waves with different wavelengths (and frequencies). The healthy human eye can recognize wavelengths between 0.36 µm (violet) and 0.78 µm (red).

If all the perceptible wavelengths of the spectrum impinge on the human eye at the same time, the impression of white light is produced.

Three Factors of Colors

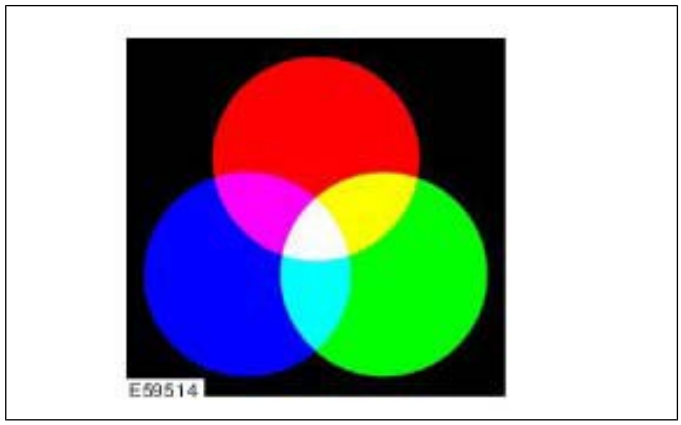
A chromatic color is comprised of three factors that are Hue, Value, and Chroma, while non-chromatic colors have only value.

Hue: The feature that characterizes each color like red, blue, yellow, and green.

Value: The degree of brightness.

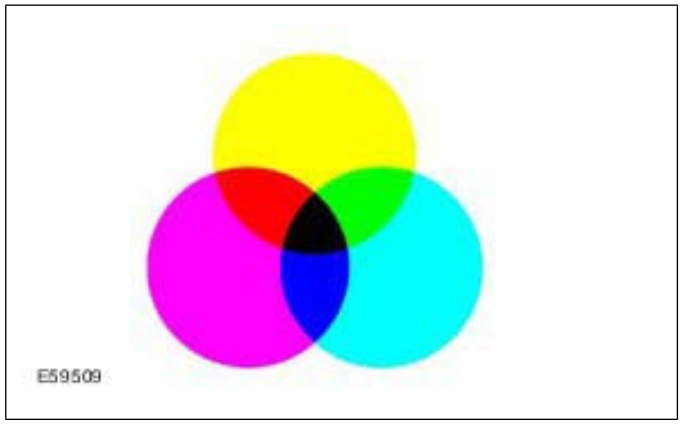
Chroma: The degree of freshness, apart from the degrees of hue and value.

Additive and subtractive color mixing



Additive color mixing is the combination of light from different sources to give white. Different intensities of the additive primary colors red, green and blue allow millions of different colors to be represented (RGB colors).

Additive color mixing is always therefore used when light should enter the eye directly (without reflection off an object). Such as in the case of computer monitors or overhead beamers.



DESCRIPTION AND OPERATION

Subtractive color mixing means mixing the primary colors cyan, magenta and yellow to form a desired color (CMY colors).

Subtractive color mixing is used when light should enter the eye of an observer after reflection from an object. Such as happens with painting or in printing.

Oswald color circle

The Oswald color circle is based on subtractive color mixing, and enables the behavior of paints when they are mixed together to be represented.

Colors lying opposite each other are complementary colors and should not be mixed together as this will produce a dull (i.e. grey) shade. If green is added to red, the red becomes greyer, not greener.

Color shades which are side by side are partner colors and produce a mixed color shade. For instance, mixing red and blue produces a pure violet.

In addition, black and/or white may be necessary to produce a particular color shade.

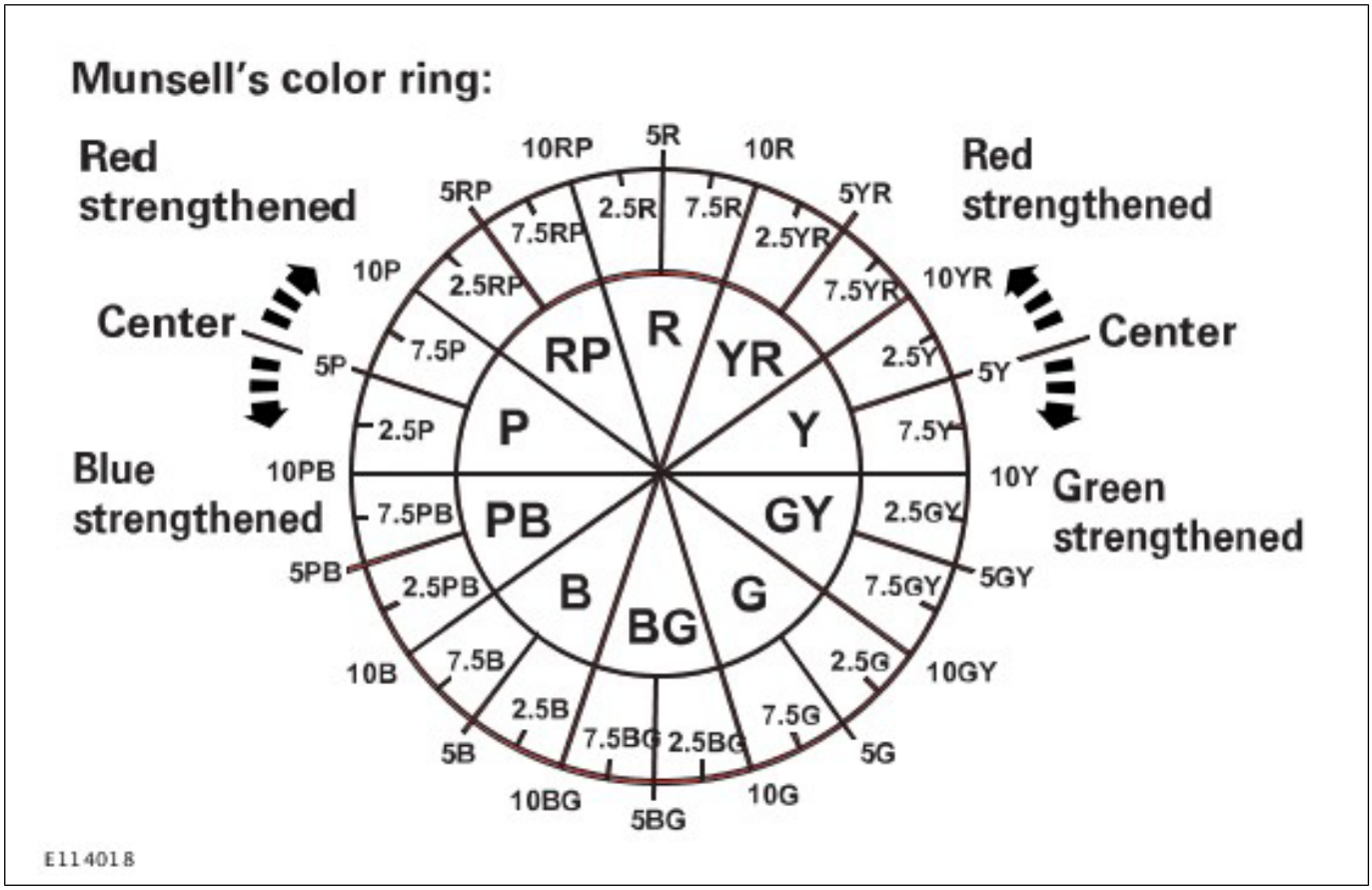
- White makes the color shade lighter.
- Black makes the color shade darker.
- With black and white the color shade becomes more dreary or greyer.

Indication of Colors

Hue Ring

Hue Ring is a relative arrangement of colors of ten main colors placed in the shape of a ring. These ten colors include, in addition to main five colors, Red ®), Yellow (Y), Green (G), Blue (B), and purple (P), another 5 colors that are to be relatively placed between them, Yellow red (YR), Yellow green (GY), Blue green (BG), Blue purple (BP), Red purple (RP). Each has is divided into 4 identical spaces with an interval of 2.5 and the center is shown at 5.

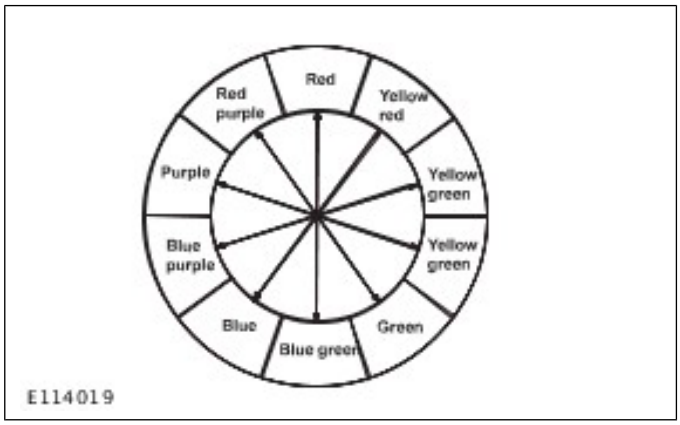
DESCRIPTION AND OPERATION



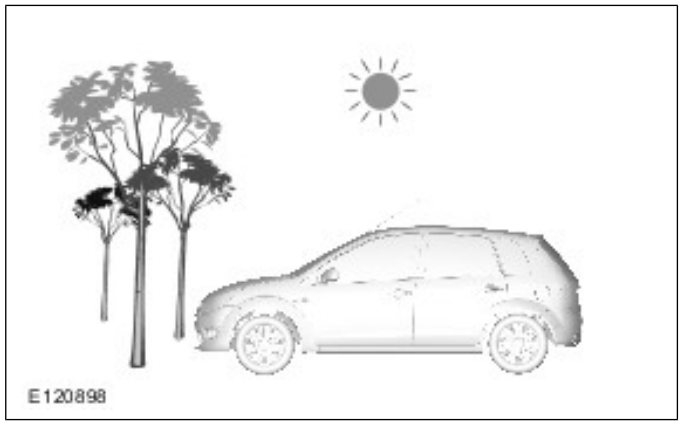
Complementary Color

In the Munsell Color Ring, the two colors located exactly opposite direction from each other are termed as complementary colors. If red and blue green, or yellow and blue purple are mixed in an appropriate ration, they turn out a non-chromatic color.

By making use of the relationship of complementary color, in order to weaken the degree of the hue, it can be attained by an addition of a little amount of its complementary color, but, as the color becomes slightly muddy or hard to return to the original, it is not advised to use this way.

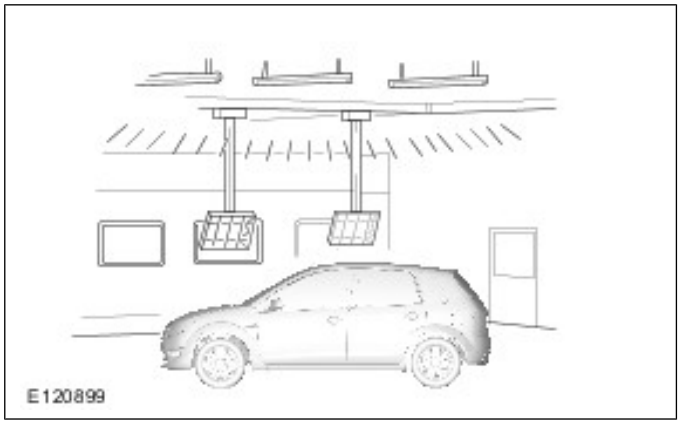


Metamerism



Outdoor

DESCRIPTION AND OPERATION



Indoor

Metamerism is the name of the effect which occurs when two colors appear identical in a particular light (e.g. artificial light), but the colors appear different under another light source (e.g. daylight).

The cause is the fact that the human brain, aided by the eyes, does not evaluate the wavelength, instead it evaluates the spectral intensity of the reflected light.

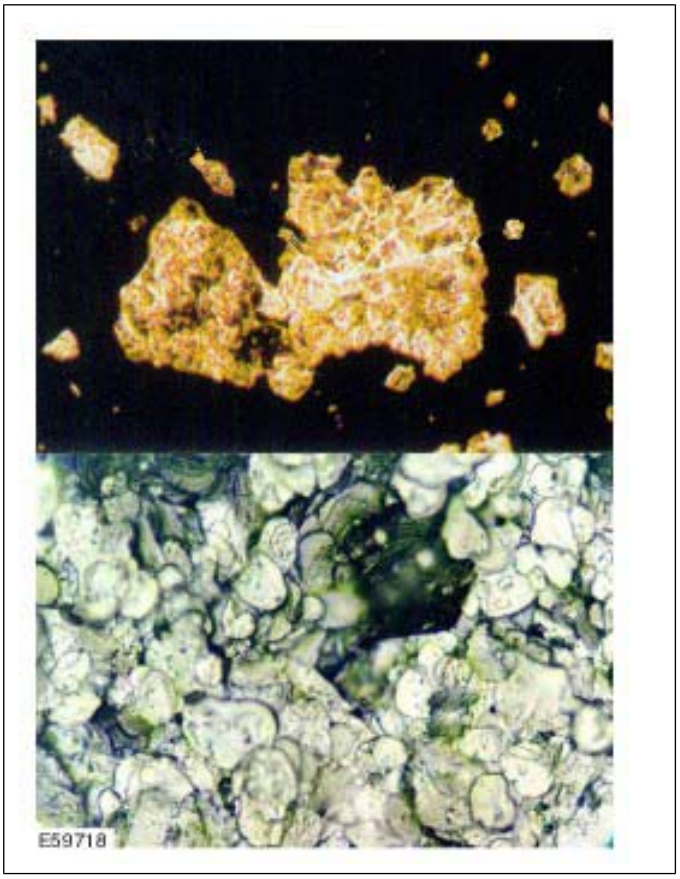
It is for this reason that color matching in practice must only ever be performed in daylight, or under special artificial light which is based on daylight.

Metallic and pearl pigments

Colored paints achieve their color effect by the addition of pigments. Pigments are colored, solid, very fine organic and inorganic particles which are insoluble in the binding material.

Metallic pigments

Aluminum platelets are added as pigment to form metallic paint.



Depending on the size and shape of the aluminum platelets, different metallic effects can be achieved:

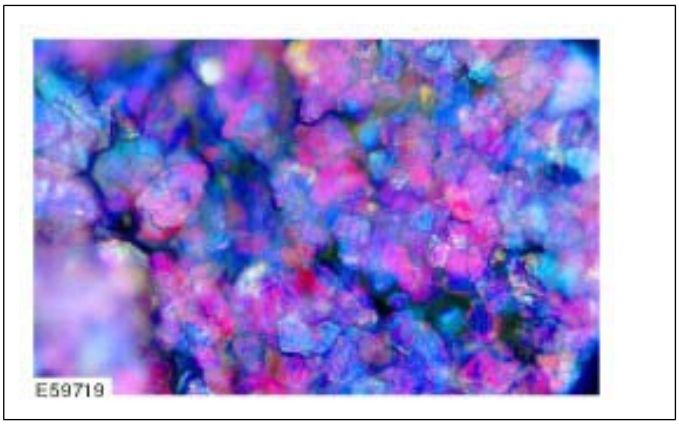
- Cornflake aluminum (1) causes very strong dispersion because of rough edges, low brilliance, very low flop and produces grey-silver shades.
- Dollar aluminum (2) causes hardly any dispersion because of the smooth surface, high brilliance, produces very light, almost white silver shades.

With metallic paints however, only a light-dark light reflection effect occurs.

Colored metallic paints are produced by the extra addition of color pigments to the metallic paint.

DESCRIPTION AND OPERATION

Pearl pigments



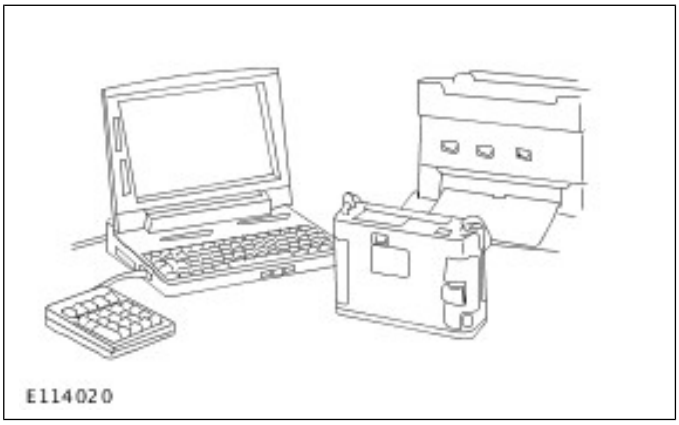
The basis of pearl pigments is formed by mica, which is metallized with a silver or gold layer.

Depending on the angles of light and observation, the mica platelets reflect different proportions of light. Because of this, the color of the paint appears to the observer to change.

Pearl pigments produce a colored and light-dark reflected light effect.

Colorimetry

Simply to compare two different colors is Colorimetry, but it is very important for paint repairing. There are two methods to do Colorimetry. One is visual comparison and another is with the use of a colorimeter. However, in actual color repair, in particular in metallic colors and pearl colors, it is extremely difficult to use a mechanical device to measure colors. So, the visual approach is mostly used in daily work places. Example of mechanical color measuring device (Computerized color measuring machine)

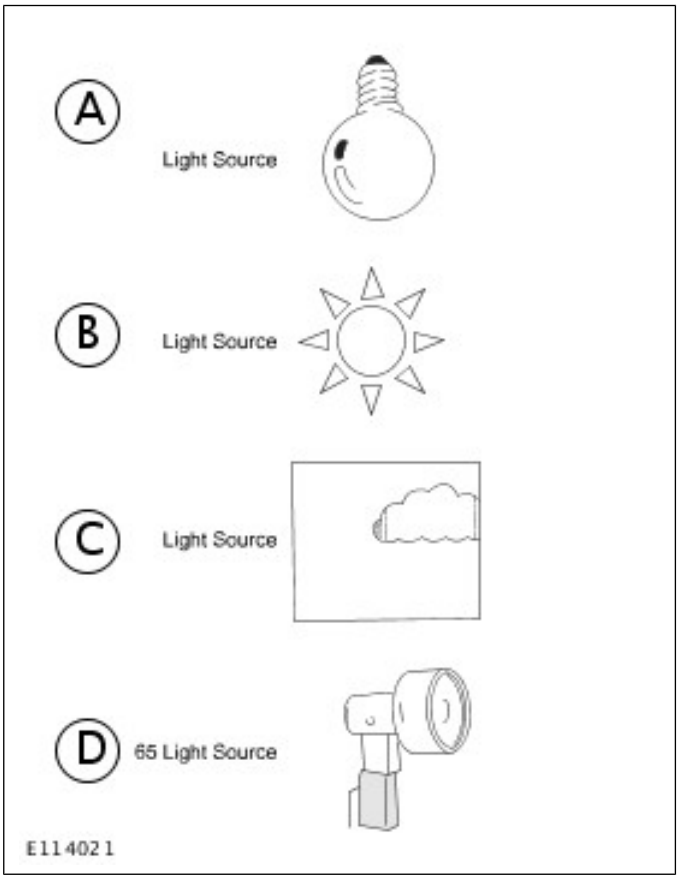


Visual Colorimetry

A car is viewed under all sorts of light sources including the sunlight, florescent light, mercury lamp, etc. The repaired color on a car body must be seen the same with the surrounding color under any light source. For this reason, the mixed color must be compared under any possible light sources.

The color of the light source is stipulated by CIE (Committee of International Electric Lighting)

- **A light source:** Electric light equivalent to that of a tungsten electric bulb.
- **B light source:** Light equivalent to that of the direct sunlight at noontime.
- **C light source:** Daylight including the light from the blue sky.
- **D65 light source:** Artificial light equivalent to the light at noontime.



Color view angle

In comparing colors, it is not enough to see a color only from a certain angle. For metallic colors and pearl colors, in particular, as the color looks different according to the direction of sight, it is necessary to see the color from different angles.

Angles to see and their terms: The direction to see basic colors is basically by angles as well.

1 - from right front

2 - from 45° upper

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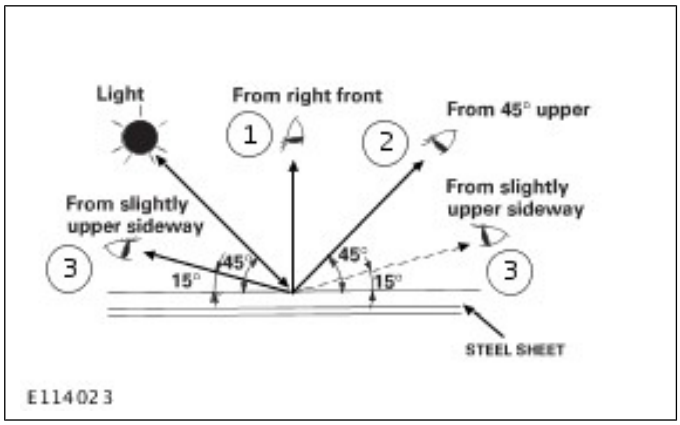
3 - from slightly upper sideway



Characteristics of Primary Colors

In mixing colors, what is important is to recognize well the characteristics of primary colors in whitening, transparency, and weatherproofness. Unless the problems of conditionally identical colors and the directions of metallic colors are well understood, correct mixing colors cannot be expected.

White mixing of primary colors

The hue produced when white is mixed to a primary color is called “Whitened tint” of the color. It is very important to understand the nature of whitened tint and its direction of the primary color and metallic base in mixing metallic colors, and those of the primary color and white.

Transparency

The transparency of a certain color depends upon the amount of pigment in the primary color, but more than that, upon the size of pigment particles. Even if the same pigments are used, the more transparent it is, the finer the size of the pigments are. The level of the transparency is one of the main factors effecting the direction of the metallic color.

Weatherproofness

Most of the primary colors have good weatherproofness. But it is also true that some of them fade quickly in color if mistakenly handled.

Blotting

Blotting is a phenomenon in which the color of the old paint layer blots up over the surface of the new paint.

Bronzing

Bronzing is a phenomenon in which a golden metallic luster appears on the surface of a newly painted layer. It tends to take place when blue or green colors are used as they are without being diluted with other color or liquid.

Metallic Base

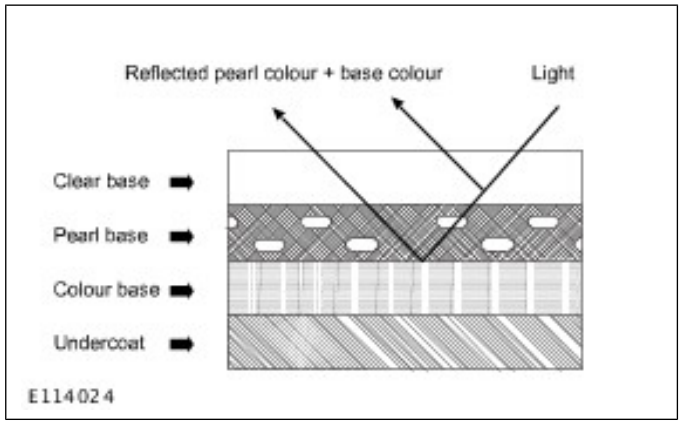
This is a kind of paint in which tiny aluminum particles are dispersed. There are many types of paints of this kind. In using this paint, it is important to understand its characteristics like its direction, size of particles, luster and brightness, whiteness and so forth. In particular, as the paints coated with pigments on the surface are in markets, it is extremely important to compare the color from various angles and under different sources of lights.

Pearl Base

This is a special kind of paint in which pigments with pearl luster (pearl pigments) is included. There are many different kinds depending upon colors, size of pigment particles, etc. In mixing color, the most appropriate pearl base must be used that corresponds to the color sample. In pearl painting, there are two ways of painting, three coat pearl painting and the two coat pearl painting. Unlike normal metallic painting, depending upon the luster and tint exclusive for pearl pigments, the deep tone of color layers can be obtained.

Three-coat Pearl Painting

The paint used for this painting is a compound of base colors and pigments with pearl luster. The paint layer visible to eyes is comprised of color base, pearl base, and clear base.



Two-coat Pearl Painting

Pearl chromatic pigments are used for this paint. As aluminum powerd is also mixed, it is possible

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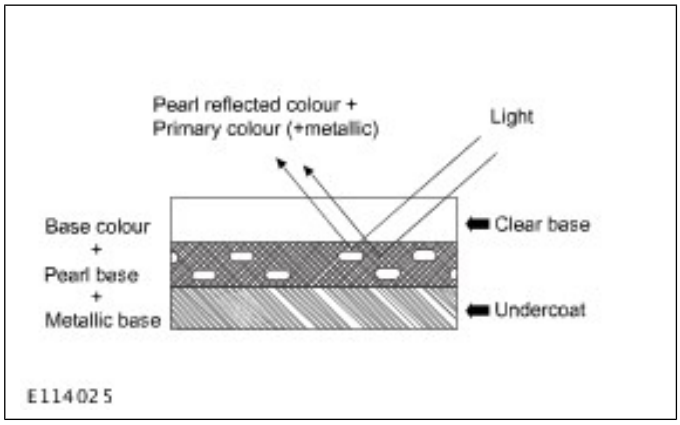
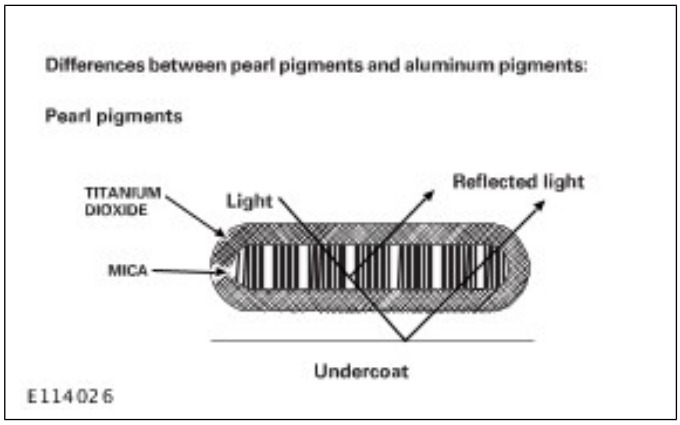
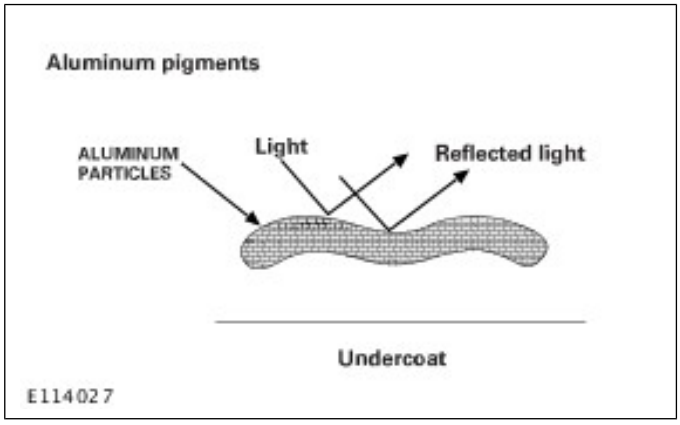
to make the same paint layer as that or normal metallic paints.



Pearl Pigments



Aluminium Pigments

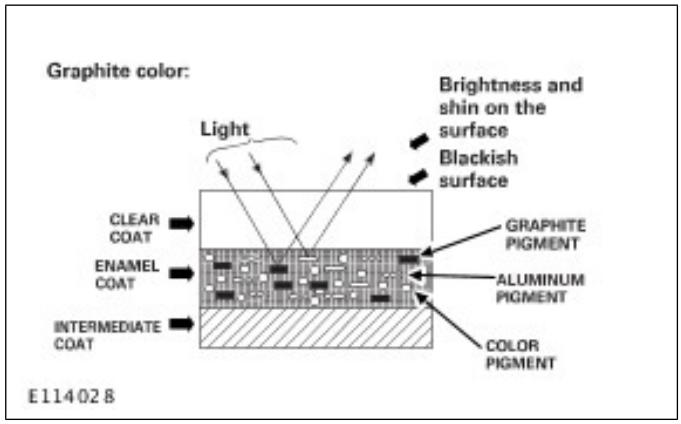


Graphite Base

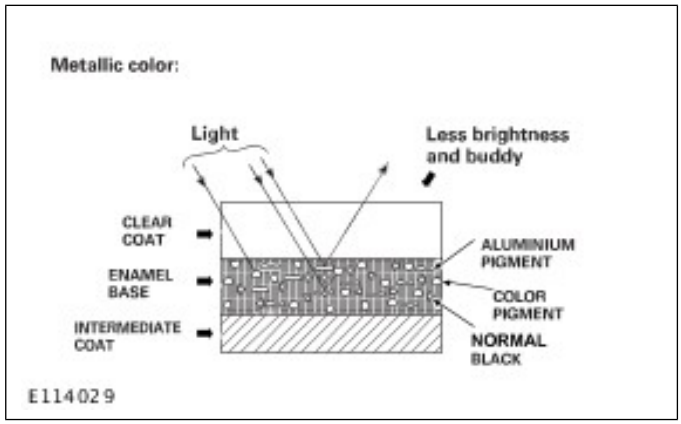
Graphite pigment is one of the graphite allotropes. It has been used as a pigment for conductible primer for plastic paints. However metallic luster and brightness have been reassessed and it being widely used.

As compared to carbon pigments widely used for black, the size of a particle is almost 5 times that of a carbon pigment and, in spite of its dark gray luster, the gap between particles is too large to secure tight paint adherence.

Comparison between graphite color and metallic color. If viewed from the right front, metallic or pearl brightness or shine is visible on the metallic or two coat pearl painting mixed with graphite pigment in low luminosity over the whole area, but if viewed from low angles, its luminosity becomes much lower and deeper with no more brightness and shine left.



Graphite Color



Metallic Color

MIO Base

MIO is a ferric oxide of a crystal structure of size 15 m. This pigment has unique features that are not shared by the conventional pigments as follows:

It can be painted very thick, almost ten times that of aluminum pigment. Even its side surface reflects the incoming light strongly.

The paint surface is so flat that the reflected light is still very strong.

When exposed to light, it shines strongly and three dimensionally like a diamond.

Its drawback is that, because of its heavy specific gravity, it tends to be deposited in the paint. Indoors or in the shadow, it looks to be a dark and deep solid color, but under the direct sunlight, it appears to be shining like lots of diamonds buried under

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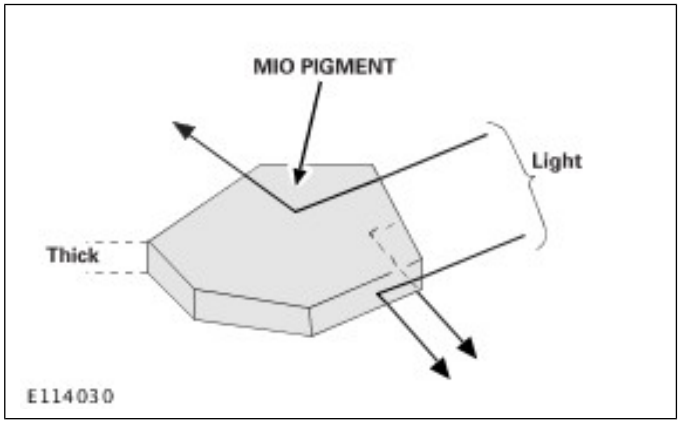
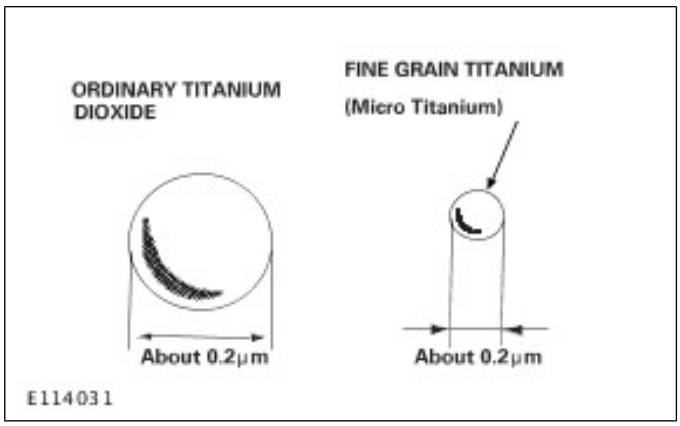
the paint surface. Because of this unique feature, it is impossible to mix color using a metallic base or pearl base in its place.



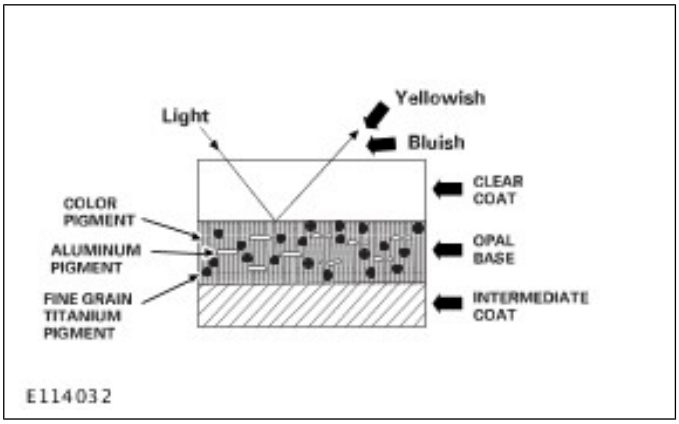
Opal White

Though the composition of pigments are the same as that for ordinary white paints, this paint appears almost half transparent as the size of pigments is very small and, more than that, titanium dioxide is used. Because of this, the concealing capacity is so limited that it is normally used as opal base (opal color) with other color or aluminum pigments mixed.



A feature of Opal Color

This paint has the same paint layer structure as that of metallic paints with fine grain titanium (micro titanium) used as a base coat. If this paint is mixed, yellowish metallic base color is seen from the right front. If seen from a low angle sideways, it looks bluish. So, as a whole, it has a charm of a two color opal tone.



Crystal Blue

The phthalocyanine pigment used as ordinary blue color is crystallized and flaked for this crystal blue pigment. The light reflected on the surface brightens like bronze and the light penetrated through the surface shines blue.

Crystal Brown

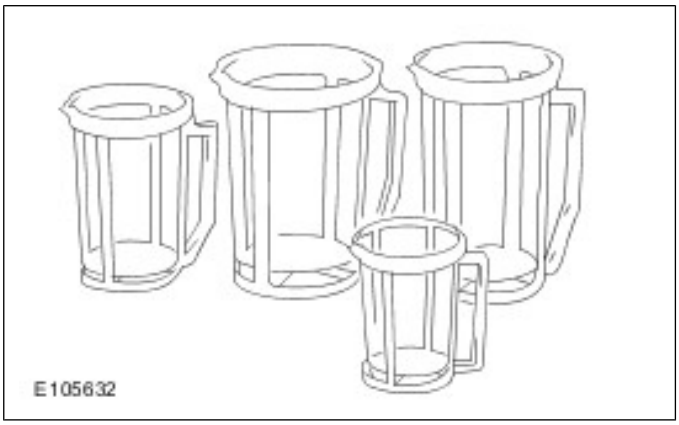
The main content of this pigment is a flake-like iron oxide that is also used for red rust colored pigment. It cannot be so thick and shines like pearl mica.

Color Matching Equipment

In order to conduct mixing colors and measuring paints as needed accurately and quickly, the following instruments and devices are needed.

Containers needed for mixing colors

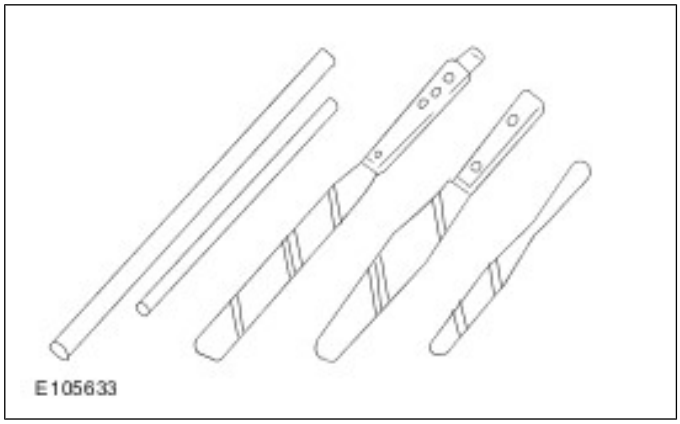
According to the amount of paints needed, get prepared with several containers of 0.2 to 18 liters.

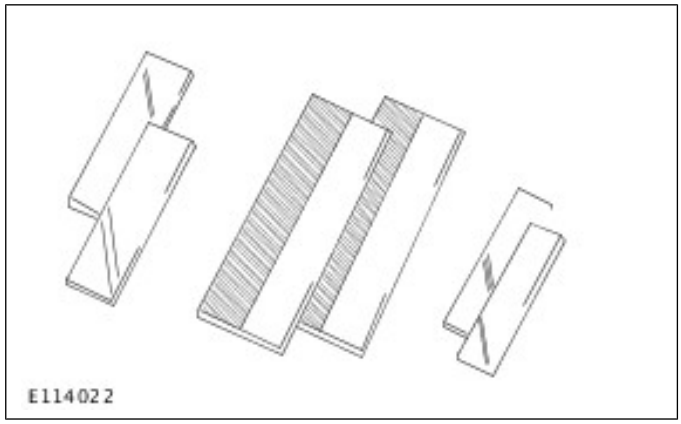


Churning Bars and Spatulas

There are also some churning bars combined spatulas. Depending upon the amount of paints needed, select churning bars and spatulas of proper lengths and sizes.

DESCRIPTION AND OPERATION





Test Plates

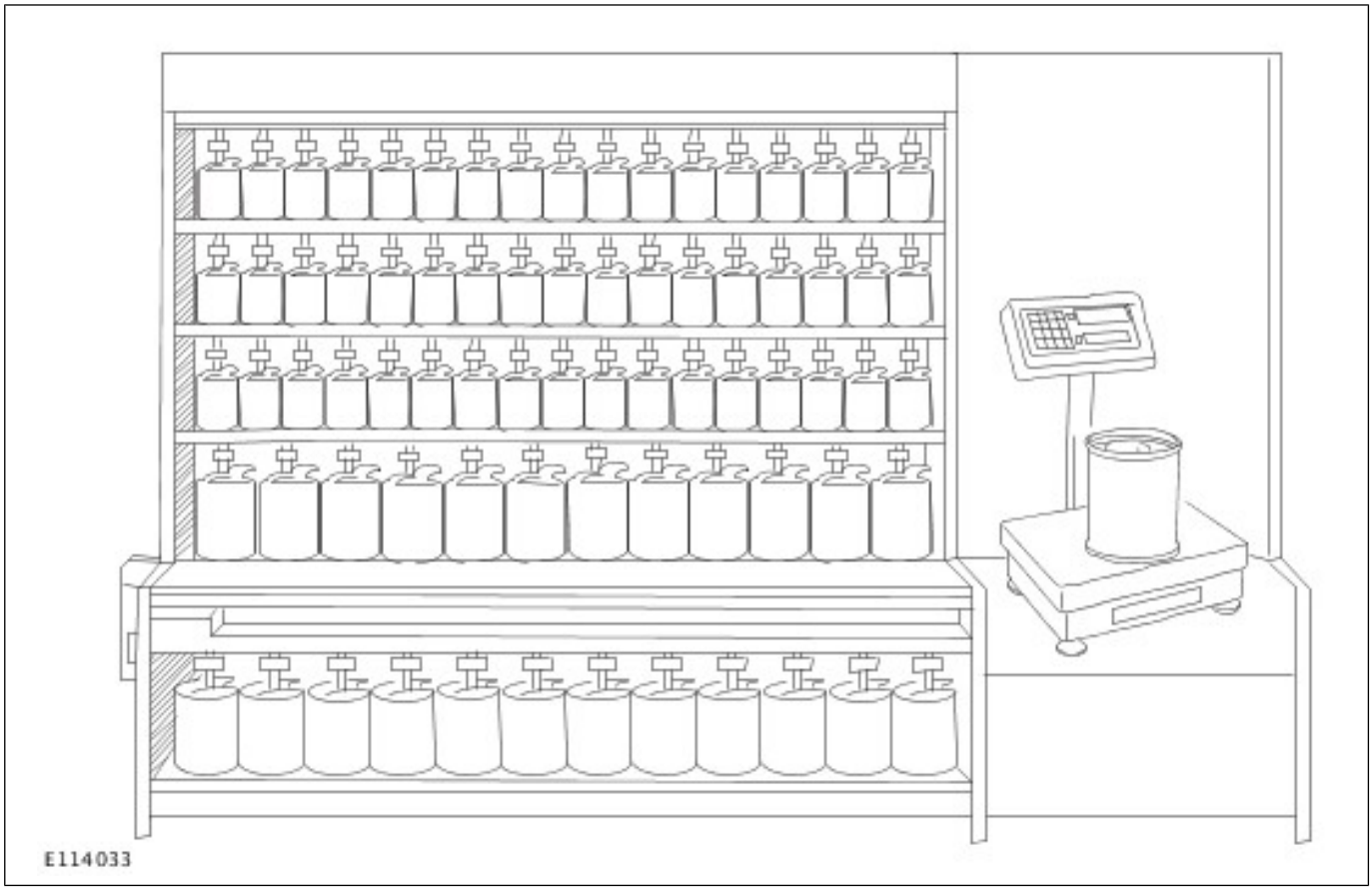
Plates, thick papers or magnetic sheets. Used as a paint test on which paint colors etc. are tested.

Spouted Agitator Cover

Used to prevent the solvent content in the paint from evaporating. The paints are easily agitated in it.

Churning Equipment

This is a sort of an electrically powered shelf. Using this churning instrument, a number of coat cans and or gallon cans containing paints can be churned all at the same time. There is a power shelf that can churn as many as 75 cans.



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Metric Color Mixing Device

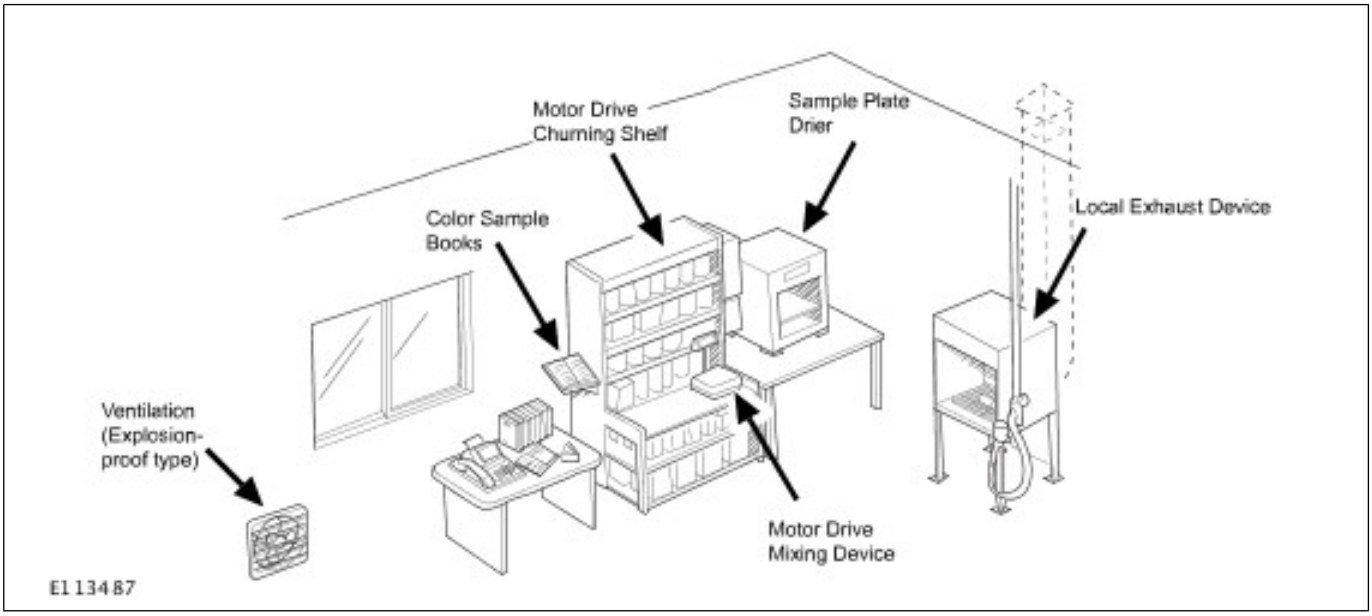
This device has several metric functions for mixing paints. It allows measures up to 6 kg at an increments of 0.1 kg. This device can be used not only for normal mixing colors but also for mixing a necessary amount of hardener and or thinner in a two-liquid mixing type paint.

Color Mixing Work

Work Environment

A good work environment is necessary for car body paint repairs.

- Abundant natural light.
- Fluorscent lights of wide range of colors.
- The surrounding wall painted with non-chromatic color.
- Workspace with a drier, sprayer and all other necessary tools and instruments well arranged.



DESCRIPTION AND OPERATION

Step of Mixing Colors

Mixing color specification is available

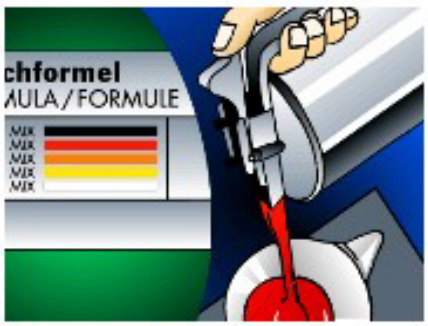
1. Confirm the color difference between the color card attached to the color sample book and the color surrounding the damaged area on the actual car.

- In a case that the color sample is not available but the mixing color spec. is available, use a small amount of paints, make a preliminary color mixing. After making a test spraying, make a test sample for the color and compare the colors.
- In a case that the difference between the color sample and the actual color on the car is too great. Confirm whether there is a different color mixing specs on the actual car color system or not.

E113696

2. Measure necessary amounts of colors.

- Compare the color with that of the actual car. If no substantial difference is found in hue, direction, and shade of color, mix the color according to the mixing color spec.
- If the difference is too great, instead of following the color spec., before mixing the colors, make an adjustment in accordance to the color difference in the amounts of primary colors beforehand.



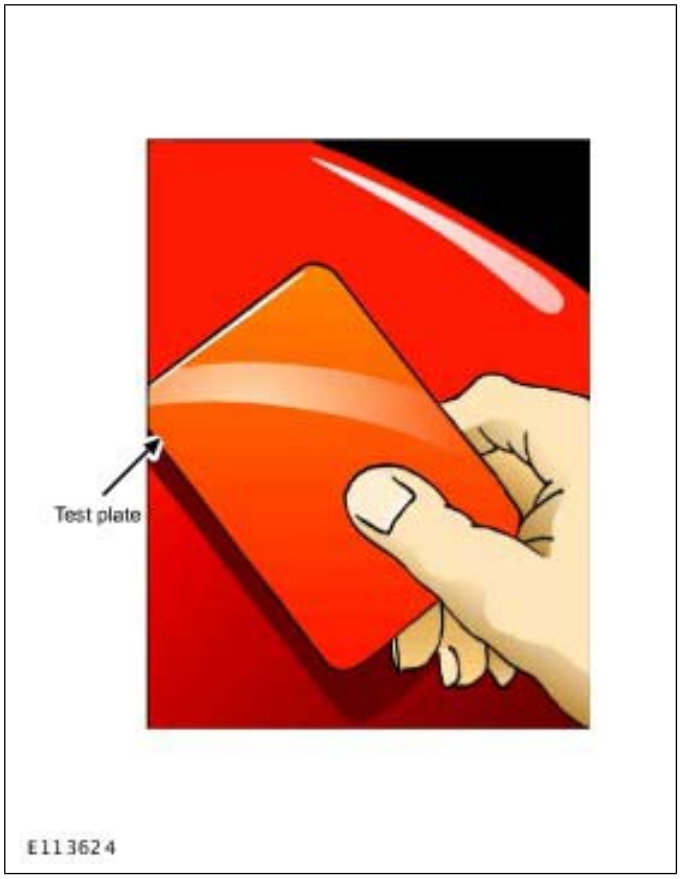
E113622

3. Painting with a spatula and color comparison. Test-paint the mixed color on a test plate and confirm whether or not it is the correct color after it dries.

E113623

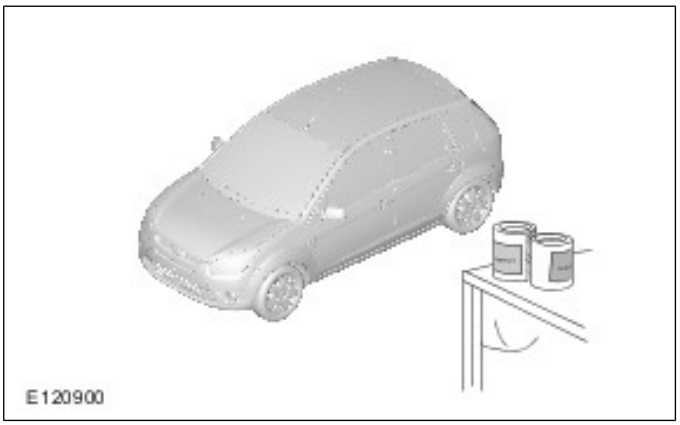
4. test painting and color comparison. Under the same condition as for the actual color repair, conduct a test painting. Take note that, in particular, pearl colors and metallic colors change greatly if painted under different painting conditions. Compare the direction, conditionally identical colors, the size of paint particles, brightness etc. of the color on the dried painted test plate with those of the actual car from every angle and under different light sources.

DESCRIPTION AND OPERATION



5. Fine color adjustments. As a rule, make a fine adjustment using a small amount of the paint used in the color spec.; however, where necessary, a new color can be added. Make repeated color mixing tests until the desired color is obtained.

2. Select primary colors. Comparing with the body color, select the most appropriate colors of which direction, hue, and other factors are close to the body color. At the same time, confirm their roughness of metallic or pearl base particles and their brightness.



Mixing colors specification is not available

When the whole body color has been replaced with another color different from the original or when the mixing colors spec. is not available. Use the following steps to match the color quickly.

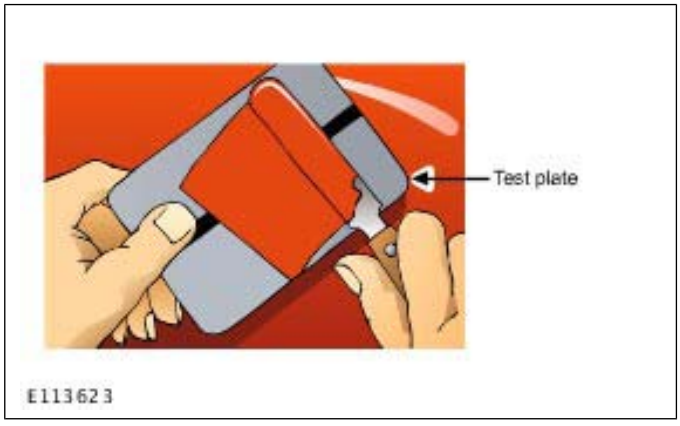
1. Select approximate colors. Select several approximate colors of which spec. is known, from the color samples.

3. Preparatory mixing color. Select the most appropriate primary colors; it is not necessary to let the color match with that of the body. Confirm the hue, direction and other factors of the color only from the selected approximated color.

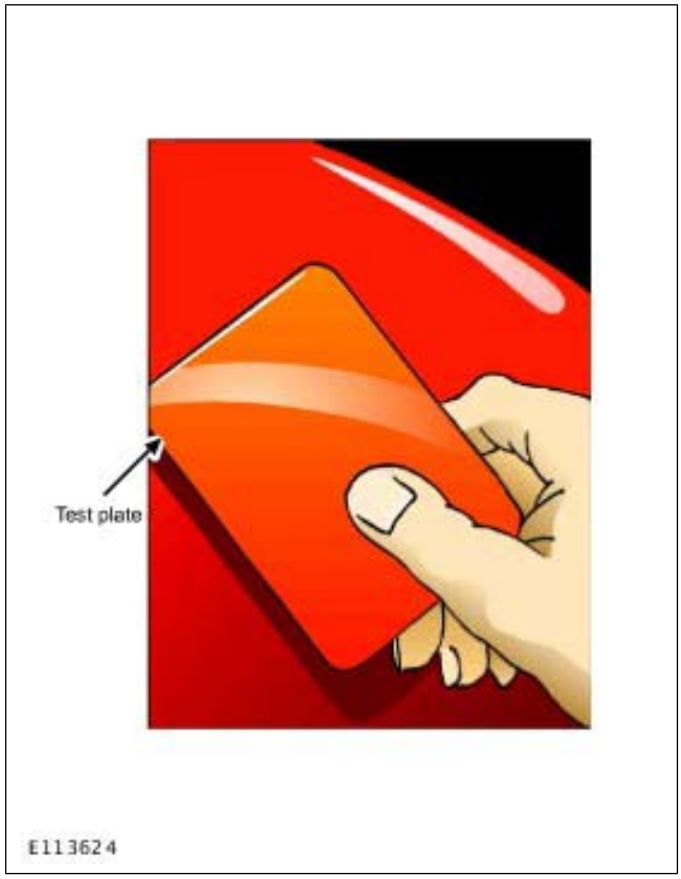
DESCRIPTION AND OPERATION

Item	Description
1	Paint

4. Spatula painting and color comparison. Paint the preparatory mixed color on a test plate and confirm if the color is the one desired after it has dried up.



5. Test painting and color comparison. Paint the preparatory mixing color on a test panel using a spray gun and confirm whether or not the color is the one desired. Repeat the process until the desired color and its mixing ratio is found.



6. Final color mixing. Based upon the color finally determined and its mixing ratio, mix the necessary amount of colors.

7. Test painting and color comparison. Under the same condition as for the actual color repair, conduct a test painting. Take note that, in particular, pearl colors and metallic colors change greatly if painted under different painting conditions. Compare the direction, conditionally identical colors, the size of paint particles, brightness etc. of the color on the dried painted test plate with those of the actual car from every angle and under different light sources.

8. Fine color adjustment. Where necessary, a new color can be added. Make repeated color mixing tests until the desired color is obtained. The color mixing is completed.

Color codes and their determination

It is necessary to determine the correct color shade of the original paintwork in order to perform a professional and perfect paint repair.

DESCRIPTION AND OPERATION

The original paint color shade can be found by:

- Inspection of the vehicle type plate with the color code stamped on it.
  - Later design
  - Earlier design
- Color shade catalog or color shade system of the manufacturer.
- The bare bodyshell plate with color designation.

Color shade catalog or color shade system of the repair paint manufacturer.

The repair paint manufacturers offer a variety of possible systems for the determining the production color shade of motor vehicles. There are electronic systems, color card systems and manuals for the determination of color shades.

Most repair paint manufacturers use the following systems:

- A tabular system based on the following parameters:
  - Color code
  - Make
  - Model
  - Build year
  - Color or color name
  - Ancillary codes
- A system with color cards based on the following parameters:
  - Make
  - Color shade
  - Build year

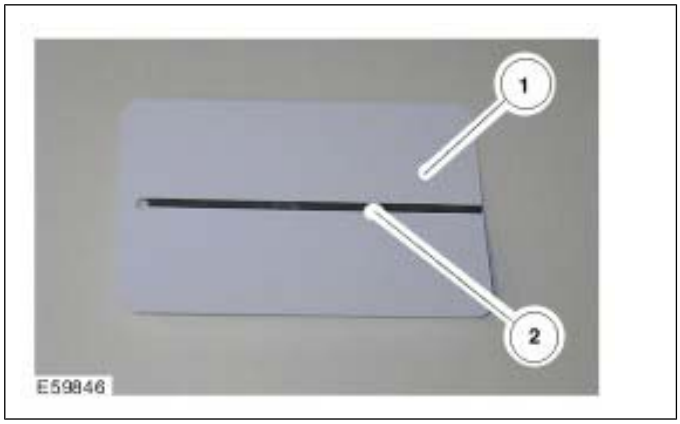
Because of the many parameters used, in a tabular system the color shade can also be determined by the lack of a parameter.

When using the color cards, emphasis is placed on matching of the original color shade with the color shade samples. For this reason this method is very helpful when the other parameters are not available.

Comparison of the results of both methods increases the certainty of using the correct original color shade and its formulation.

Additional certainty can be achieved during color shade determination by making a color sample plate. Here it is however important to apply the complete paint structure with base paint and clear lacquer onto a sample plate (1) in order to carry out a color shade and color coverage test.

DESCRIPTION AND OPERATION



The color shade comparison is done by comparing the vehicle paintwork with the sample plate (1). The color coverage test is possible by using the black test stripe (2): If the test stripe (2) is still visible after test painting of the sample plate (1), the coverage is not good enough.

By using this determination of the original color shade, the formulation and information on any very slight fine adjustments which may be necessary can be established.

Matching tinted filler to the color code

NOTE: Color samples must always be made from the same materials as the subsequent repair painting. Perform color shade matching in the fully hardened state, in natural light or under suitable artificial light.

Various tinted fillers are used during factory painting. In order to achieve the exact color shade of the factory applied paint, attention should be paid that the correctly matched fillers are used.

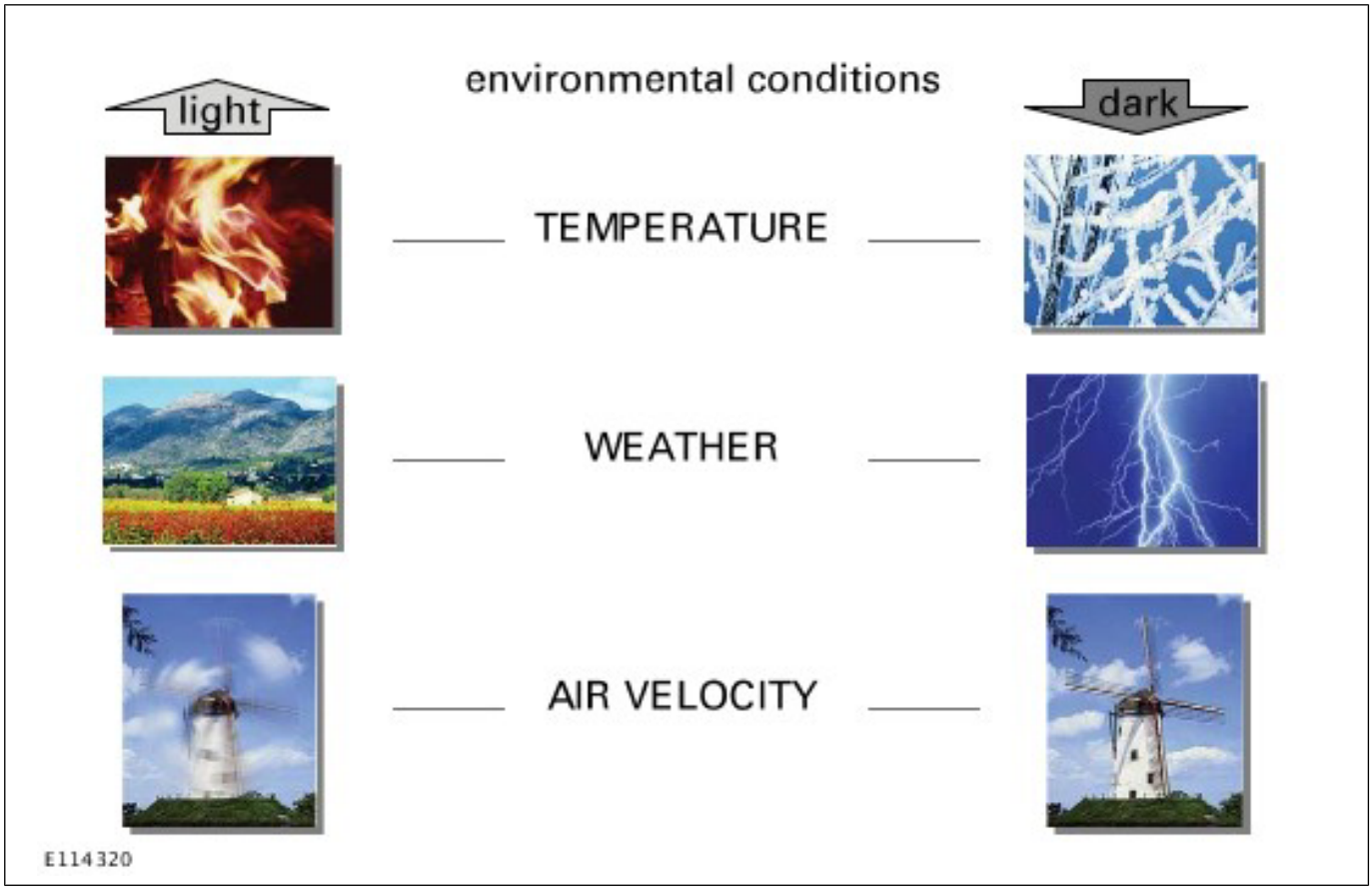
The repair paint manufacturers offer suitable precolored primers. The use of filler color cards allows the matching color shade to be determined.

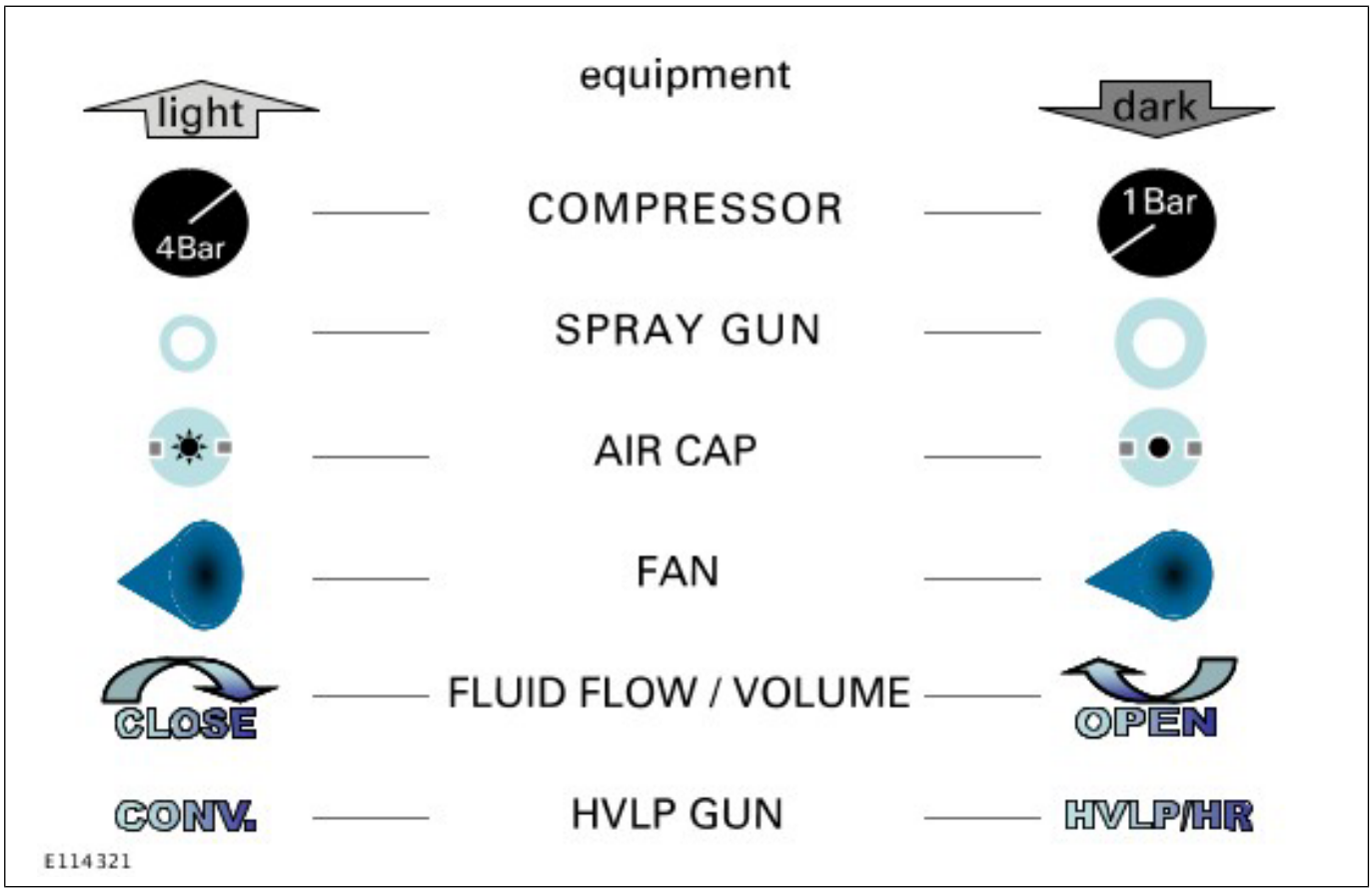
Color Influencing Factors

Some of the colour influencing factors are

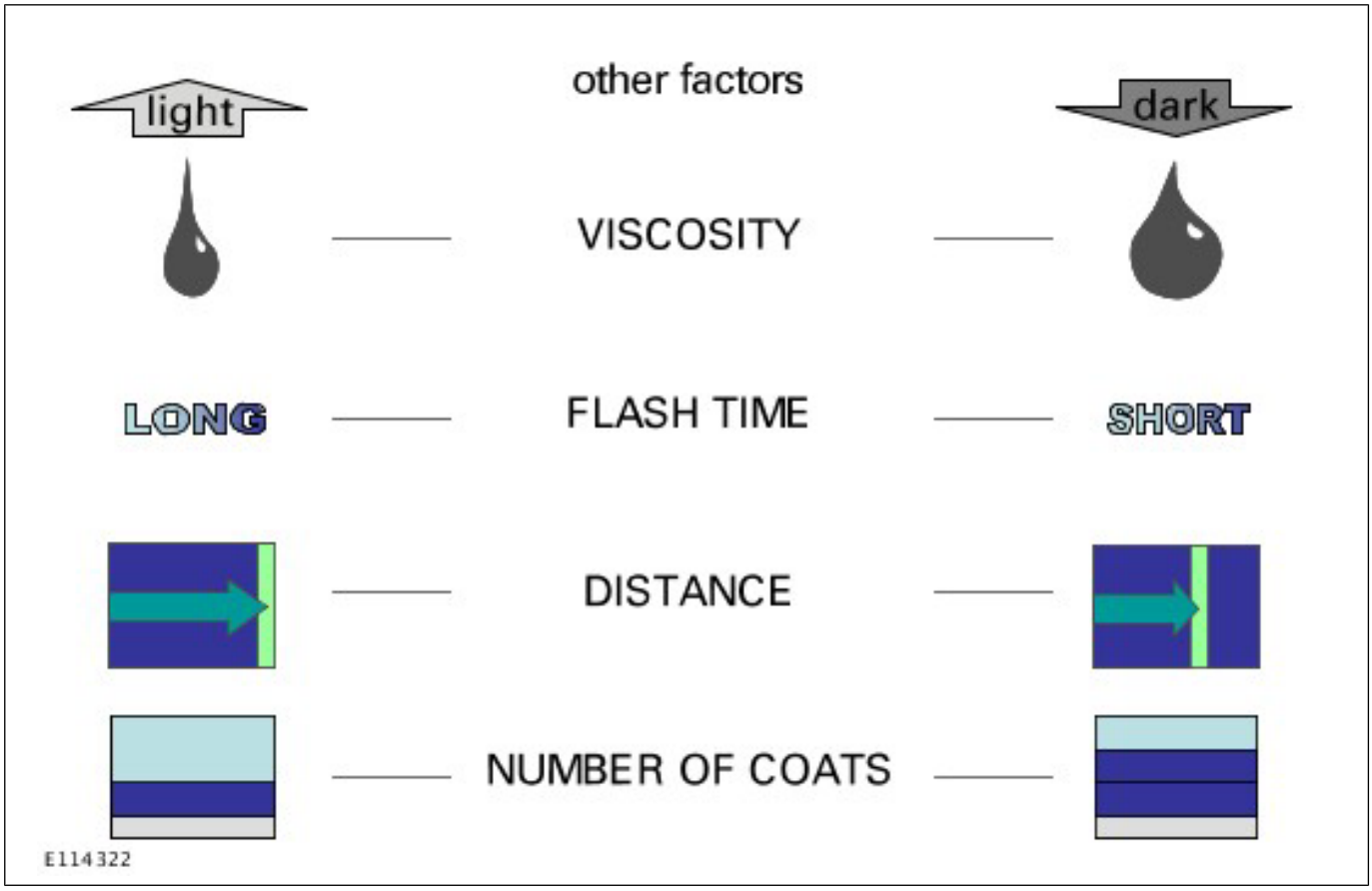
- **Environment**
- **Product**
- **Application**
- **Equipment**

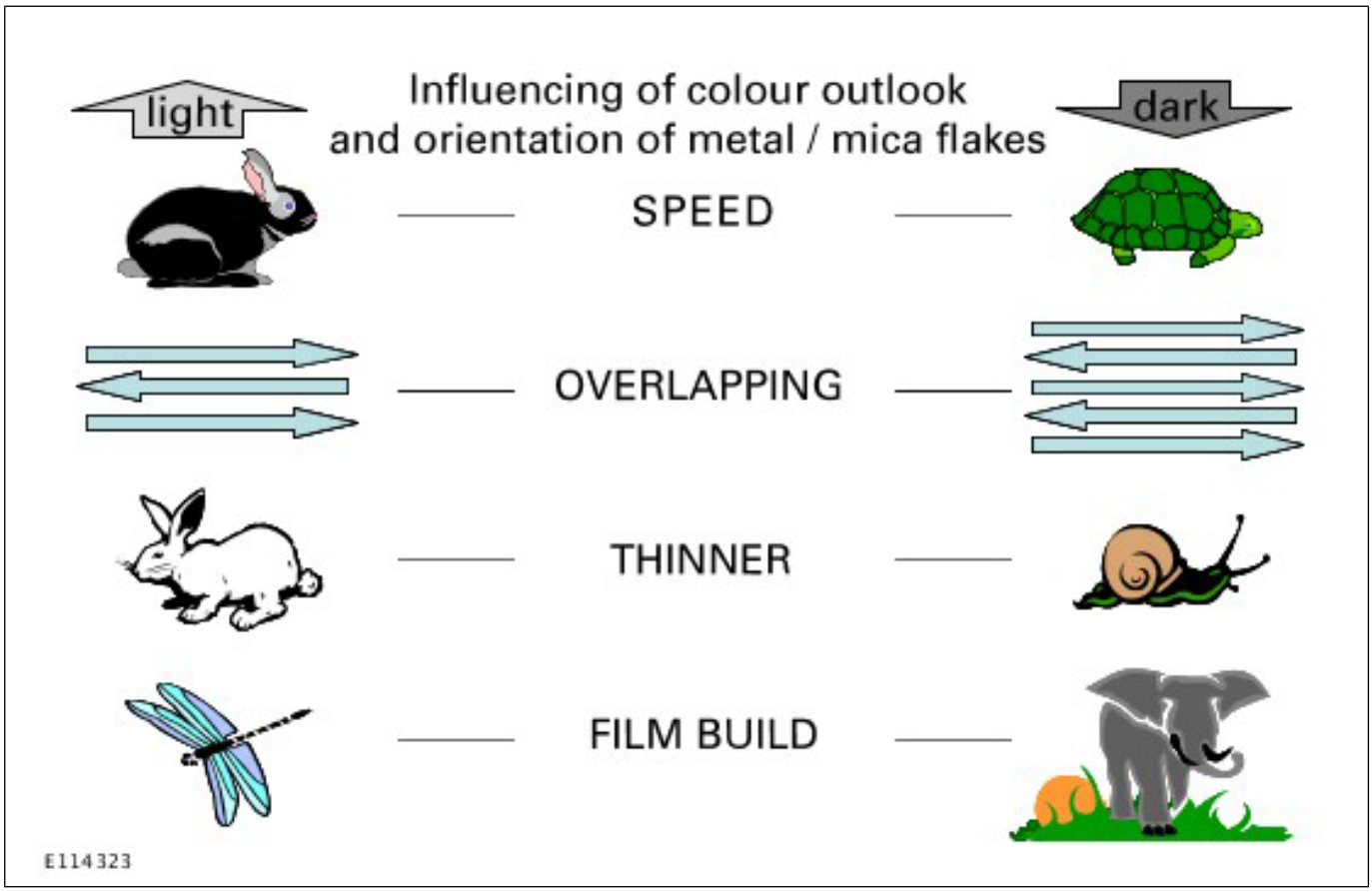
DESCRIPTION AND OPERATION





DESCRIPTION AND OPERATION





DESCRIPTION AND OPERATION

Tips and Tricks

Comparing paint structures

It may happen that an area remains visible, especially when the area of the repair is small. The reason for this is the structural variation in the paint surface at the repair location compared with the original paint finish. The original paint finish has a slight orange peel effect while the repair areas is extremely smooth.

This effect can be reduced by fine sanding using P3000 of the area around the repair location and then polishing.

Etching substrate

If the substrate can be etched during the solvent test, suitable preparation must be done.

Job steps:

NOTE: Follow the manufacturer specific instructions.

- Sand the damaged area extensively using an eccentric sander and P80 or P120 abrasive sheets. Finish off sanding with P150 or P180.
- Remove the sanding dust and clean the area of the damage using silicone remover.
- Apply polyester stopper to the bare panel and to the damaged area.
- Sand the dried polyester stopper to an even surface using P80 - P150. Finish sanding using P180 - P240. If required apply more stopper, again only on the bare panel.
- Wet sand the residual old paint finish using P600 - P800. Transitions with P400 - P600. Clean with silicone remover.
- Prime bare metal areas with acid primer.
- After the acid primer has been left exposed to the air for the correct evaporation time, apply 2-component primer filler in thin layers over the complete repair area, leaving enough air exposure time in between coats.
- After the filler has dried, sand wet with P800 or sand dry with P400. Sanded through areas must be covered again with 2-component Nonstop filler primer.

Another possible method of preventing etching of the substrate is to use water-base primer and filler materials.

Masking Process

Masking is conducted when lower coat (primer surfacing) and top coat are painted.

The purpose of masking is not only to prevent the paint from adhering to unnecessary area other than the repaired one, but also not to dirty the car or not to let dust and dirt in the car.

According to where the repaired area is or what kind of painting method is employed, the work processes or methods are different.

NOTE: When water based paints are used, all materials must be stable towards water.

Plan the masking work:

- Determine the sequence of masking work. Sometimes after masking film has been applied, it is difficult or impossible to reach certain areas.
- Prepare the masking material.
- Start with small difficult areas.

Pay special attention to the areas of profiled seals, edges, openings and paint transitions.

Masking Tools

Masking paper

Masking paper is pasted to cover a part of the panel to prevent there to be attached by paint, paint mist etc. during paint work.

There are several different kinds of masking papers available. Some of them have an anti-solvent penetration effect; some have a high heat proofing effect, or a liquid type-masking agent that can be applied with a spraying gun.

Masking Tape

Masking tape is often used together with a masking paper to cover a part of the panel that should not be spoiled by paint mist or it is also used by itself for the same purpose.

Normally, masking tapes made of paper are widely used, but there are also metallic tapes, which have a heatproof effect and plastic tapes which can be neatly cut, are used, depending upon the purposes.

Masking tape is available in various widths for special application areas. In practice however, a wide tape has proved best for almost all areas,

DESCRIPTION AND OPERATION

also taking into account the time required for masking work.

Composition:

Back surface treatment agent: to prevent a tape from sticking to another tape.

Backing: Tape base material to maintain paper toughness.

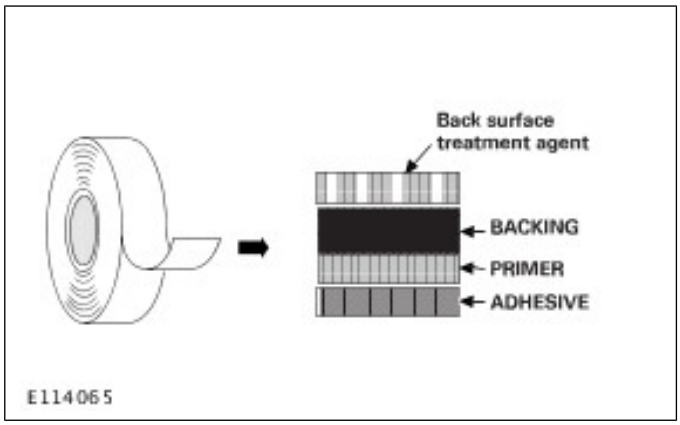
Primer: Enhance adherence of glue to the backing material of the paper.

Adhesive: Glue the tape to the panel tightly.

NOTE: Use of differing masking materials is often much more time-consuming.

Advantages

- Good coverage. Narrower tapes must often be applied in several layers.
- More resistant to tearing.
- Wide tapes can be applied deep into joints and therefore protect from paint mist and contamination.
- Removal is often easier.

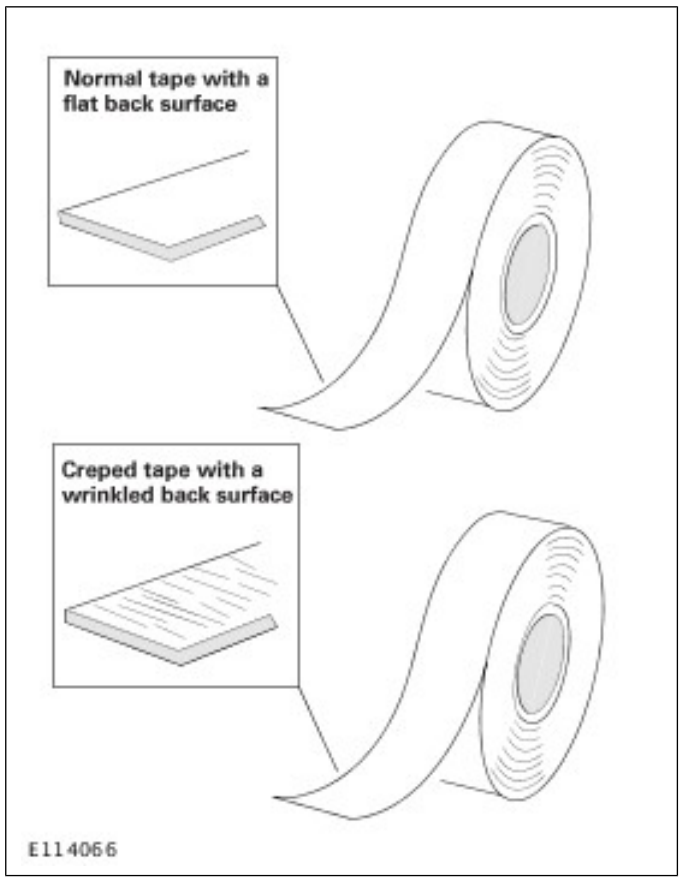


Selection of masking tapes:

The tape made of normal paper is usually used for fixing masking papers. Apart from that, there is another tape made of strong Japanese paper that has heat-proofing, anti-solvent effects. Further, it is manufactured so that it does not leave glue residue after the tape has been peeled off.

The plastic tape is ideal for bordering, hemming, line drawing, or for the ending of curved surface or two-tone color.

In the quality of the backing surface, there are two kinds, one is tape with a flat surface and another has a creped surface. As a creped tape shrinks to some extent, it is used for the curved surface.



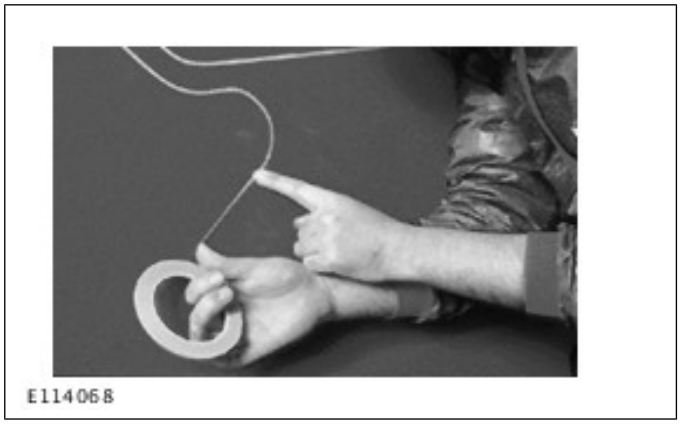
Masking tapes for two tone color painting:

This type of tape is called a vinyl tape, a hemming tape, or line tape. It is ideal for the ending of a curved surface or the ending of two-tone color. The use of this type of tape ensures clear cut-lined painting.

Tapes for paint stripe:

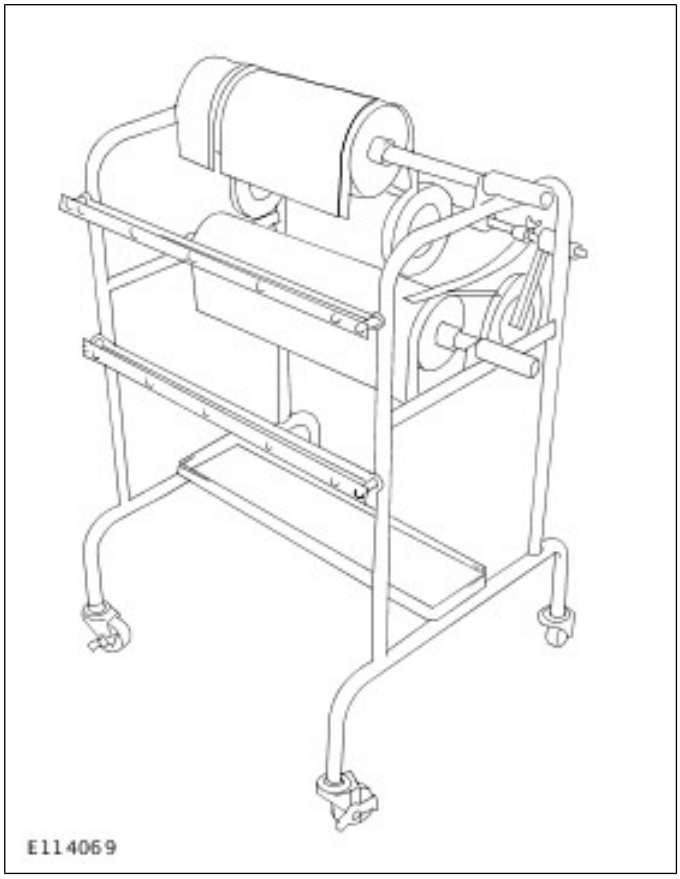
As this type of tape has cut-in of various widths, so, it can be used for paint linings of various widths.

DESCRIPTION AND OPERATION



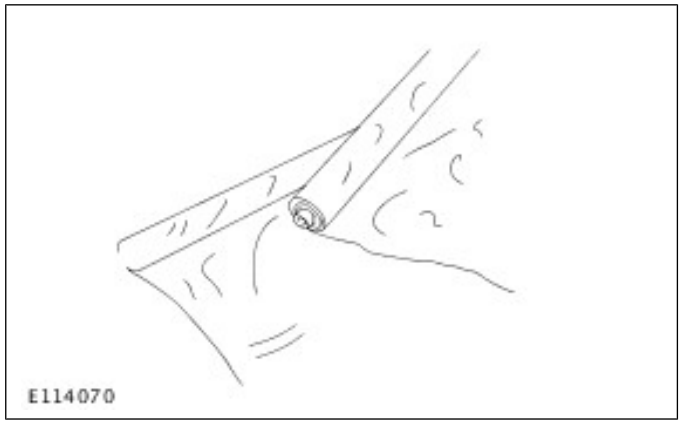
Paper Dispenser

In this device, rolled masking paper and masking tape are combined in a set. Therefore, it is possible to draw out the needed size of a masking paper with tapes already pasted on it where it is needed. This device makes it possible to set the masking papers of different sizes simultaneously.



Polyvinyl Sheet

This plastic sheet is composed of three combined layers, polyethylene, polypropylene, and polymer for the automotive use as masking sheet. It has a paint mist absorption effect and, even after the paint is dried up, it never drops paint as powder.

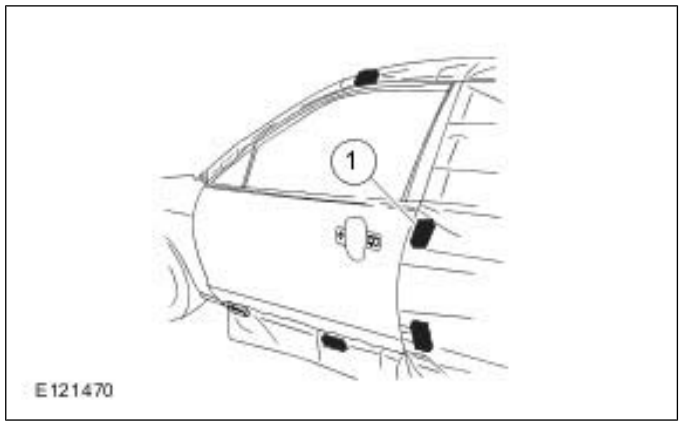


Sheet Dispenser

Using this stand it is easy to take out the polyvinyl sheet.

Magnet

It is used to fix a vinyl sheet on the vehicle or press tight a wrinkled vinyl sheet in a pulled state. With the use of this magnet, it is possible to shift the position of a vinyl sheet from one place to another for easy repair work.

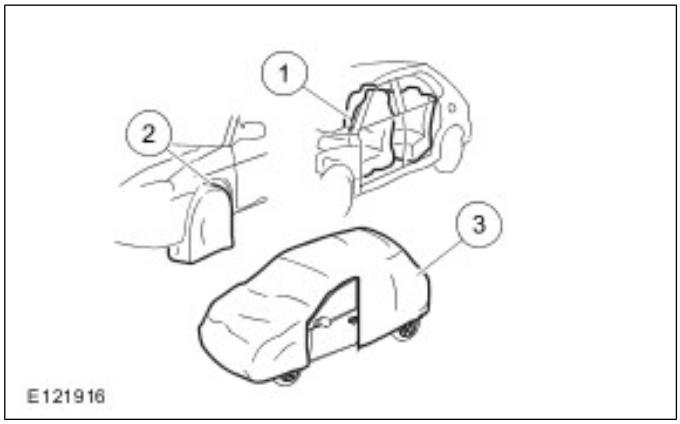


Item	Description
1	Magnet

DESCRIPTION AND OPERATION

Special Covers

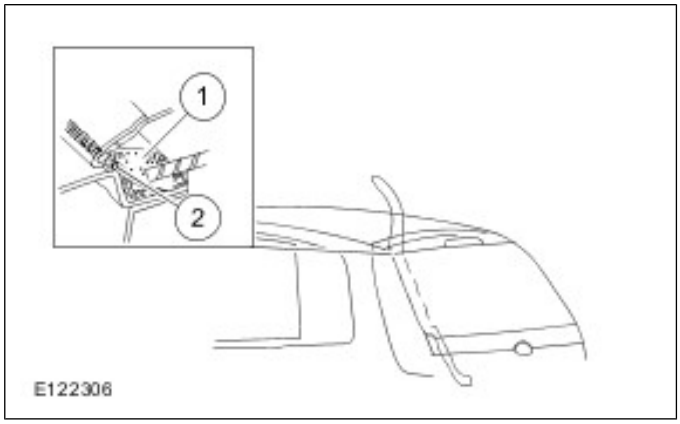
There are body covers of a variety of uses. One cover covers a whole body, another covers just a half part of a vehicle body. In addition, there are wheel covers, or sheet covers that protect the cabin from being unnecessarily paint-stained.



Item	Description
1	Seat cover
2	Wheel cover
3	Body cover

Trim Cord

This cord is used to prevent the rubber strips around glass from being paint-stained. By inserting it between the rubber stripe and body, the stripe can be separated from the body.

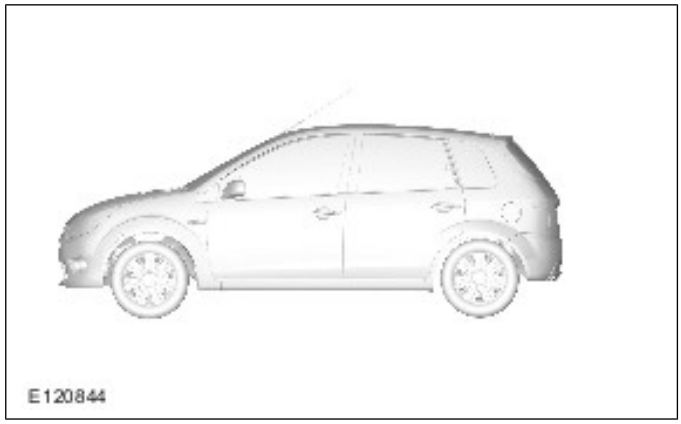


Item	Description
1	Weatherstrip
2	Cord

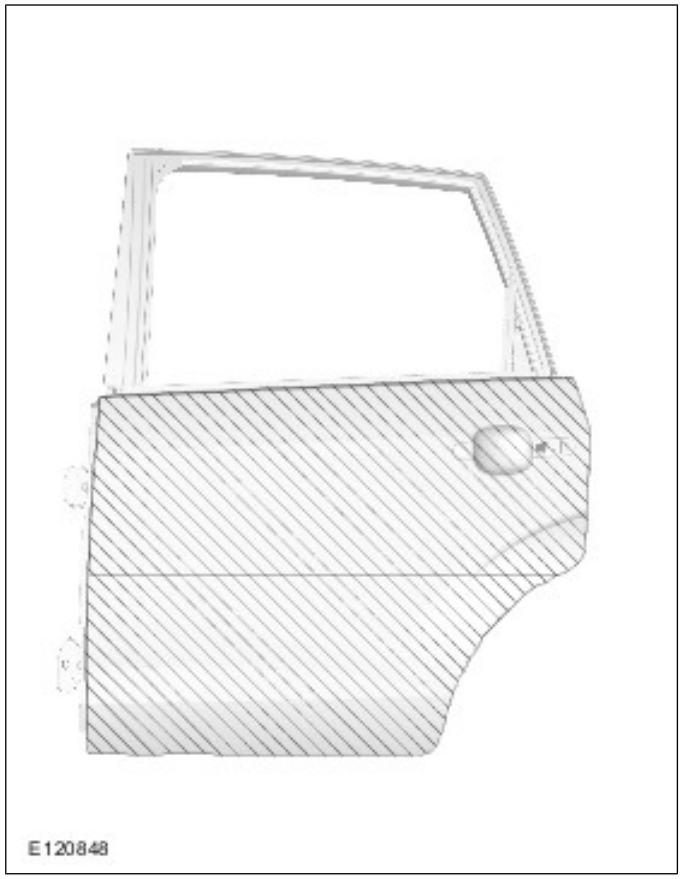
Methods of Masking

Masking work can be divided into four groups.

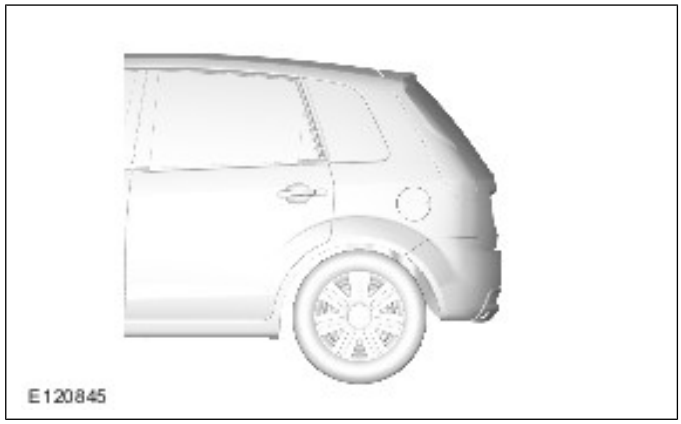
1. To paint a whole vehicle.



2. To paint an individual panel.



3. To paint an individual panel (block painting) and to paint the adjoining panel in gradation.

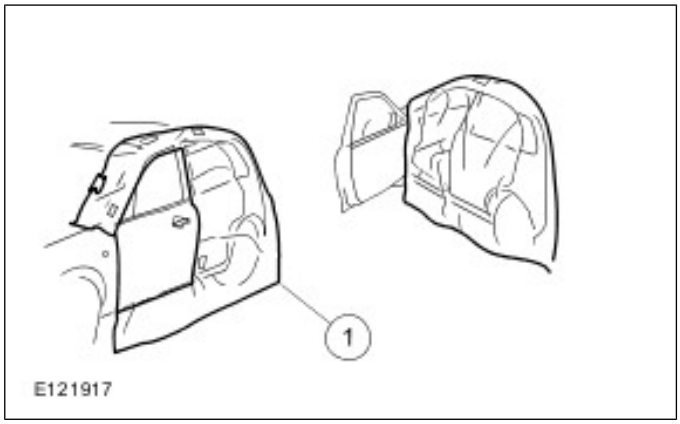


DESCRIPTION AND OPERATION

Endings of Adjoining Panels

Vinyl masking (In the case of masking a door):

The inside of the door where paint mist tends to attach to is masked beforehand. Cover the whole vehicle other than the door with vinyl sheet and close the door with the vinyl sheet in place so as to prevent entry of paint mist from the door opening into the inside of the cabin.

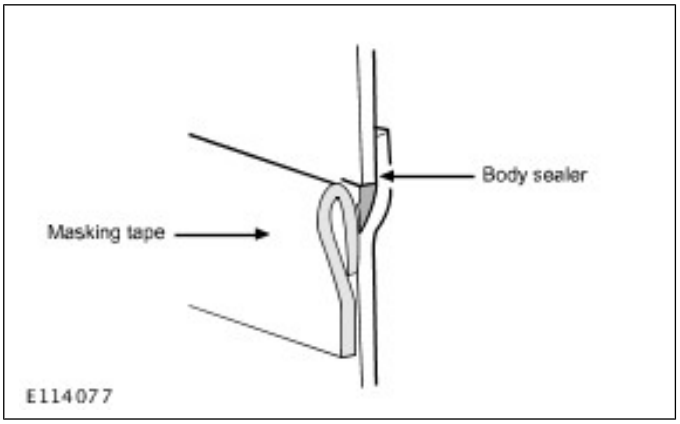


Item	Description
1	Vinyl sheet

Ending of body sealed panel:

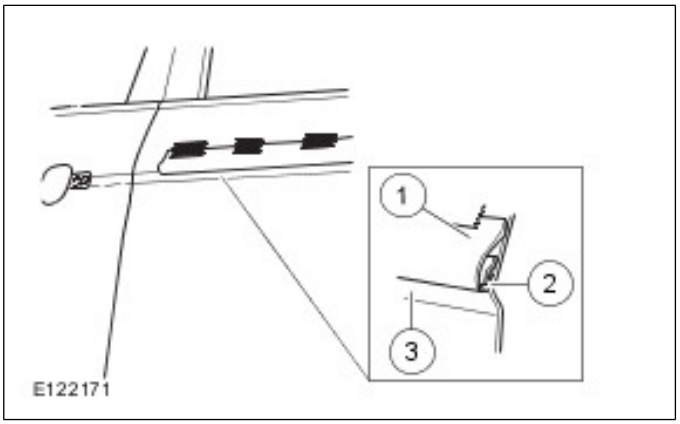
When the body sealing area is inside the panel, align the end of painting with the body sealing area, which makes the steps at the sealing area less conspicuous.

Even at the end of the sealing area, by painting with the masking tape folded up as shown in the figure, it is possible to make the steps far less conspicuous.



End of painting if a featureline is on the panel:

If only a part of a panel is repaired, there is a way to make the color difference from the old paint surface less conspicuous and finish the end of painting neat. Making the end line of paint by folding up the masking tape can get rid of the steps.

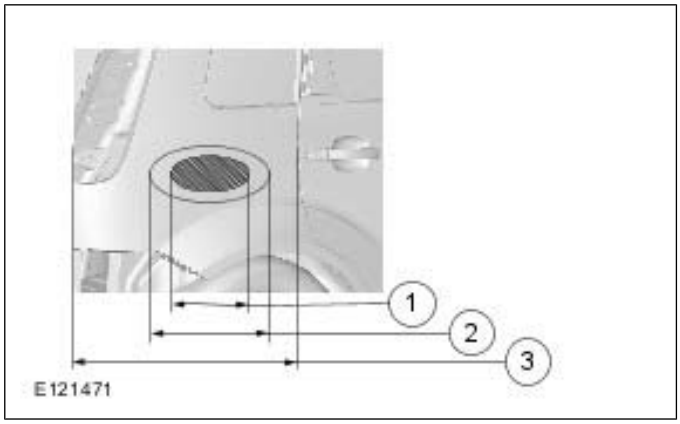


Item	Description
1	Masking tape
2	Glued surface
3	End of painting

End of Enamel Gradated Clear Block Painting

If the enamel paint is painted with gradation and clear coat is block-painted on the panel, the bordering are with the adjoining panel is only clear-painted. As clear coat is transparent, unless there is no conspicuous step, small irregularities cannot be recognized. Further, if paint is applied with gradation along the edge area after clear coat is applied, and the masking paper or tape is peeled off, the step looks less conspicuous.

DESCRIPTION AND OPERATION

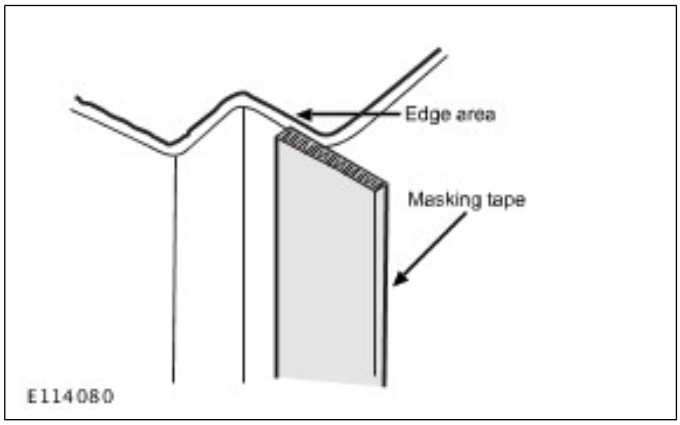


Item	Description
1	Deside on enamel base colour
2	Enamel gradated pigment
3	Clear coat area

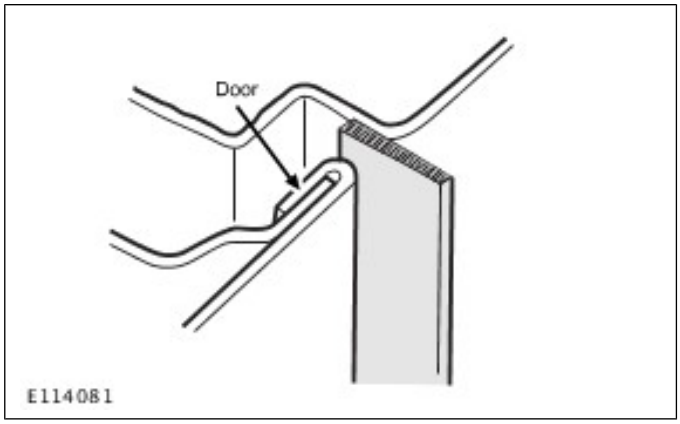
Example of Masking Process

Outer panel and door edge:

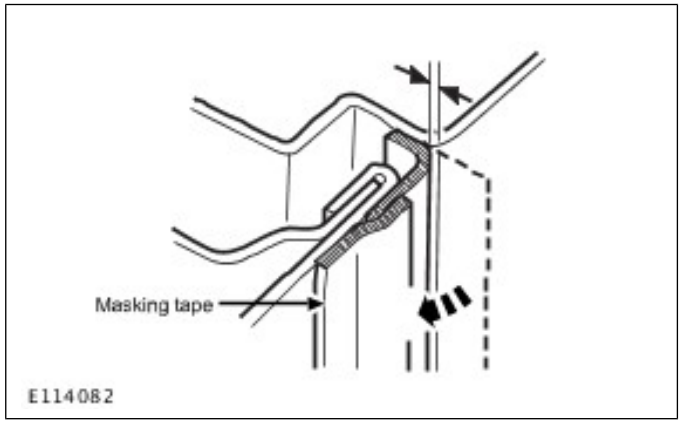
1. Place the masking tape with the glued surface toward the painted surface at the outer panel corner area.



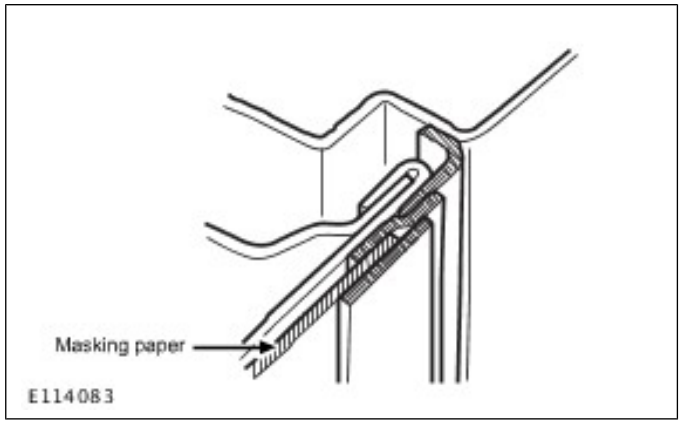
2. Close the door.



3. Without ending the tape just at the outer panel corner, place the tape so that it ends further inside the corner.



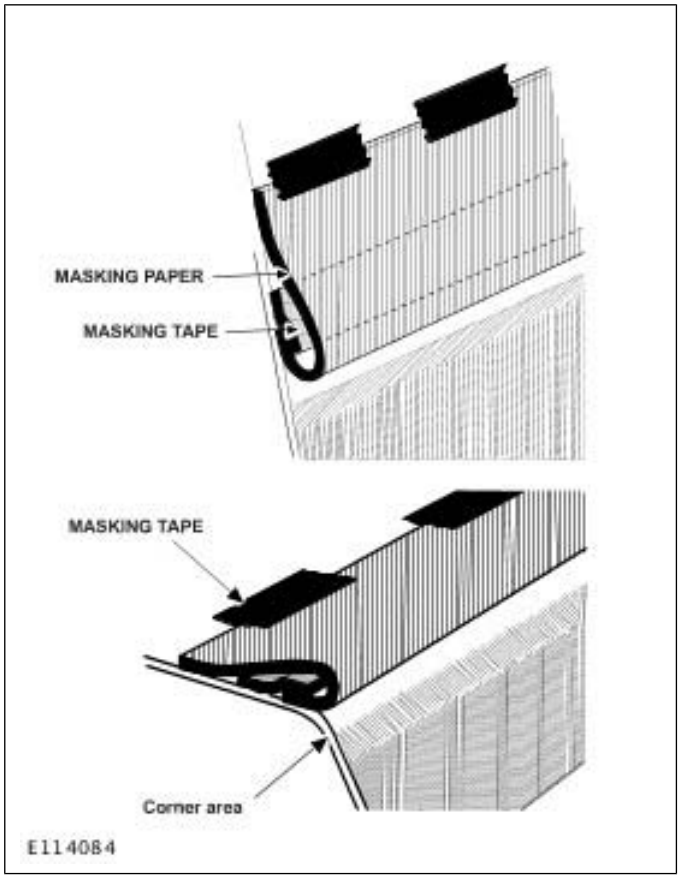
4. Mask the whole door.



Reverse Masking

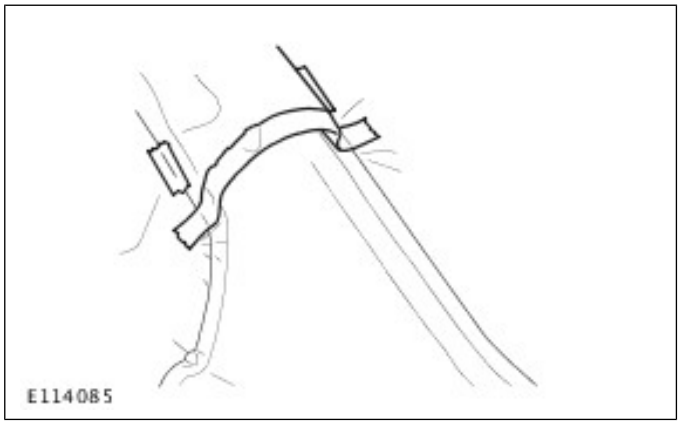
Fold up the masking paper and make a rounded area so that paint mist is slightly attached on its end of painting. For the flat surface area, use a masking paper and for the corner area, used a masking tape. There are two ways of masking in reverse way. One is to use a tape and another is to use a masking paper.

DESCRIPTION AND OPERATION



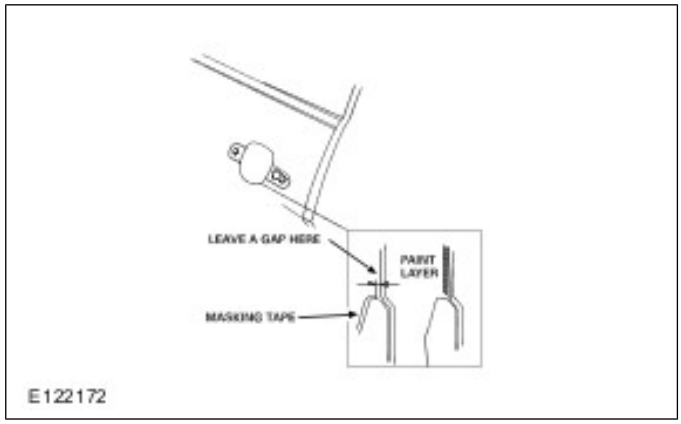
Tunnel Masking

To paint a pillar or something like that, this masking method makes the step at the painting end less conspicuous by lifting the masking paper. Depending upon the number of gradated paintings, painting is carried out with the masking tape lifted at two or three stages.

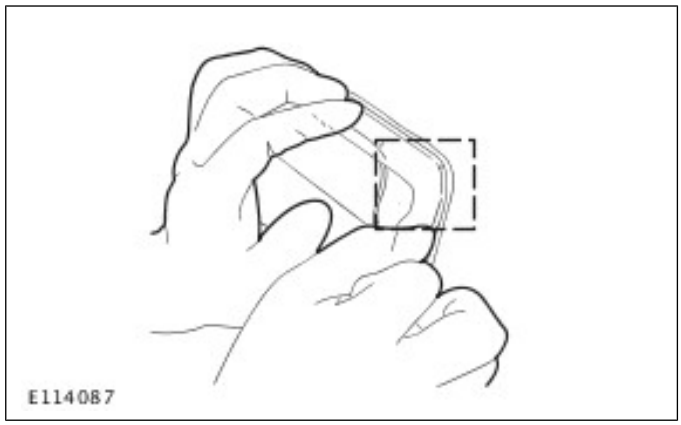


Masking with External Attached Parts Installed

When masking with the external attached parts installed, make masking with a gap identical to the thickness of the paint layer left. If masking is made without the gap of the depth, the tape is joined to the paint layer, making it difficult to peel off the tape later.



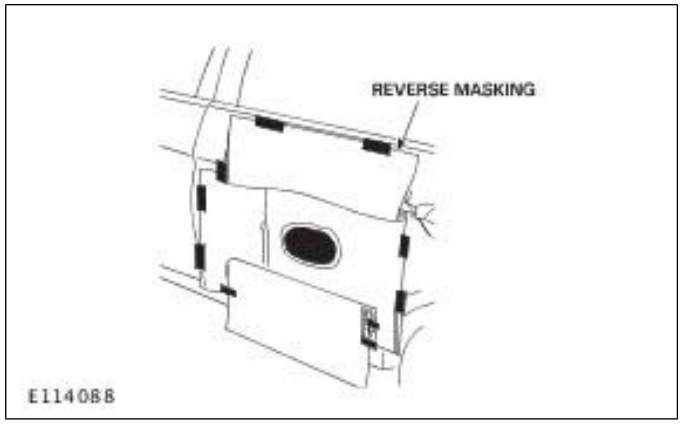
To make masking at the corner (rounded) area of the part, place the masking tape with some margin. Do not paste it tightly. It is not good to connect another piece of tape at the corner area.



Masking in Primer Surfacer Painting

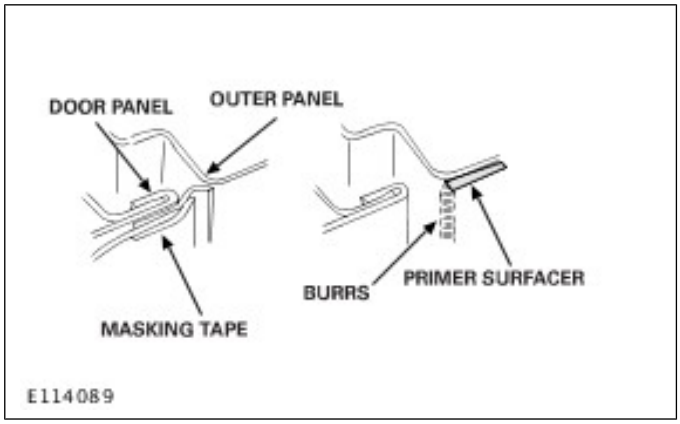
Key Points

Make reverse masking around the repair area.



Burrs of the painting layer tends to grow at the door edge area. Remove burrs by polishing, if necessary.

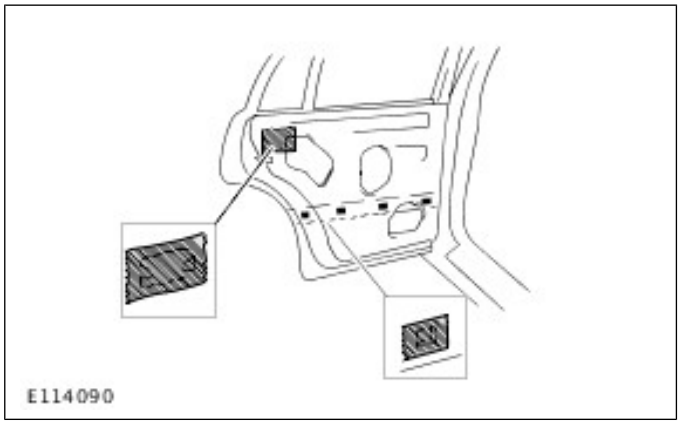
DESCRIPTION AND OPERATION



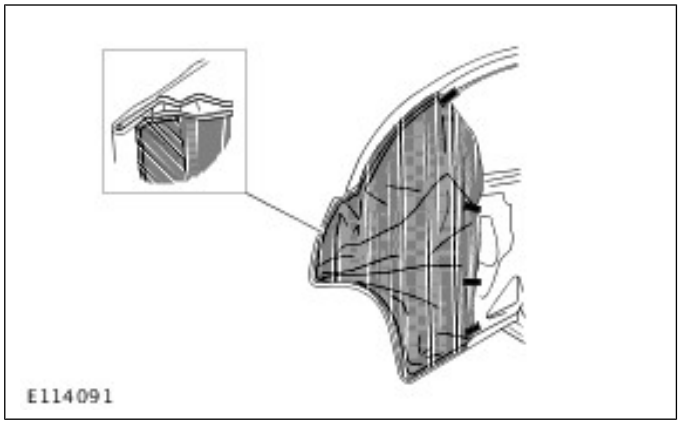
Masking Process for Top Coating

Rear Door

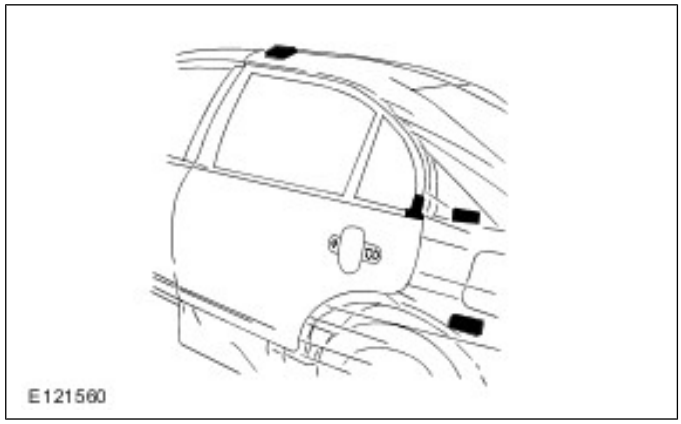
1. Cover the outer handle and door protector installing holes with tapes from the inside of the door to prevent entry of paint mist.



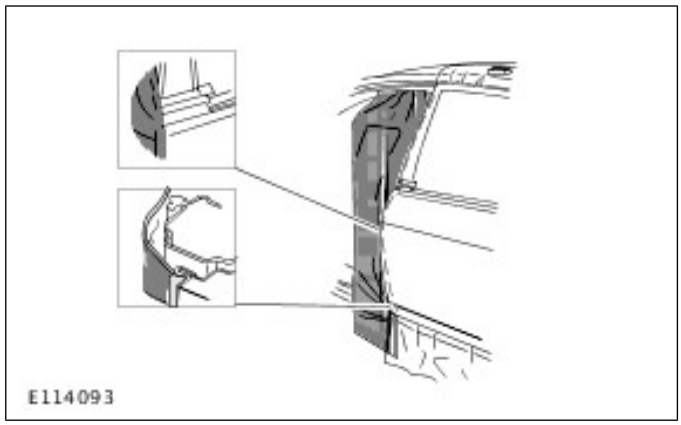
2. Cover the rear door rear inner panel with the masking paper up to the body sealing edge to prevent entry of paint mist.



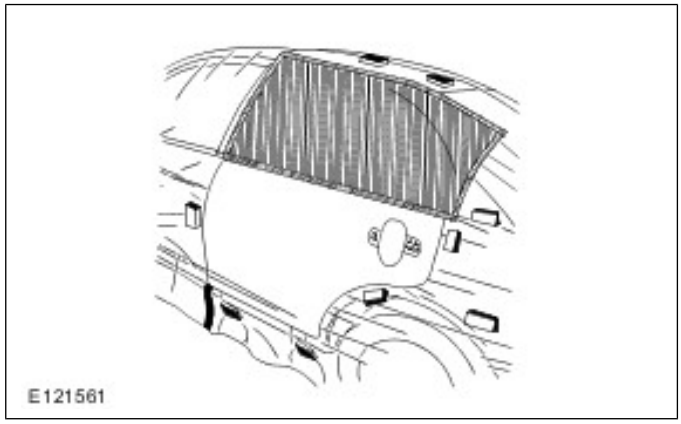
3. Insert a vinyl sheet between the rear door and the body as shown in the figure below, to prevent entry of paint mist from the body openings and close the door and then place masking paper on it.



4. To prevent paint mist from adhering to the front openings of the rear door and the center door pillar, attach a masking tape to the flange area to mask the center pillar together.



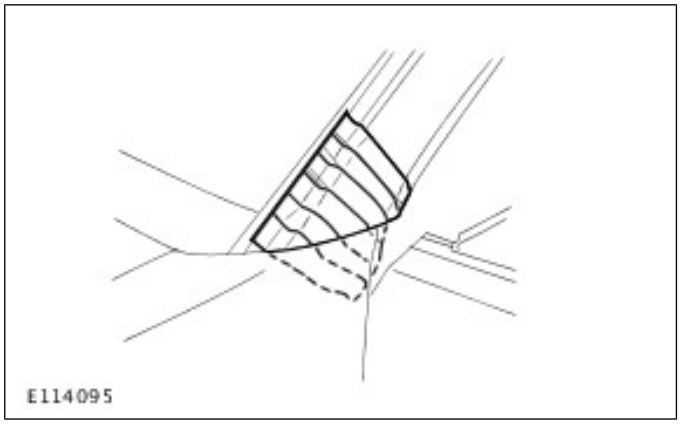
5. In order to prevent entry of paint mist from the front door opening into the cabin, insert a vinyl sheet between the front door and body and close the front door. Then turn back the vinyl, and cover the door glass with masking paper.



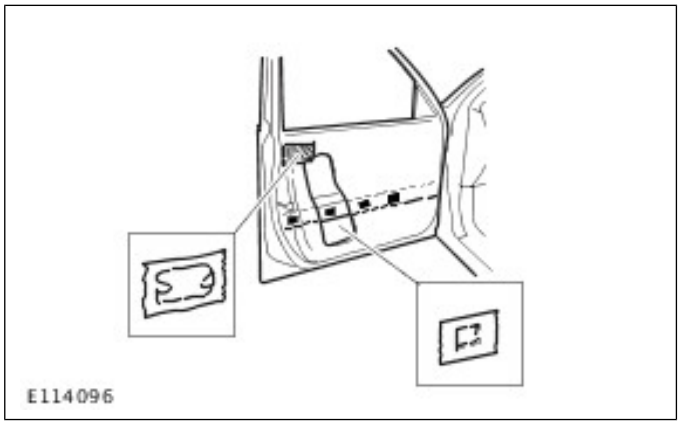
Front Door and Front Fender

1. To prevent adherence of paint mist to the lower part of the front pillar, place masking tape between the front pillar and front fender.

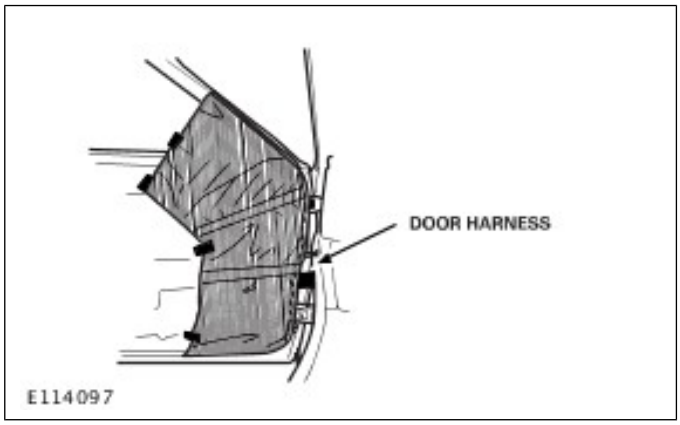
DESCRIPTION AND OPERATION



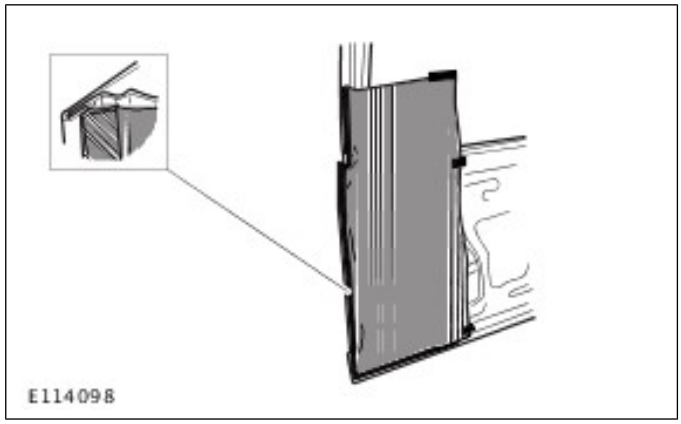
2. Cover the outer handle and door protector installing holes from the inside of the door.



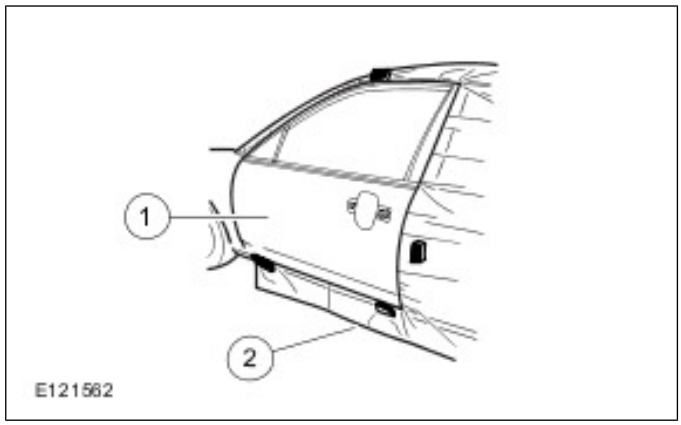
3. Put masking tape over the front area of the front door ending at front door hinge, and place masking tape over the door harness to prevent adherence of paint mist to it.



4. Place masking paper to cover the rear inside surface of the front door.

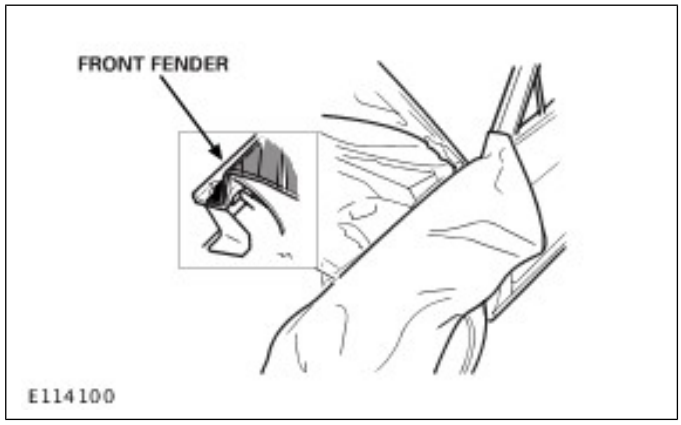


5. In order to prevent entry of paint mist from the front door opening into the cabin, insert a vinyl sheet between the front door and the body and close the door. Then place masking paper.



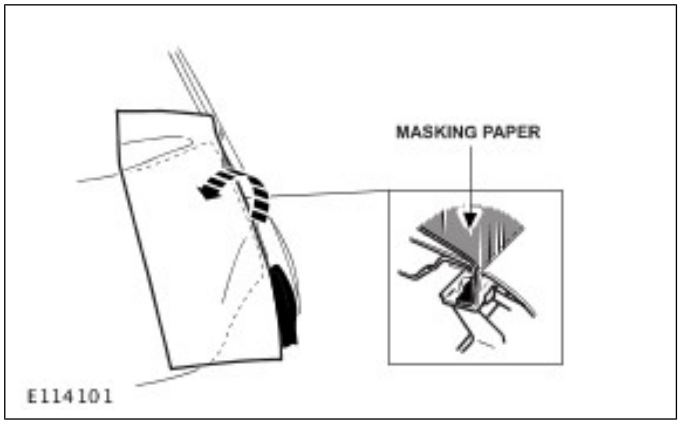
Item	Description
1	Front door
2	Vinyl sheet

6. Open the hood and place masking paper along the front fender as shown.

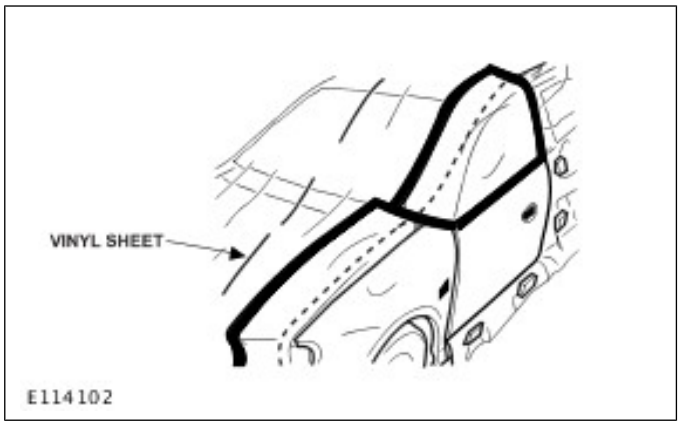


7. Close the engine hood, turn back the paper toward the hood so that the paper does not stick to the fender.

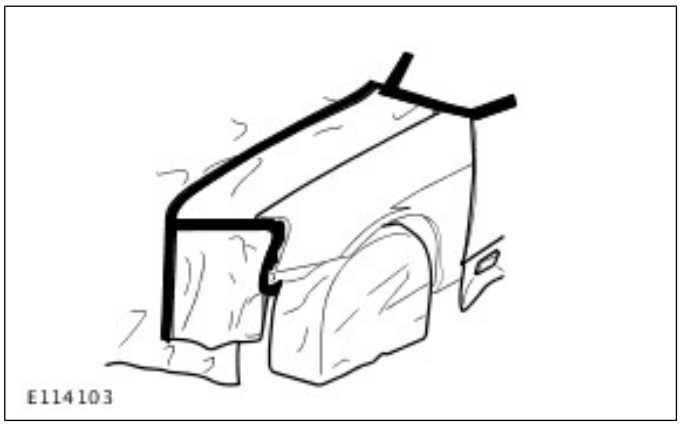
DESCRIPTION AND OPERATION



8. Place a masking vinyl sheet as shown below to cover everything other than the front fender. Turn back the paper on the hood and fix it with tape, and masking paper covering the door glass.

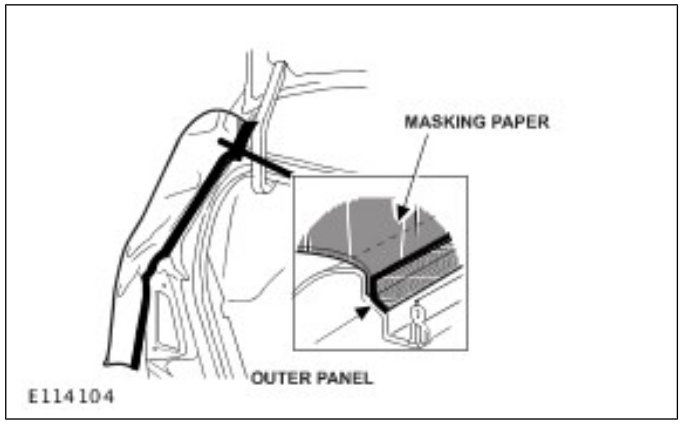


9. To prevent paint mist from adhering to the wheel or dust from coming out of the wheelhouse, place a masking paper or vinyl sheet over the wheelhouse and wheel.



Rear Side Outer Panel

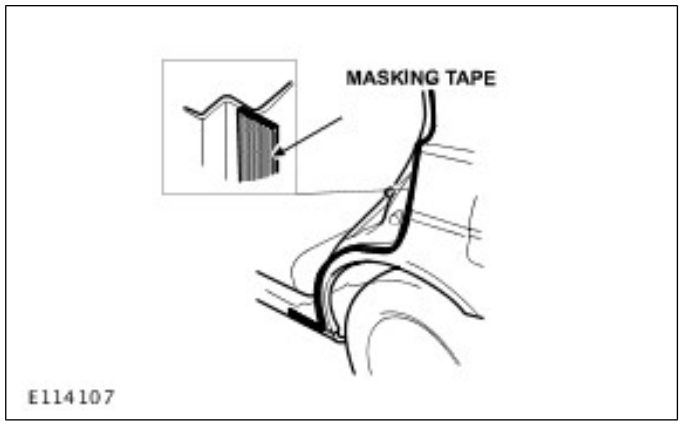
1. Open the trunk lid and place masking paper over the inside of the outer panel trunk lid opening.



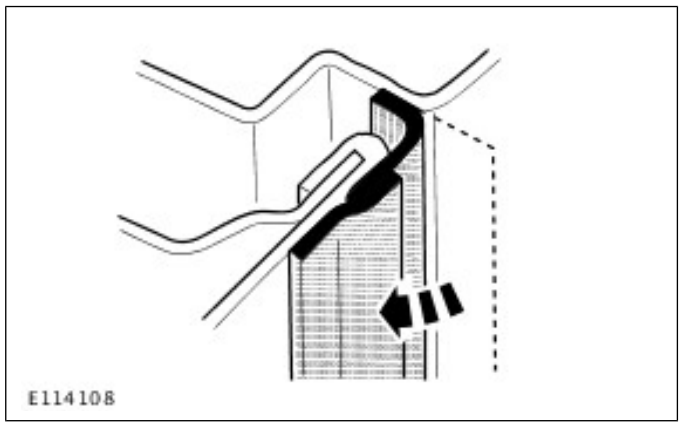
2. Close the trunk lid, turn back the paper toward the trunk lid so that the paper does not stick to the rear outer panel, and cover the rear window glass with masking paper.

3. Place masking tape on the rear of the outer panel along the sealing area. Place a masking vinyl sheet to cover the roof rear window and trunk lid and fix the papers with tape at the vinyl sheet.

4. Place a tape along the press line of the outer panel rear door opening so that the glued surface of the masking tape faces the outer panel.

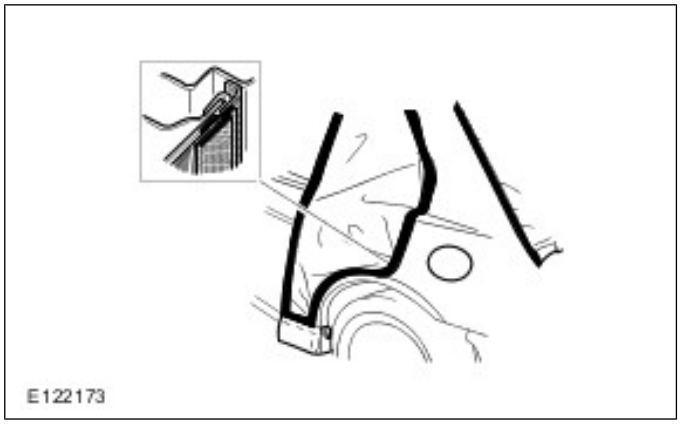


5. Close the rear door and turn back the tape toward the door side and place masking paper, and attach it with tape.

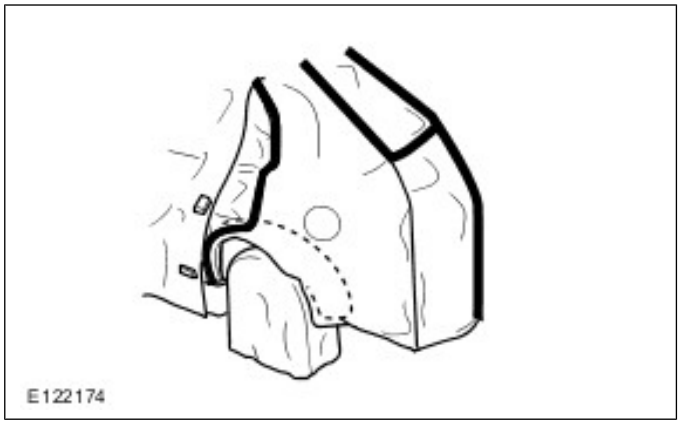


6. Place masking paper over the rear door.

DESCRIPTION AND OPERATION



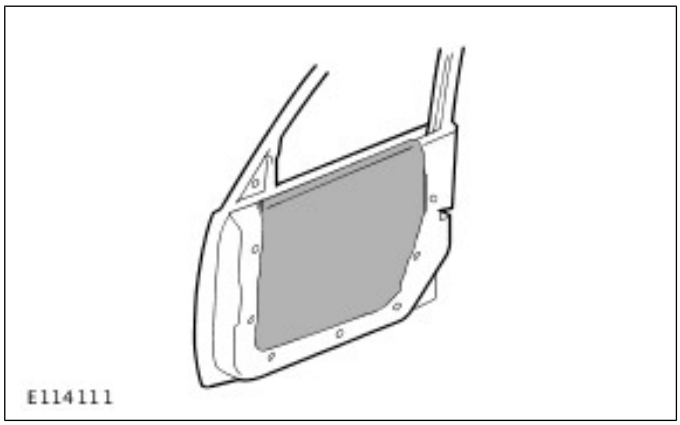
7. Place a vinyl sheet to cover the whole part except the outer panel. Place a masking sheet to cover the rear wheelhouse and wheel to prevent paint mist from adhering to the wheel or dust from coming out of the wheelhouse. On the rear pillar where the painting is gradated, use the tunnel masking method.



Masking in a Whole Vehicle Painting

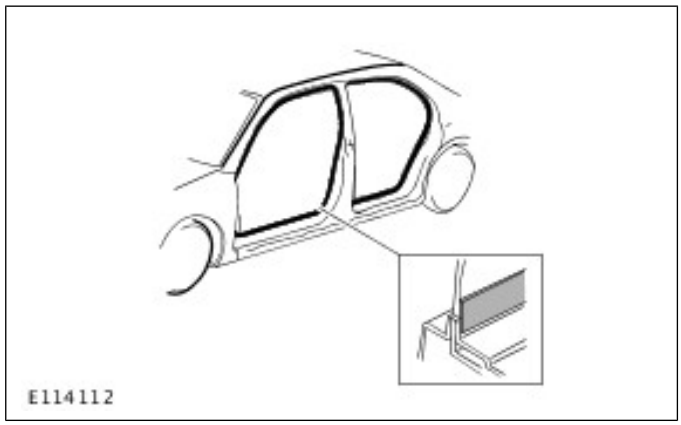
Inside the door panel:

Place masking sheet until the edge of it comes to the inside of the door lining because the end of the masking paper is hidden when the door lining is later placed in position.



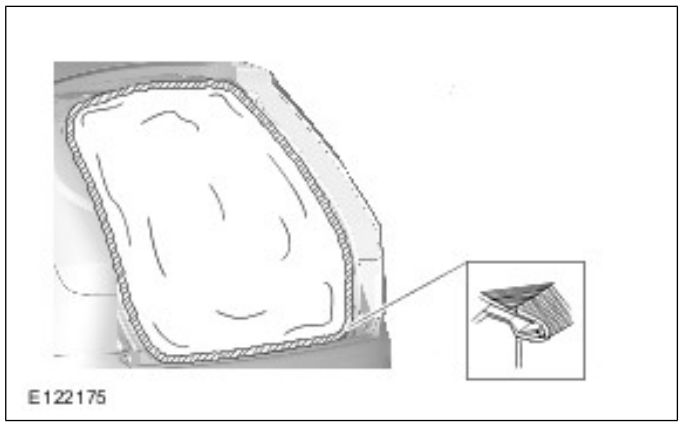
Door opening:

Place masking sheet until the end of it comes to the door opening trim and side garnish installing flange because the end of the masking is hidden when the door opening trim and side garnish are installed.



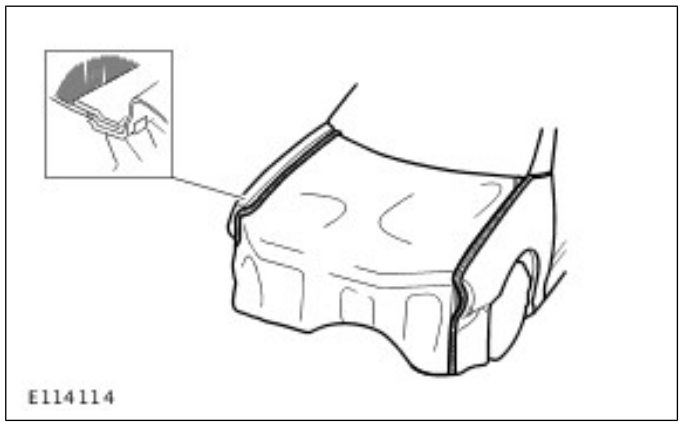
Trunk opening area:

Place masking sheet to cover the trunk lid opening along the weather strip installing flange because the end of the masking tape is hidden when the weather strip is installed in position.



Engine compartment:

Place masking sheet to cover the engine compartment opening along the front engine fender installing area.



DESCRIPTION AND OPERATION

Color shade problems

If a vehicle color shade is taken from a vehicle on a hot summer day and the mixed color applied, this may cause color shade problems. Some colors change so much at higher temperatures that it can lead to an incorrect result. Red color shades are particularly prone to this shade behavior.

This means that color determination should always be done on the bodywork when it is at about the same temperature as the later working temperature will be. The best temperature of the item is between 15° and 25° C.

Isopropanol and water

Painted surfaces are very easily cleaned using a mixture of 70% water and 30% isopropanol (can be obtained through a laboratory supplies specialist or a pharmacist).

Temperature reduction spray

If finishing work must be performed on touched-up surfaces and newly painted plastic parts, problems may arise. The paint and the transitions are not yet fully hardened.

NOTE: When working with the polishing machine, make certain that each operating run lasts no longer than about 5 - 10 seconds, in order to prevent the paint becoming warm.

Even so, in order to be able to polish over transitions, temperature reduction spray must be applied to the surface. The transition area is then alternately sprayed and polished until a perfect transition surface is achieved.

Paint faults on soft plastic components where elasticizer additive has been used in painting must be wet sanded using grade P2000 - P2500 paper.

In doing this the sanding location and the surroundings are sprayed with temperature reduction spray and the paint faults sanded out by hand. Afterwards the location is polished as described above.

Paint plane

Dirt inclusions and paint runs can be removed with the sanding cylinder ("Finiball") and hand sanding or eccentric sander in a wet sanding process.

Another practical tool for removal of paint faults which lie proud of the surface is the paint plane.

NOTE: Guide the tool carefully with the minimum of force. It must not tilt, otherwise more serious damage may easily be caused.

This tool allows paint faults to be carefully removed in shavings. Afterwards the surface must be polished using suitable materials.

Shading

Even when all the rules, steps and corresponding instructions have been followed concerning possible shades, it may happen that the mixed color shade does not exactly match the vehicle color.

In these cases, shading must be done. Because there is no fixed formula for this, experience and a trained eye are important. Some rules must be followed for shading.

NOTE: Self-made color sample plates of the current colors are very helpful for determining the color shade. Refer to the chapter Color Determination and Color Theory.

- When shading, if possible only use the paint mixture that is also allotted in the color shade formula.
- Observe the rules concerning contrary colors (complementary colors) and partner colors according to the Oswald color circle.
- Complementary colors are not recommended during shading because they mutually inhibit and lead to muddy mixtures.

Sanding marks

In certain circumstances, the recommended sanding methods up to now are no longer suitable for light metallic color shades. Wet sanding with

grade P1200 paper or a grey sanding pad can cause sanding scratches which can become very visible under certain lights.

In order to achieve an excellent paint result on difficult color shades, follow these working rules:

- Sand filler as before, rub down area to be painted with 3M ultra fine matting sponge and 3M matting gel.
- Sand filler as before, rub down area to be painted with soaked 3M wet sand paper P1500 - P2000.
- Sand filler as before, rub down area to be painted with 3M 260 L P1000 eccentric (Interface Pad).

Improving touch-up work

During application of special effect base paints, the effect particles align themselves exactly parallel to the surface in the paint layer while it is still liquid. This means a particular thickness of the paint layer is required.

Because during painting the layer thickness in the transition zones reduces from normal to zero, the effect particles can no longer align themselves. This leads to lighter, darker or cloudy zones.

If 1-component clear lacquer is sprayed before the base coat, this effect is prevented. An optically perfect transition will result.

SECTION 502-00 Uni-Body, Subframe and Mounting System

VEHICLE APPLICATION: 2010.25 Figo

CONTENTS PAGE

SPECIFICATIONS

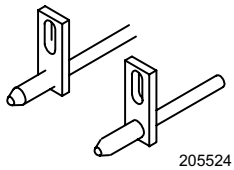
Torque Specifications

Item	Nm	lb-ft	lb-in
Stabilizer bar connecting link to stabilizer bar	55	41	-
Lower arm ball joint to wheel knuckle	48	35	-
Engine support insulator retaining bolts	80	59	-
Steering gear retaining bolts	48	35	-
Crossmember front retaining bolts	70	52	-
Crossmember rear retaining bolts	175	129	-
Exhaust flexible pipe to catalytic converter retaining nuts - Vehicles with 1.25L, 1.4L or 1.6L engine	44	32	-
Exhaust flexible pipe to muffler and tailpipe assembly retaining nuts - Vehicles with diesel engine	47	35	-
Exhaust flexible pipe to catalytic converter retaining nuts - Vehicles with 2.0L engine	47	35	-

REMOVAL AND INSTALLATION

Crossmember

Special Tool(s)

 205524	Alignment Pins, Subframe 205-524 (15-122)

General Equipment

Securing strap
Transmission jack
5 mm Allen key

Materials	
Name	**Specification**
Grease	SA-M1C9107-A

Removal

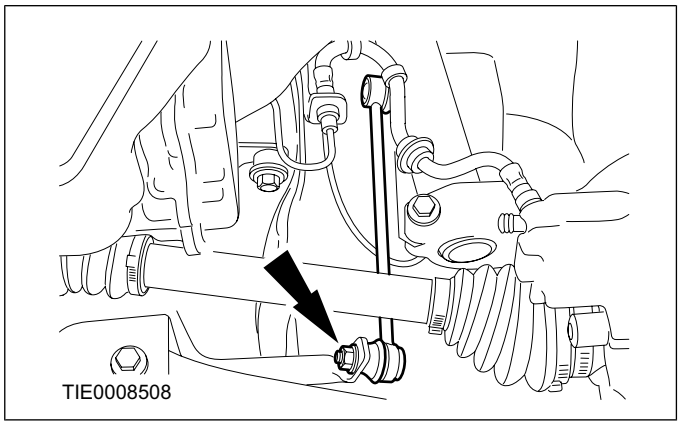
All vehicles

1. **Remove the front wheels and tires.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

2. **NOTE: Use a 5 mm Allen key to prevent the ball joint from rotating.**

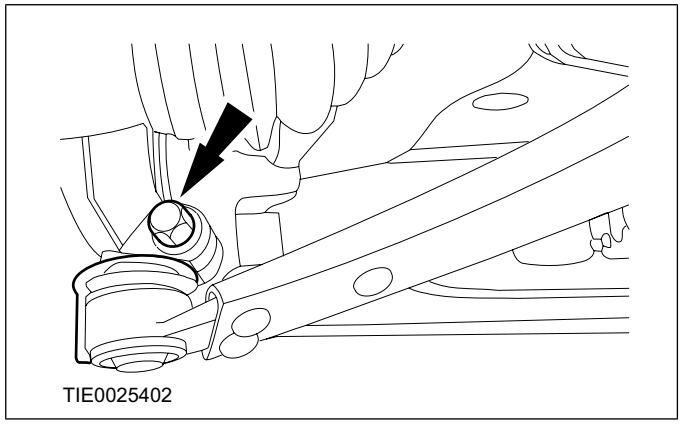
   Detach the stabilizer bar connecting link from the stabilizer bar on both sides.


TIE0008508

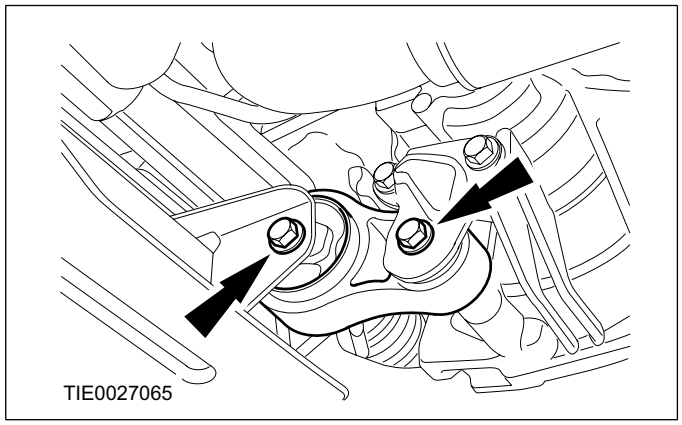
3. **CAUTION: Protect the ball joint seal using a soft cloth to prevent damage.**

   Detach the lower arm ball joint from the wheel knuckle on both sides.

- Remove the heat shield.

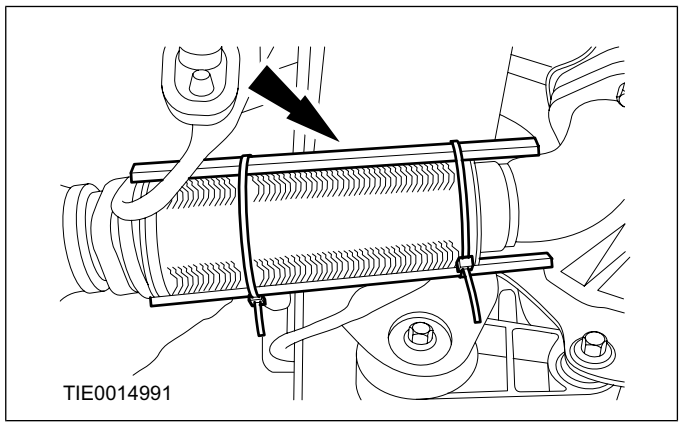

TIE0025402

4. **Remove the engine support insulator.**


TIE0027065

5. **CAUTION: Over bending of the exhaust flexible pipe may cause damage resulting in failure.**

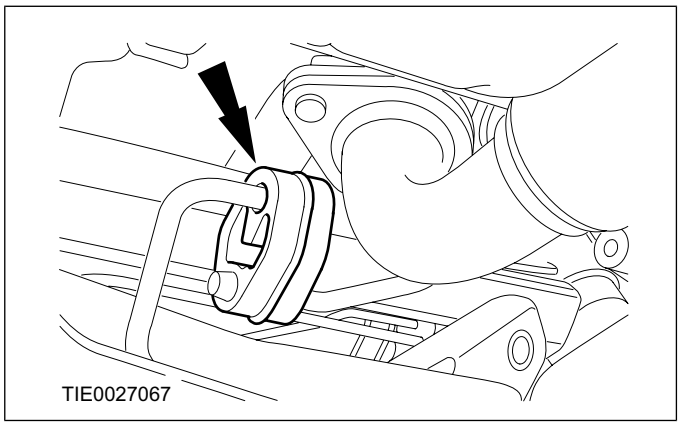
   Support the exhaust flexible pipe with a support wrap or splint.


TIE0014991

6. **CAUTION: Take care when removing the exhaust hanger insulator to prevent damage.**

REMOVAL AND INSTALLATION

Remove the exhaust hanger insulator.



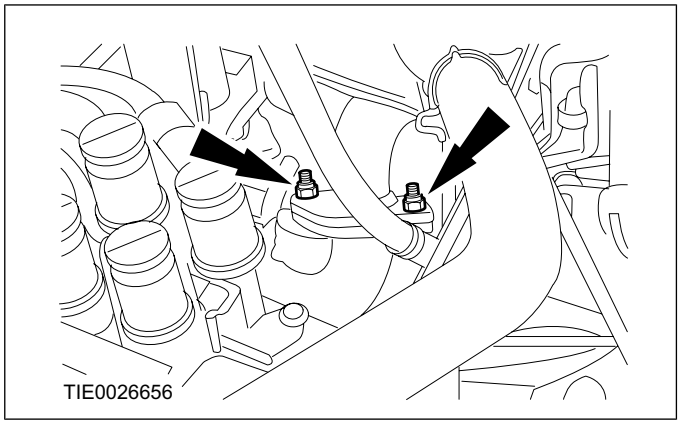
Vehicles with 1.25L, 1.4L or 1.6L engine

7. **CAUTION: Twisting the exhaust flexible pipe more than two degrees may cause damage resulting in failure.**

NOTE: Use a pry-bar to prevent the exhaust flexible pipe from twisting when removing the exhaust flexible pipe to catalytic converter retaining nuts.

Disconnect the exhaust flexible pipe from the catalytic converter.

- Remove and discard the exhaust flexible pipe to catalytic converter gasket and retaining nuts.



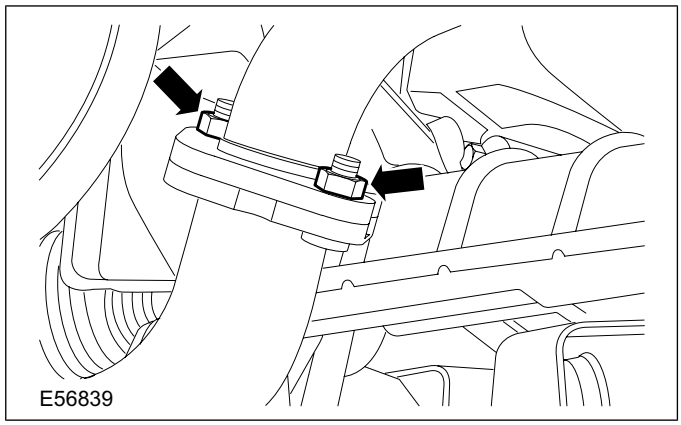
Vehicles with diesel engine

8. **CAUTION: Twisting the exhaust flexible pipe more than two degrees may cause damage resulting in failure.**

NOTE: Use a pry-bar to prevent the exhaust flexible pipe from twisting when removing the exhaust flexible pipe to muffler and tailpipe assembly retaining nuts.

Disconnect the exhaust flexible pipe from the muffler and tailpipe assembly.

- Discard the gasket (if equipped) and nuts.



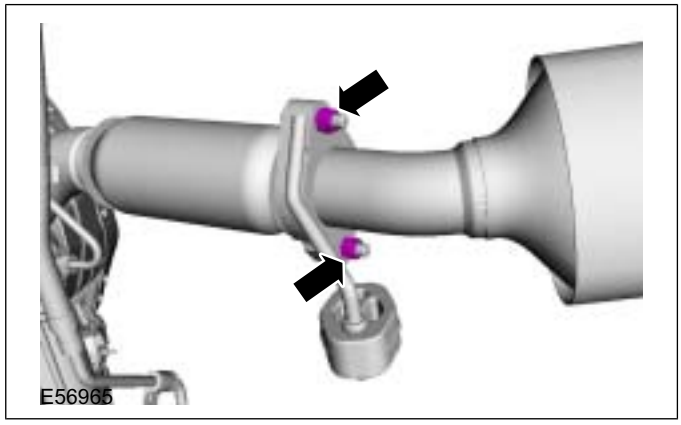
Vehicles with 2.0L engine

9. **CAUTION: Twisting the exhaust flexible pipe more than two degrees may cause damage resulting in failure.**

NOTE: Use a pry-bar to prevent the exhaust flexible pipe from twisting when removing the exhaust flexible pipe to catalytic converter retaining nuts.

Disconnect the exhaust flexible pipe from the catalytic converter.

- Remove and discard the exhaust flexible pipe to catalytic converter gasket and retaining nuts.

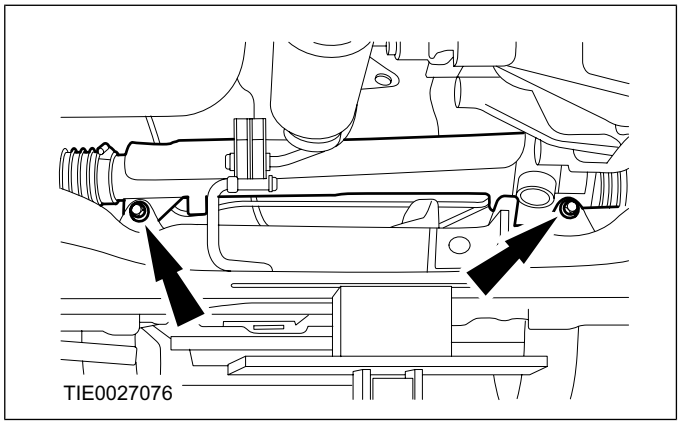


All vehicles

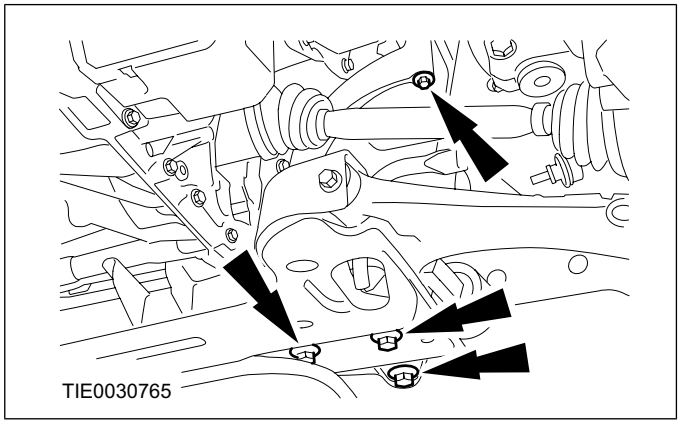
10. **Detach the steering gear from the crossmember.**

REMOVAL AND INSTALLATION

- Using cable ties, support the steering gear on both sides.

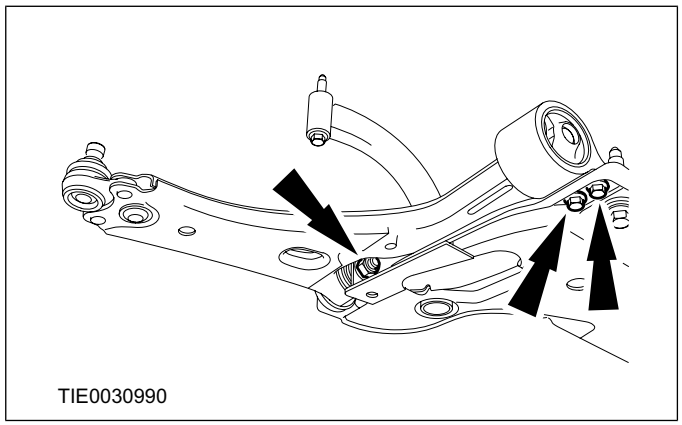


11. **Using a transmission jack and wooden block, support the crossmember and lower arm assembly.**
12. **Secure the crossmember and lower arm assembly to the transmission jack using a securing strap.**
13. **Remove the crossmember retaining bolts on both sides.**



14. **Using the transmission jack and wooden block, remove the crossmember and lower arm assembly.**
15. **NOTE: If a new crossmember is to be installed remove the lower arms.**

Remove the lower arms.



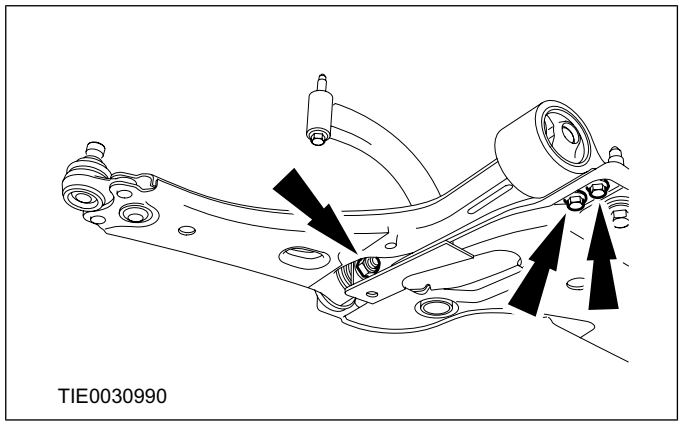
Installation

All vehicles

1. **NOTE: If installing a new crossmember, install the lower arms.**

NOTE: Do not fully tighten the lower arm to crossmember retaining bolts at this stage.

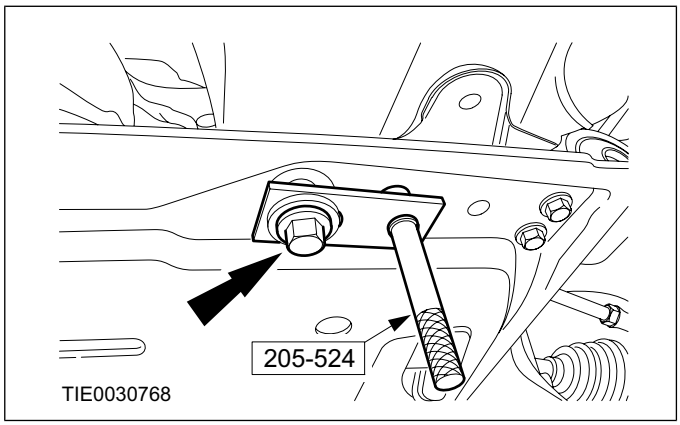
Install the lower arms.



2. **Using the transmission jack and wooden block, position the crossmember and lower arm assembly.**
3. **NOTE: Use the inner crossmember retaining bolt to locate the special tools.**

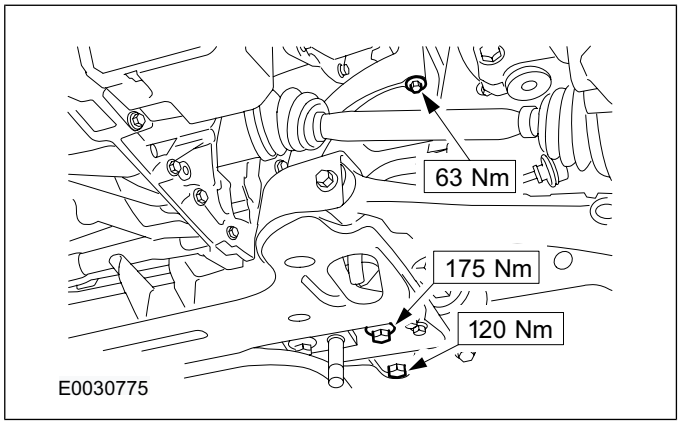
REMOVAL AND INSTALLATION

Install the special tools on both sides.

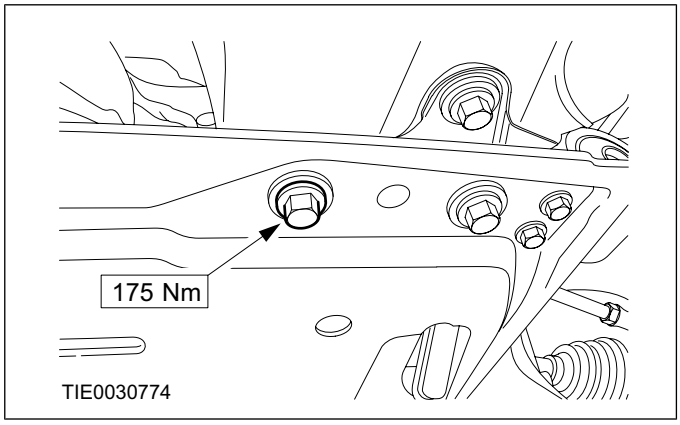


4. **CAUTION: While tightening the crossmember retaining bolts, make sure the crossmember does not move.**

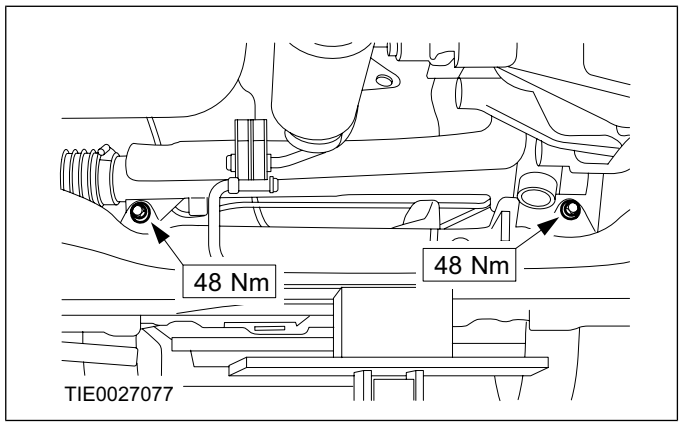
   Install the crossmember retaining bolts on both sides.



5. **Remove the special tools.**
6. **Install the crossmember inner retaining bolts on both sides.**



7. **Remove the transmission jack and wooden block.**
8. **Attach the steering gear to the crossmember.**



Vehicles with 1.25L, 1.4L or 1.6L engine

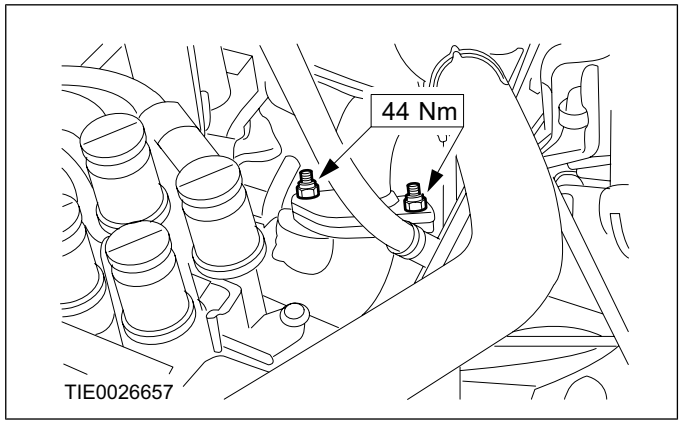
9. **CAUTION: Twisting the exhaust flexible pipe more than two degrees may cause damage resulting in failure.**

NOTE: Use a pry-bar to prevent the exhaust flexible pipe from twisting when installing the exhaust flexible pipe to catalytic converter retaining nuts.

NOTE: Coat the exhaust flexible pipe to catalytic converter studs with grease.

NOTE: Install a new exhaust flexible pipe to catalytic converter gasket and retaining nuts.

Connect the exhaust flexible pipe to the catalytic converter.



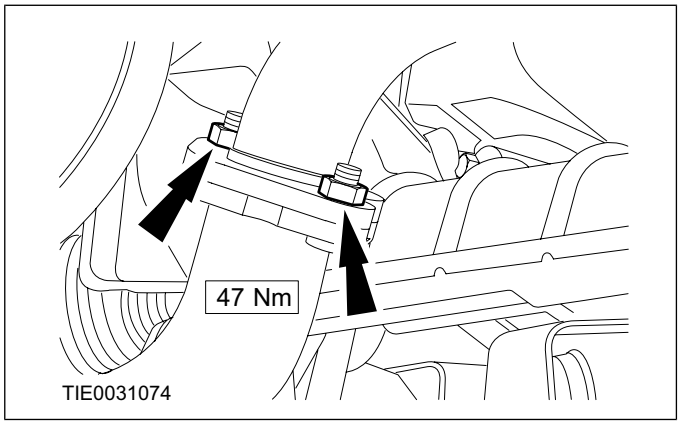
Vehicles with diesel engine

10. **WARNING: Make sure that new nuts are installed.**

Attach the exhaust flexible pipe to the catalytic converter.

REMOVAL AND INSTALLATION

- Install a new exhaust flange gasket (if equipped).



Vehicles with 2.0L engine

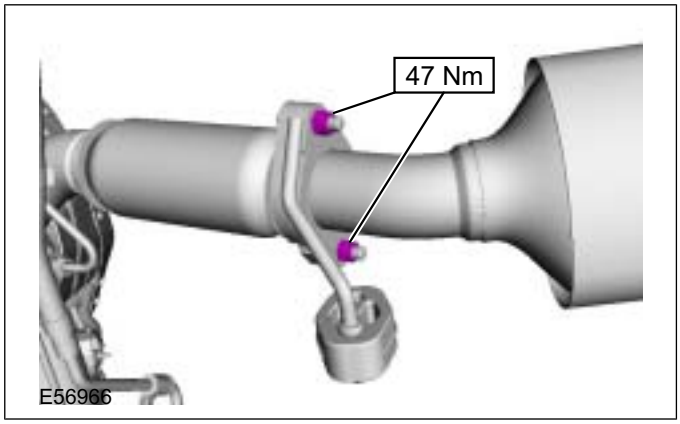
11. **CAUTION: Twisting the exhaust flexible pipe more than two degrees may cause damage resulting in failure.**

NOTE: Use a pry-bar to prevent the exhaust flexible pipe from twisting when installing the exhaust flexible pipe to catalytic converter retaining nuts.

NOTE: Coat the exhaust flexible pipe to catalytic converter studs with grease.

NOTE: Install a new exhaust flexible pipe to catalytic converter gasket and retaining nuts.

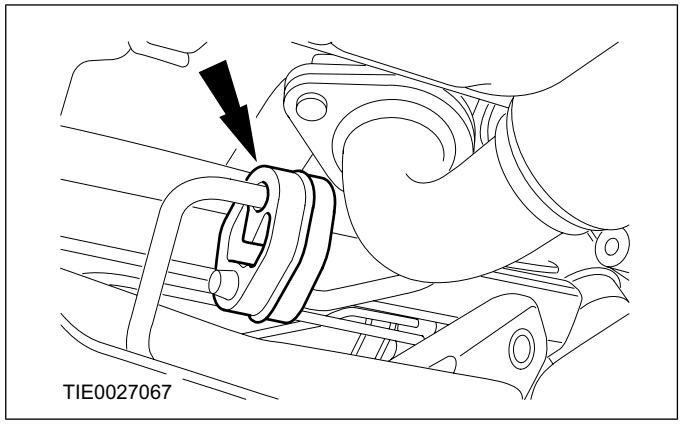
Connect the exhaust flexible pipe to the catalytic converter.



All vehicles

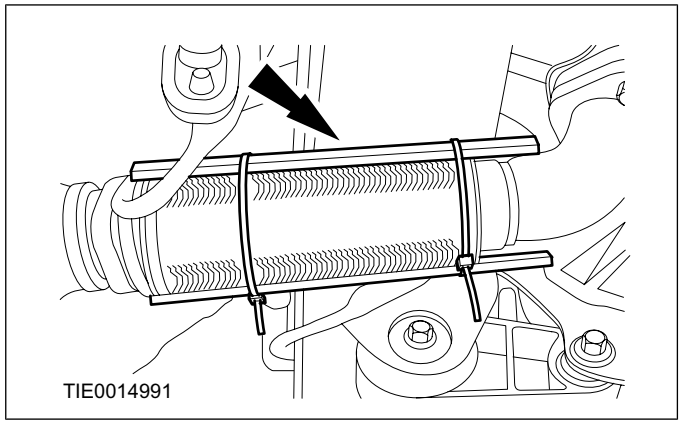
12. **CAUTION: Take care when installing the exhaust hanger insulator to prevent damage.**

Check the exhaust hanger insulator for damage. Install a new exhaust hanger insulator if required.

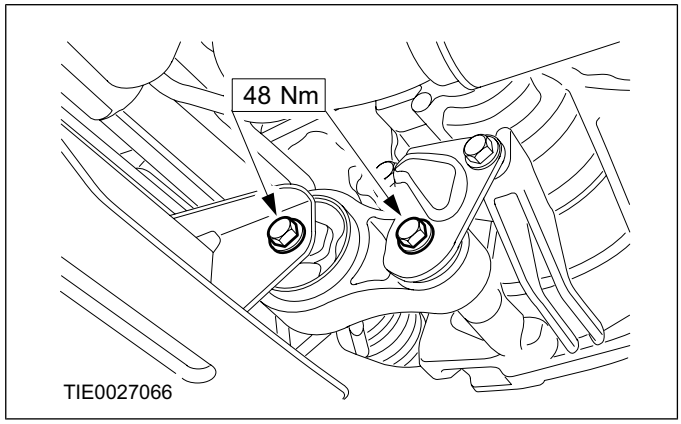


13. **CAUTION: Over bending of the exhaust flexible pipe may cause damage resulting in failure.**

Remove the exhaust flexible pipe support wrap or splint.



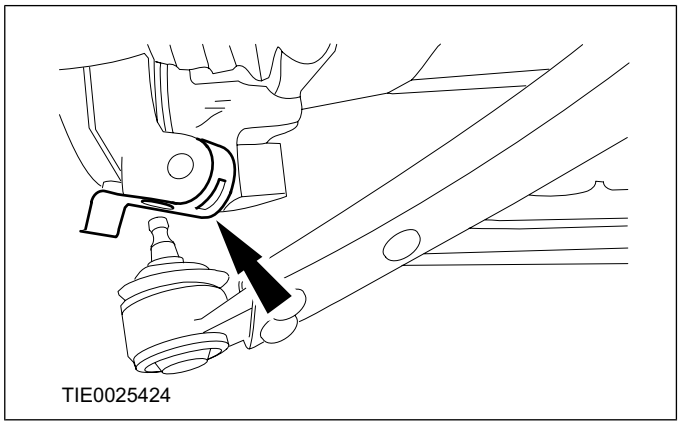
14. **Install the engine support insulator.**



15. **CAUTION: Make sure that the heat shield is installed to prevent damage to the ball joint.**

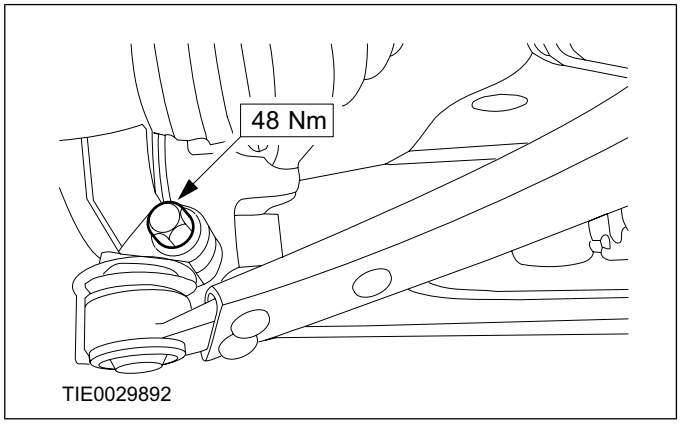
REMOVAL AND INSTALLATION

Attach the heat shield to the wheel knuckle on both sides.


TIE0025424

16. **CAUTION: The lower arm pinch bolt must be installed from the rear of the wheel knuckle.**

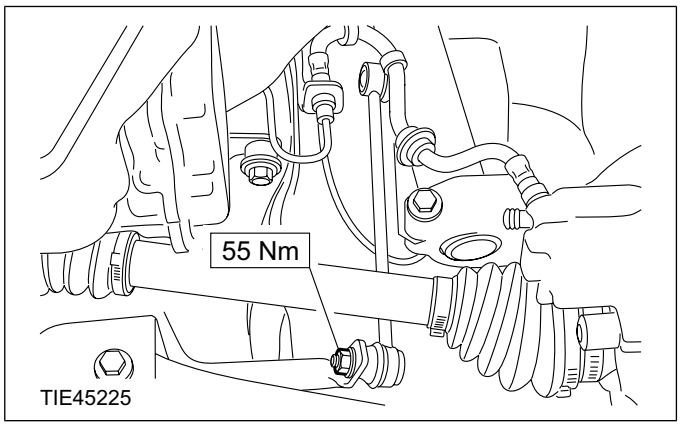
    Attach the lower arm ball joint to the wheel knuckle on both sides.



TIE0029892

17. **NOTE: Use a 5 mm Allen key to prevent the ball joint from rotating.**

    Attach the stabilizer bar connecting link to the stabilizer bar on both sides.



TIE45225

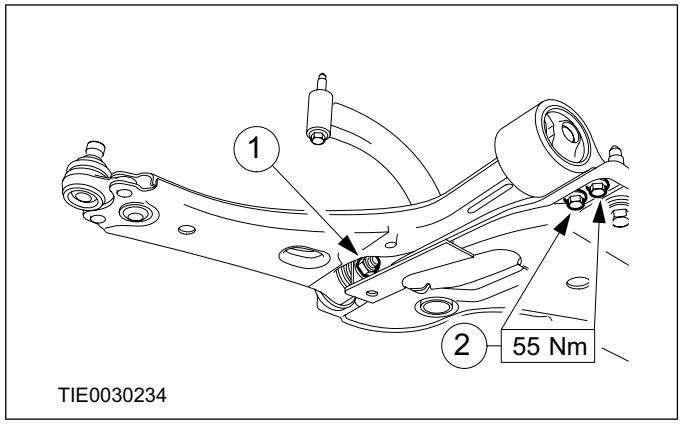
18. **Install the front wheels and tires.**

    For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

19. **NOTE: The lower arm to crossmember retaining bolts must be tightened with the vehicle weight on the road wheels.**

    Tighten the lower arm to crossmember retaining bolts on both sides.

    1. Tighten the lower arm to crossmember front bolt in two stages.
       - Stage 1: 80 Nm.
       - Stage 2: 55 degrees.
    2. Tighten the lower arm to crossmember rear retaining bolts.



TIE0030234

20. **Check the toe setting and adjust as necessary.**