Issued under the authority of the Department
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# Fire and Rescue Service Manual

## Volume 2
## Fire Service Operations

## Incidents Involving Rescue From Road Vehicles


Including Interactive CD

HM Fire Service Inspectorate
Publications Section

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## Volume 2
## Fire Service Operations

### Incidents Involving Rescue From Road Vehicles



HM Fire Service Inspectorate
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# Preface

Incidents involving rescue from road vehicles are dramatically increasing in frequency. 3,500 people die on the roads in the UK each year, with another 35,000 seriously injured. The Fire and Rescue Service, as the primary rescue service, requires national guidance to ensure a similar standard of response anywhere across the UK. This manual is designed to fulfil these requirements by highlighting current best practice with regard to detailing vehicle rescue techniques and first responder trauma care.

Although modern motor vehicles are becoming safer for the occupants, due to advancement in technology, therefore, persons are now more likely to survive a higher speed impact. However, they are more likely to become entrapped either within the metal work of the vehicle or by the nature of their injuries.

Section 8 of The Fire and Rescue Service Act 2004 and Fire (Scotland) Act 2005, Section 10 place the Statutory Duty on the FRSto respond to Road Traffic Collisions. With this duty comes the requirement to provide personnel, and equipment, to make arrangements for dealing with calls, to make arrangements for obtaining information and taking reasonable steps to prevent or limit damage.

The Fire and Rescue Service's (FRS) response to road traffic collisions must continue to develop through structured training, provision of advice and guidance and by striving to stay up to date with advancing vehicle technology.

This manual is designed to promote current best practice and reflects the most recent up to date information sourced from vehicle rescue specialists both from in the UK and from around the world. It is divided into easy to use reference chapters, which although independent, form a complete guide when read in their entirety.

It is important to note that the health and safety of all persons at the scene of an RTC should remain uppermost in the mind of the Incident Commander and this has been taken into account during the production of this manual. It is acknowledged that Dynamic Risk Assessment and other circumstances may require alternative local procedures or variations to be applied.

This manual should be used as guidance in conjunction with the policy guidance of the individual Fire and Rescue Service. This manual replaces the guidance provided in Manual of Firemanship, Book 12 – Practical Firemanship – Chapter 3 and FRS Manual Volume 4, Foundation Training and Development, Chapter 4, 4.7, Techniques 4 to 10 inclusive.

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Figures 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.20, 1.32, 1.33, 1.35, 1.36, 1.37, 1.38, 1.39, 1.40

Figures 4.8, 4.9, 4.5.3a, 4.5.3b, 4.5.3c, 4.5.3d, 4.5.3e, 4.10, 4.5.6a, 4.5.6b, 4.5.6c, 4.5.6d, 4.5.6e, 4.5.7a, 4.5.7b, 4.5.7c, 4.11, 4.16, 4.17, 4.18, 4.10.8a, 4.10.8b, 4.10.8c, 4.10.8d, 4.10.9a, 4.10.9b, 4.11.2a, 4.11.2a, 4.11.2b, 4.11.2c, 4.11.2d, 4.11.2e, 4.11.4a, 4.11.4b, 4.11.4c, 4.11.4d, 4.11.4e, 4.11.4f, 4.11.4g, 4.11.4h, 4.19, 4.12.2a, 4.12.2b, 4.12.2c, 4.12.2d, 4.12.2e, 4.12.2f, 4.12.2g, 4.13.1a, 4.13.1b, 4.13.1c, 4.13.1d, 4.13.1e, 4.14.1a, 4.14.1b, 4.14.1c, 4.15.2a, 4.15.2b, 4.15.2c, 4.15.2d, 4.15.3a, 4.15.3b, 4.15.3c, 4.16a, 4.16b, 4.16c, 4.16d, 4.16e, 4.17.5a, 4.17.5b, 4.17.5c, 4.17.5d, 4.17.6a, 4.17.6b, 4.17.6c, 4.18.2a, 4.18.2b, 4.18.2c, 4.18.2d, 4.18.2e, 4.18.2f, 4.18.2g, 4.18.2h

Figures 5.8, 5.9, 5.8, 5.12, 5.15, 5.16

Appendix 3: Figures A.3.1, A.3.2, A.3.3



# Incidents Involving Rescue From Road Vehicles

## Contents

# Acknowledgements

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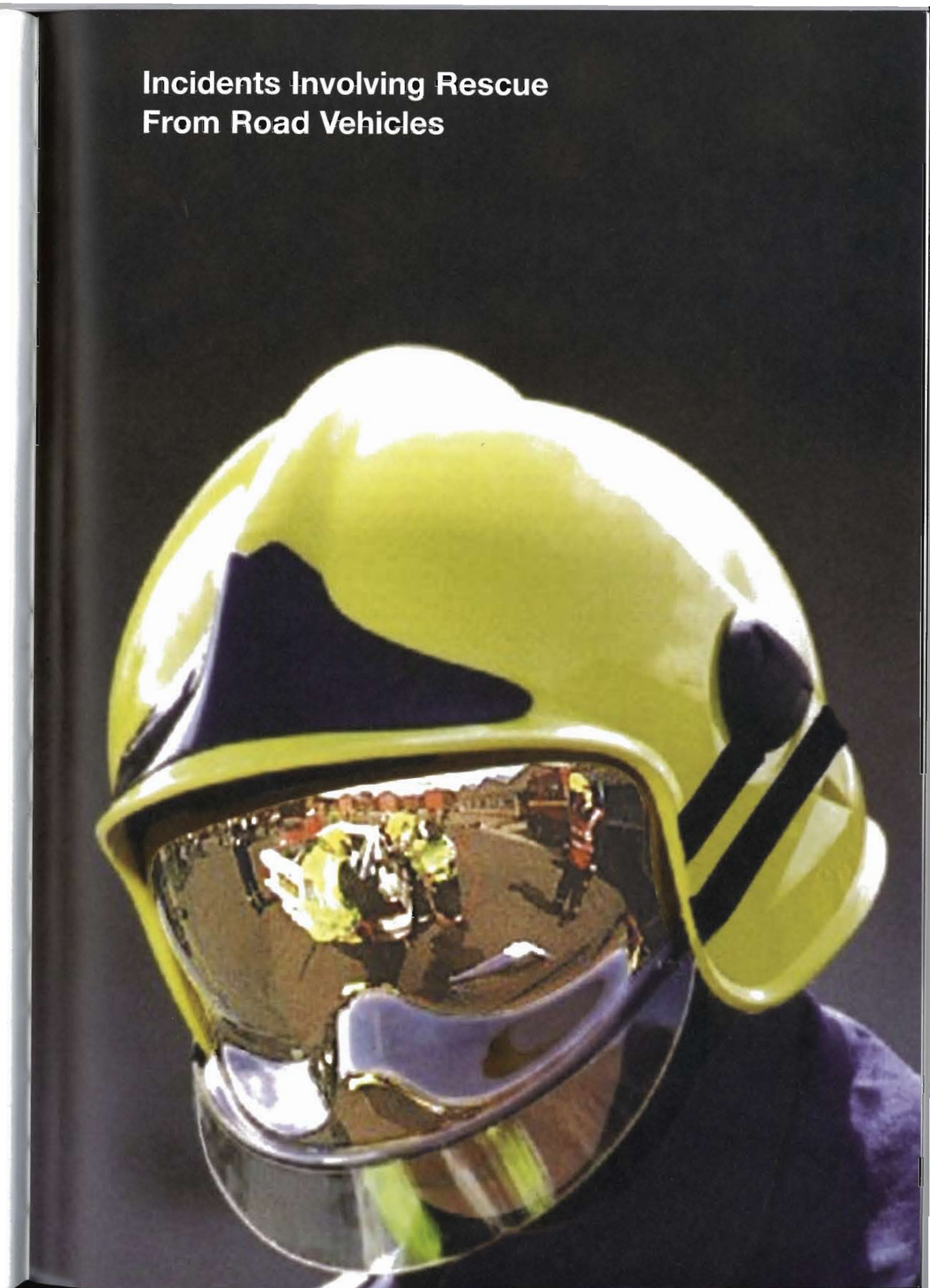


# Chapter 1 – Vehicle Design and Construction

## 1.1 Introduction to the Anatomy of Vehicles

In almost all survivable car crashes most of the vehicle will remain intact, but will be re-proportioned due to the force of the crash. Any member of a rescue crew must resist the tendency to be intimidated by the appearance of the crushed metal and regard each piece of the car as if it was intact. Whilst it is important for the crew to use common terms in communication, it is also equally essential for them to know the functions of each piece of the vehicle prior to taking any action. The well-informed rescuer will know what to expect as a result of taking action on a specific component of the vehicle.

## 1.2 Car Design Trends

There are three basic trends in the design of today's automobiles:

- Unit Body Design.
- Full Frame Design.
- Space Frame Design.

### 1.2.1 Unitary Body Design

Better known as the uni-body, this design trend is by far the most prevalent technique used today. The uni-body has no chassis frame underneath the body to hold the components together. Instead, the unitary body design actually uses the floor, posts, doors and roof to hold the car together. This is accomplished by using reinforcing techniques for the roof rails and posts and by adding strengthening creases in the floorpan to make the uni-body a sort of rolling truss. (See Figure 1.1.)

In a roof truss in building construction, the roof and floor may be under tension or compression, depending on the situation. A similar situation will exist in vehicle construction. This fact explains why it is essential to completely stabilise a vehicle prior to carrying out any cutting or spreading techniques.

Inserting step blocks or other suitable cribbing under the car not only prevents the car from moving during the extrication but also prevents it 'relaxing' in place when the roof posts are severed. Uncontrolled settling of the vehicle raises the chances of placing even more pressure on the trapped casualty.

### 1.2.2 Full Frame Design

The full frame design is found mostly on light trucks, vans and four-wheel drive vehicles such as the Mitsubishi Shogun etc. When a full frame chassis is used, two steel rails provide the support to which the floor, suspension, drive train and body are attached. Although a full frame gives the vehicle good support, it is still essential to stabilise all such vehicles prior to performing rescue techniques.

### 1.2.3 Space Frame Design

Several concept and production vehicles have been designed using a space frame method.

The frame on these vehicles resembles a cage on to which the body panels are attached with either fasteners or adhesives. The bodies of these vehicles are designed for appearance and to protect the passengers from the elements unlike other designs, not to support the overall structure. Therefore, it may be necessary for

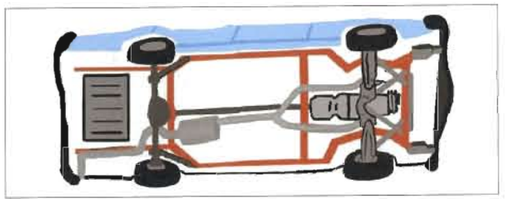


*Figure 1.1 Use the strengthened areas to assist when stabilising.*

rescuers to remove body panels in order to expose the metal structure that is actually trapping the casualty.

To date, the materials used to construct space frames have been metal. However, all-plastic space frames have been successfully crash tested, making the technology available today. (See Figure 1.2.)

Low volume sports cars and especially kit cars are the predominant vehicles seen on the road with space frames.

## 1.3 Designed Strengths

The vehicle crumple zones and the Crash Impact Absorbing Structure (CIAS) of modern vehicles provide the first point of protection. When the "G" forces increase and the damage starts to intrude into the passenger cell, the other systems, such as seat belts (primary restraint) and Supplementary Restraint Systems (SRS), will offer protection to the seated occupants.

The safety of the occupants is reliant on the passenger cell strength, but the body panels are designed to deform in a controlled manner, thus dissipating the energy of the collision away from the seated occupants, and absorbing the forces of the collision.

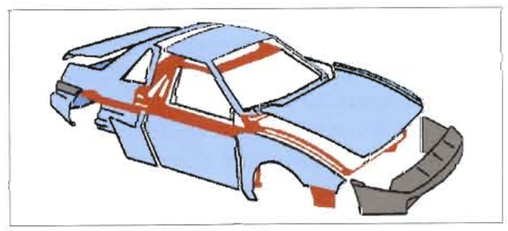


*Figure 1.2 Beware of Carbon Fibre*

## 1.4 Posts and Pillars

Older vehicles have posts/pillars made of rolled sheet metal, with reinforcements at both ends, leaving a single thickness of metal at the centre. This provides an ideal place to cut.

Newer vehicles have much thicker posts/pillars, often with strengthened steel inserts and SRS components hidden inside. **For this reason internal trim must always be removed to ascertain the location of such components before attempting to cut pillars.**

## 1.5 Roofs

The roofs of most cars are framed by hollow rolled sheet metal of a heavier gauge than the skin of the car. The sides of the frame are known as 'cantrails' with the front and rear edges known as 'header rails'. This frame provides some roll-over protection to the passengers, but is dependant on the strength of the posts. Across the opening in the frame, you may find pressed sheet metal ribs that furnish the rigidity for the sheet metal skin that covers the exterior of the entire assembly.

## 1.6 Doors

Doors on a vehicle are designed for easy access and egress to the passenger compartment. When the vehicle is involved in an accident a jammed door presents one of the most challenging rescue evolutions.

It is important for the rescuer to consider a door as an assembly with characteristics that can be used to favour the rescue.

### 1.6.1 Traditional construction

Each skin is made of a thin piece of stamped sheet metal that is bent and creased and pre-drilled to provide a housing for the other door components. Inside there is an increased use of additional strengthening beams that usually extend from the latch area to the front of the door between the hinges. These are made of heavy gauge sheet metal to form a beam, or heavy gauge tubing to form the crosspiece that becomes the side impact protection. The inner skin is the target when using hydraulic spreaders to force open a jammed door. If the spreader tips can be placed between the inner skin and the door jambs, the door can usually be opened simply by spreading open the gap.

### 1.6.2 Modern Construction

Some modern vehicles do not have an "inner skin" as such, but have a structure similar to a picture frame. There is a vast hole in the panel into which a semi-structural "cassette" (usually plastic) is inserted. This cassette carries all of the inner door components except the outer handle (on the outer skin) and the latch itself.

Latch locking mechanisms for doors have a variety of different designs. All designs have a common aim to close the door snugly into the aperture and, when necessary, be able to lock it in place. Another feature is the 'anti-burst' capability. This is to prevent the door flying open when the vehicle is involved in a collision. (See Figure 1.3.)

## 1.7 Steering Wheel and Column

Today the column has evolved into a variety of assemblies of rods, tubes and pressed structures. These are designed to collapse in a controlled manner on impact. Some modern columns even have pyrotechnic devices to change the collapse behaviour in different types of crashes. The upper steering column often provides a mounting for the ignition lock and switch, and various stalk switches for the horn, wipers, lamps etc. Therefore, performing an action on the steering column could result in some surprises, such as having the car's engine start during steering wheel displacement.

Disconnection of the battery prior to this evolution is imperative.

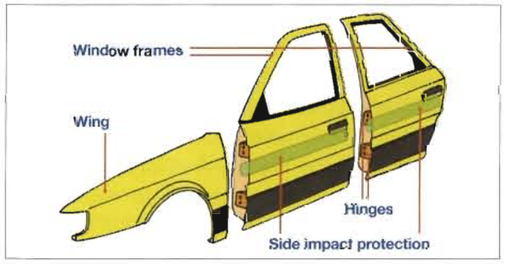



*Figure 1.3 Side Impact Protection.*

If the car is equipped with a tilting mechanism in the steering column, the joint will be the weakest part, which will break easily if pressure is applied above the joint.

In cars with front wheel drive, a joint in the column may be found at the floorboard inside the passenger compartment. This joint can cause problems if attempts are made to relocate the steering column. The lower portion of the column may press into the casualty, causing additional injury. Also in many cases, the column has broken free of the dash assembly and remains pivoted freely at the joint.

Because of this potential for further casualty injury, it is no longer desirable to relocate the steering column in a front wheel drive vehicle by using a pulling technique. It is generally more advisable to use a dash roll up manoeuvre to free a casualty trapped by the dash or the steering column.

## 1.8 The Engine

### 1.8.1 Fuel Systems

The fuel tank of modern cars may be found anywhere in the vehicle, including directly behind or even between the front seats. The rescuer should never assume that the tank is directly underneath the boot of the car. The tank may or may not be vented to the outside. It can be constructed of metal, plastic and kevlar as manufacturers have addressed the problem of fuel tanks rupturing during a collision. However, the fuel tank should always be considered as a primary hazard.

Most vehicles now use electric fuel pumps to transfer the fuel from the tank to the engine intake system. These fuel pumps can continue to supply fuel under pressure after a collision or during a vehicle fire. Some manufacturers have installed an inertia emergency shut off switch that interrupts the electrical supply to the pump in a collision.

Most vehicles use two fuel lines to transfer fuel between the fuel tank and the engine. One line transfers the fuel from the fuel tank to the engine, whilst the other line is used to return the unused fuel back to the tank. Fuel hard lines are commonly steel pipe but aluminium may be encountered. They always have a flexible joint at the engine

because the engines rocks around on its mountings. There is often a flexible joint at the tank end to aid assembly

### 1.8.2 Potential fuel tank locations

There has been a significant trend in recent years to move the fuel tank from under the boot (behind the rear axle) to under the rear seat (in front of the rear axle) to reduce the risk of rupture in rear impacts.

In fact, the vast majority of cars have the fuel tanks under the rear seat but there are always exceptions and they can still be found in the following locations:

- under the floor of the boot
- within the boot
- at the back of the rear seat, within a rear wheel well
- under the vehicle, between the axles.
- between the front seats

### 1.8.3 LPG Fuelled Vehicles

#### 1.8.3.1 General

Approximately 5% of vehicles in the UK are fitted with LPG fuel systems. Invariably the storage tanks (which may contain up to 200 litres of fuel) are located in the rear section or boot compartment of vehicles. However, they may be located in the engine compartment, alongside the wings or in the cargo space immediately behind the front seats in commercial vehicles. There may also be more than one tank.

Currently, there is no legislation governing the fitting of alternative fuel systems to motor vehicles and therefore they may be fitted in the following ways:

- Factory fitted systems.
- Vehicles converted post delivery by approved specialists.
- Vehicles converted by non approved installers.
- Systems installed by individuals using DIY kits.

It is not correct to assume that professionally installed systems are usually relatively easy to identify. There is a voluntary system which provides a green sticker for the vehicle but even if this is provided there is every chance that it would have been destroyed early on in a fire. It is also incorrect to believe that there will be a secondary fuel filler located elsewhere on the vehicle. Some Volvo models install the LPG filler behind the alternative fuel filler. Only one outer filler cap is provided.

**NOTE: Until determined otherwise, all vehicles involved in fire should be treated as alternative fuelled vehicles.**

#### 1.8.3.2 Hazards

A professionally installed system should be fitted with a pressure relief valve. In the event of a fire and the valve operating correctly there will be a powerful jet of flame 5–7 metres in length which will pulse from the relief valve for up to 20 minutes, depending on the amount of LPG in the tank. Any pulsing or constant flame from a pressure relief device is likely to project from the front or rear of the vehicle, dependant on the location of the storage tank. This flame will pose an obvious risk to firefighters who should only approach from the vehicle sides if necessary.

Regardless of the system involved, the main hazard presented to firefighters, at fires involving vehicles fitted with LPG fuel systems, is the possibility of the tank undergoing a Boiling Liquid Expanding Vapour Explosion (BLEVE).

A BLEVE can occur when an LPG tank is subjected to heat from an external source. It is more likely to happen if the system has been fitted by an individual using a DIY kit, or by a non approved installer, as there may not be a pressure relief valve fitted to the system. However, even with a pressure relief valve fitted to the system and operating correctly, it may not prevent the tank from rupturing.

The LPG tank can withstand a build up of pressure so long as the metal retains its strength. Even with continued relief valve operation the liquid level drops, exposing greater areas of the metal to heat. Flame impinging on the dry wall of the tank will create temperatures high enough to weaken the metal, leading eventually to failure of the tank. This is immediately followed by the release of boiling LPG liquid, the effect of which is the flash evaporation of the liquid. Ignition of the expanding vapour cloud creates a blast, flash and fireball. The cylinder fragments may be propelled over 200 metres.

**NOTE: It is possible for a tank correctly fitted with a Pressure Relief Valve (PRV) to still rupture. If there is direct localised flame impingement on a cylinder then the vapour will be expanding at a far greater rate than the PRV can vent.**

#### 1.8.3.3 Suggested Operational Procedure

Mobilising Centres should ascertain as much information as possible regarding the fuel type of any vehicle fire on the initial emergency call.

On arrival at the incident appliances should be parked at least 20 metres from the vehicle involved. This will provide protection should the PRV operate. However, this will not be far enough should the tank rupture. Evidence suggests that fragments of an exploding tank can travel up to 200 metres.

Prior to committing crews into the risk area the Incident Commander must undertake a dynamic risk assessment and gather as much information as possible from the respective owner or driver of the vehicle (if available), to ascertain if the vehicle involved is fitted with an LPG system.

If the vehicle is fitted with LPG, jets should be applied from behind any available cover, which provides effective shielding. Consideration should also be given to the use of ground monitors.

It is essential to provide immediate cooling to the LPG tank to prevent a BLEVE occurring. Care should be taken not to extinguish any jet following actuation of the pressure relief valve, as this will allow a flammable gas cloud to develop. Water applied to the LPG tank should be continued until all the LPG has been exhausted or the pressure relief valve has been reset. Covering jets may be applied to prevent fire spread to other areas.

If the vehicle is not fitted with an LPG installation, the Incident Commander may allow firefighters to approach the vehicle to tackle the fire in the normal way.

When tackling any vehicle fire, appropriate PPE and RPE, consisting of full fire kit and breathing apparatus, must be worn.

Due to the possibility of flame projection from the front or rear of a vehicle fitted with LPG and the risk of other projectiles, firefighters should approach from the **side of the vehicle utilising any shielding available** if possible.

Whilst using cutting equipment during rescue operations at Road Traffic Collisions, there is a risk of severing LPG fuel lines, which have been routed (either professionally or by DIY installers) via the sills. There are still some vehicles on the road that have LPG fuel systems fitted with a manual shut off device, this is usually located in the engine compartment, and actuated prior to performing any cutting operations. Failure to isolate the system will result in the free flow of LPG, creating a flammable gas cloud. More common are LPG fuelled vehicles fitted with automatic shut off devices. These are normally found as part of the engine management system and backed up with systems fitted as integral parts of the tank (as soon as the engine stops the fuel is shut off). These are further backed up with valves that operate to shut off the fuel if there is excess flow. (more flow than would be normal to fuel the engine).

Guidance on the garaging of such vehicles can be found in HELA Local Authority Circular LAC52/6 Garaging of Liquefied Petroleum Gas Fuelled Vehicles, Mechanical Handling and Maintenance Equipment (available at http://www.hse.gov.uk/LAU/LACS/52-6rev.htm

## 1.9 The Seats

The front seat base part has a metal "anti-submarine" pan, with pressed, metal parts all around, tubes are rare, steel wires non-existent. The front seat back may have a tubular cross piece at the top, and maybe one lower down, but the main side structures are usually pressed steel. Some seats still have steel wires across but plastic mesh systems are becoming more common instead.

Rear seats historically used to be less substantial than front seats, but recent changes in legislation for luggage retention and for 3 point centre seat belts mean that rear seats are much stronger now and in some vehicles may be even heavier than front seats.

### 1.9.1 Adjustments

The front seats are designed to have a range of adjustments to suit different drivers/passengers and to provide access to the rear seating:

- Forward and reverse travel.
- Pivot or folding back (two door).
- Reclining seat back.
- Height adjustment.
- Lumbar support.
- Seat base tilting.

On some executive and sports models, several of the above adjustments can be powered by the vehicle electrics. The rear seats can be fixed fully or partially folded to allow access and provide extra space from the vehicle boot area.

Some vehicles are fitted with adjustable/removable head restraints. In addition, electric folding rear seats are starting to be installed in high spec vehicles.

## 1.10 Battery Locations

The most common battery location is in the engine compartment of most passenger vehicles, however it is important to be aware that some vehicle manufacturers use alternative locations, such as:

- under rear passenger seats
- in the boot
- in the front wheel arch
- Under front seats, (especially in 4×4 vehicles)

It should be noted that it is possible for vehicles to have more than one battery.

## 1.11 Standard Terminology

### 1.11.1 Basic Vehicle Terminology

Figure 1.4 illustrates basic vehicle terminology.

### 1.11.2 Vehicle Construction terminology

To ensure that everyone understands commands on the extrication scene, standard terminology should be used where possible. Use terms such as "driver's side" and "passenger side" instead of "left" and "right"

**Note:** the terms "pillars" and "posts" tend to be used for the same meaning. Generally, start naming the posts/pillars from the front of the vehicle, i.e., screen post "A". (See Figure 1.5.)

## 1.12 New Vehicle Technology

### 1.12.1 Introduction

Recent legislation, together with consumer pressure, has focused vehicle manufacturers into taking action to protect the occupants of their motor vehicles.

This massive development in the area of vehicle safety construction has meant that both extrication techniques and equipment have had to change in order to keep up with advances in the motor industry. Obviously certain advancements in construction will impact on the rescue services more than others, but the distinct differences in the way vehicles are now built have a direct impact on successful vehicle rescue.

Modern vehicle rescue techniques have been designed to work in conjunction with new car technology, but the capability of the rescue tools employed at the scene of an incident must be considered before utilising a specific technique. Bearing in mind that vehicle extrication holds certain risks, it must always be remembered that in all actions taken, the balance between safety and efficiency has to be found. Training allows the process of risk identification and mitigation to become easier. (See Figure 1.6.)

Side impact reinforcements bars can lead to door removal difficulties when involved in frontal impacts. (See Figure 1.7.)

Boron rod reinforcements in the dashboard area may affect techniques, such as "dash board roll"



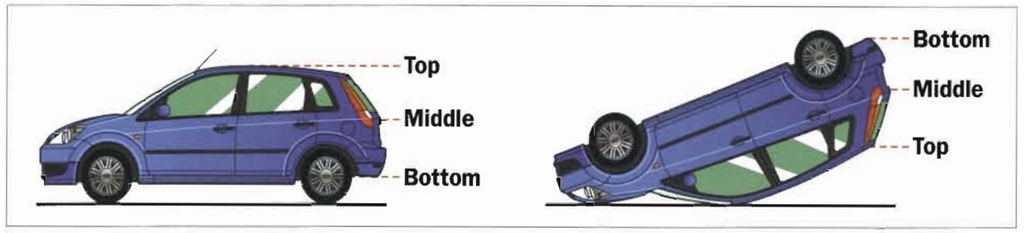



*Figure 1.4 The orientation of the vehicle does not affect the terminology.*

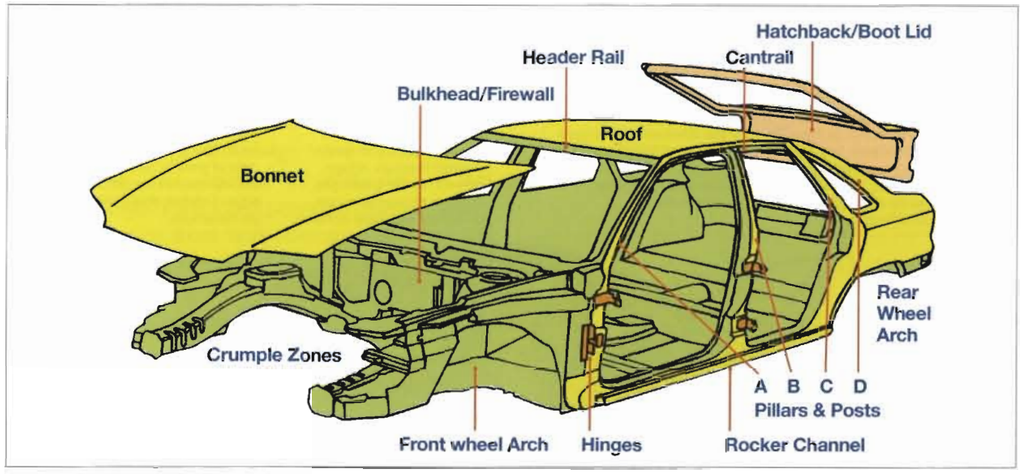



*Figure 1.5 Vehicle construction terminology.*

and "dash lift", not to mention cutting through posts and pillars. (See Figure 1.8.)

### 1.12.2 New Vehicle Technology

Unlike understanding human anatomy, understanding the anatomy of safety improvements is an ongoing process. Safety features vary widely from year to year in their design and placement amongst makes and models. For this reason it is essential for rescuers to know how these safety improvements may affect their every day rescue operations. (See Figure 1.9.)

### 1.12.3 Safety Systems

Motor vehicle manufacturers use two types of safety systems in their vehicles to protect the occupants.

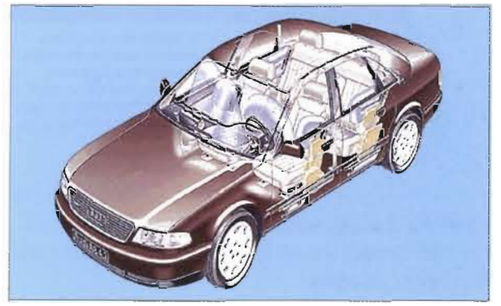


*Figure 1.6 Safety, efficiency and cost affecting vehicle design.*

#### 1.12.3.1 Active safety systems

Active safety features refer to measures taken to avoid an accident and can be functioning the whole time the car is being driven, active safety features include:

*Figure 1.7 Side Impact Bars.*

*Figure 1.8 Dashboard reinforcement.*

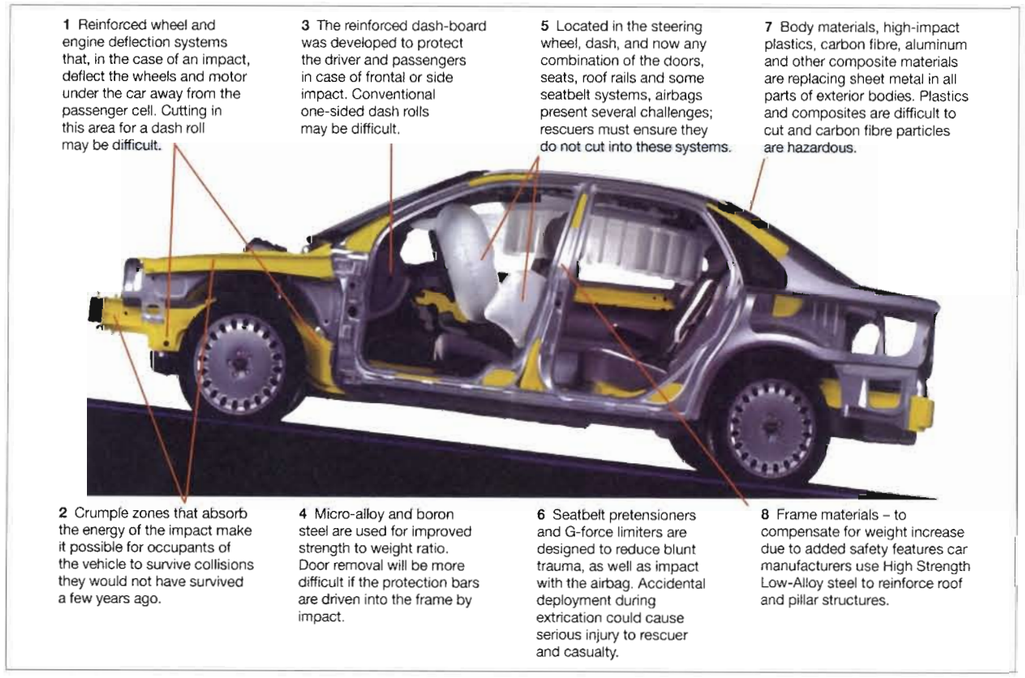



*Figure 1.9 Some standard safety improvements.*

- Power steering
- Anti-lock braking system
- Traction control
- Independent suspension
- Tyre technology
- Variable intermittent wipers
- Visibility

### 1.12.3.2 Passive safety systems

Passive safety features refer to measures taken that are designed to alleviate the consequences of an accident, such as supplementary restraint systems and may include:

- Driver and passenger airbags
- Side and curtain airbags
- Front and rear crumple zones
- Side impact bars
- POP UP rollover protection devices
- Seat belt tensioners/G force limiters
- Collapsible steering column
- Laminated Glass
- Steering Wheel and fascia padding.



As passive safety systems have a direct bearing on casualty survival and vehicle rescuer's safety, these elements will be considered in detail.

### 1.12.3.3 Airbags

Front Impact Airbags: designed to deploy in the event of a frontal impact, these bags are commonly located in the steering wheel and various dashboard locations. All airbag systems are not alike but do contain similar components.

### 1.12.3.4 Traditional Front Impact Airbags

Developments have provided different solutions. Gas restraint bags or airbags were developed by Mercedes in 1967. Airbags are safety devices that have saved many lives and prevented serious injury to the driver or front seat passenger of a vehicle involved in a full frontal or near frontal collision.

A typical air bag restraint system is located on the driver's side in the steering wheel hub or sometimes on the passenger side underneath a plastic bolster on the dash. If the vehicle is fitted with an airbag, it is usually marked on the screen and/or the steering wheel; 'SRS' (Supplementary Restraint System). (See Figure 1.10.)

At the time of impact, the air bag is rapidly inflated with nitrogen. The nitrogen is generated pyrotechnically when sensors detect an abrupt deceleration between set limits. Initiation causes a pellet of sodium azide to burn and produce enough nitrogen to inflate the bag. The following sequence of events take place when an air bag system is deployed.

**(a) The Incident**
The sensors detect the full frontal or near frontal impact and react to the negative 'G' Forces imposed by the collision. If two of the sensors detect the impact, they send an electronic signal to the initiation mechanism.

Figure 1.11 shows typical impact angles at which the airbag may be activated.

**(b) Initiation**
The initiation mechanism receives the signal to burn and ignites the rapid burning sodium azide.

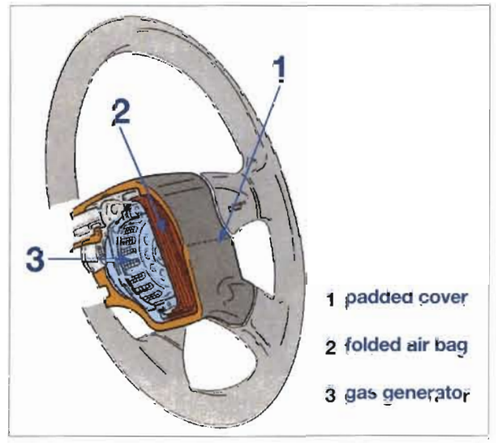



*Figure 1.10 Steering Wheel Air Bag arrangement.*

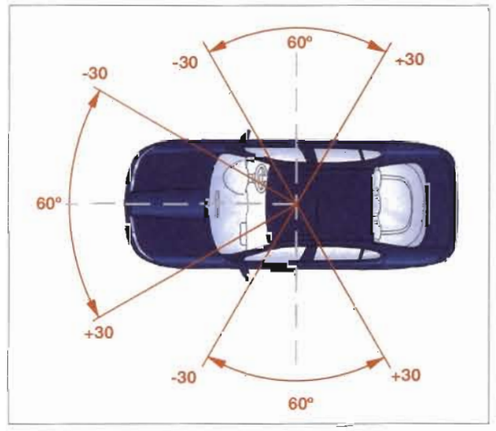



*Figure 1.11 Typical Angles of Airbag Activation.*

**(c) Gas Generation**
The sodium azide ignites and immediately produces the nitrogen required to fill the air bag rapidly.

**(d) Deployment**
The airbag is pressurised with gas which causes the cover to rupture along pre-defined lines and the bag emerges and fills. The occupant loads the airbag causing it to vent and thereby cushioning the impact. Figure 1.12 shows the airbag deflating after the vehicle has rebounded.

**(e) Deflation**
Once the air restraint system has done its job, the nitrogen is exhausted through vents either in the

*Figure 1.12 Airbag Deployment.*

rear of the bag or in the steering column. Inflation and deflation of the air bag are over in a fraction of second.

The driver is in contact with the air bag only for a moment while the collision is still in progress. Before he/she has time to look up, the air bag has already deflated.

### 1.12.3.5 Driver and Passenger Airbag Deployment

Figure 1.13 shows the main stages of air bag deployment.

### 1.12.3.6 SRS Airbag (Deployed)

One safety concern for emergency personnel, that arises when a system has activated, is direct skin contact with the deflated air bag itself. A chalky white powder will be found on the bag. This powder is slightly alkaline and, although considered non-toxic, it may cause minor irritation to an individual's skin, nose and eyes.

Manufacturers claim that the inflation chemical (sodium azide) will not be present once the bag is deployed.

It is possible to cut away a deployed bag. If this is done, the bag should be placed in a plastic bag and disposed of properly.

**Never tamper with the unit.**

There may be traces of sodium azide or potassium nitrate present – both are highly flammable and poisonous.

### 1.12.3.7 SRS Airbag (Not Deployed)

The first priority is to recognise that a vehicle is equipped with an Air Bag System. Once this has been established, the air bag should be disarmed. This is achieved by disconnecting the negative side of the battery. At this point, the SRS Air Bag is not completely disarmed.

A capacitor, used to deploy the bag in case of an electrical failure, can still fire the system. However, this loses its charge within about two minutes on most vehicles (note, earthing both battery terminals may discharge the capacitor immediately).

Rescue efforts should not be unnecessarily delayed waiting for the decay of the charge. But rescuers should remain clear of the immediate area of the bag. The chances of inadvertently triggering a bag operation are not great. However, rescuers should never place themselves between the system and the casualty, nor place any object near the airbag that could become a projectile until disarming has been effected.

### 1.12.3.8 Modern SRS Systems

The traditional air bag system has been considered in some depth; it is also important to be familiar with the new (post 2003) generation of SRS systems, as several aspects differ:

- All the latest generation airbag systems are interlinked with the vehicle electronic control unit. Some are inflated by a stored pressure gas cartridge which may be further energised by using reacting gases, such as hydrogen and oxygen.
- Front seat sensors determine if the passenger seat is occupied and may also provide information about the driver and passenger weight and proximity to the airbag.
- Multi stage airbags may deploy as appropriate depending on the severity of the crash, the weight of the occupants and their proximity to the airbag. If the crash is severe and the

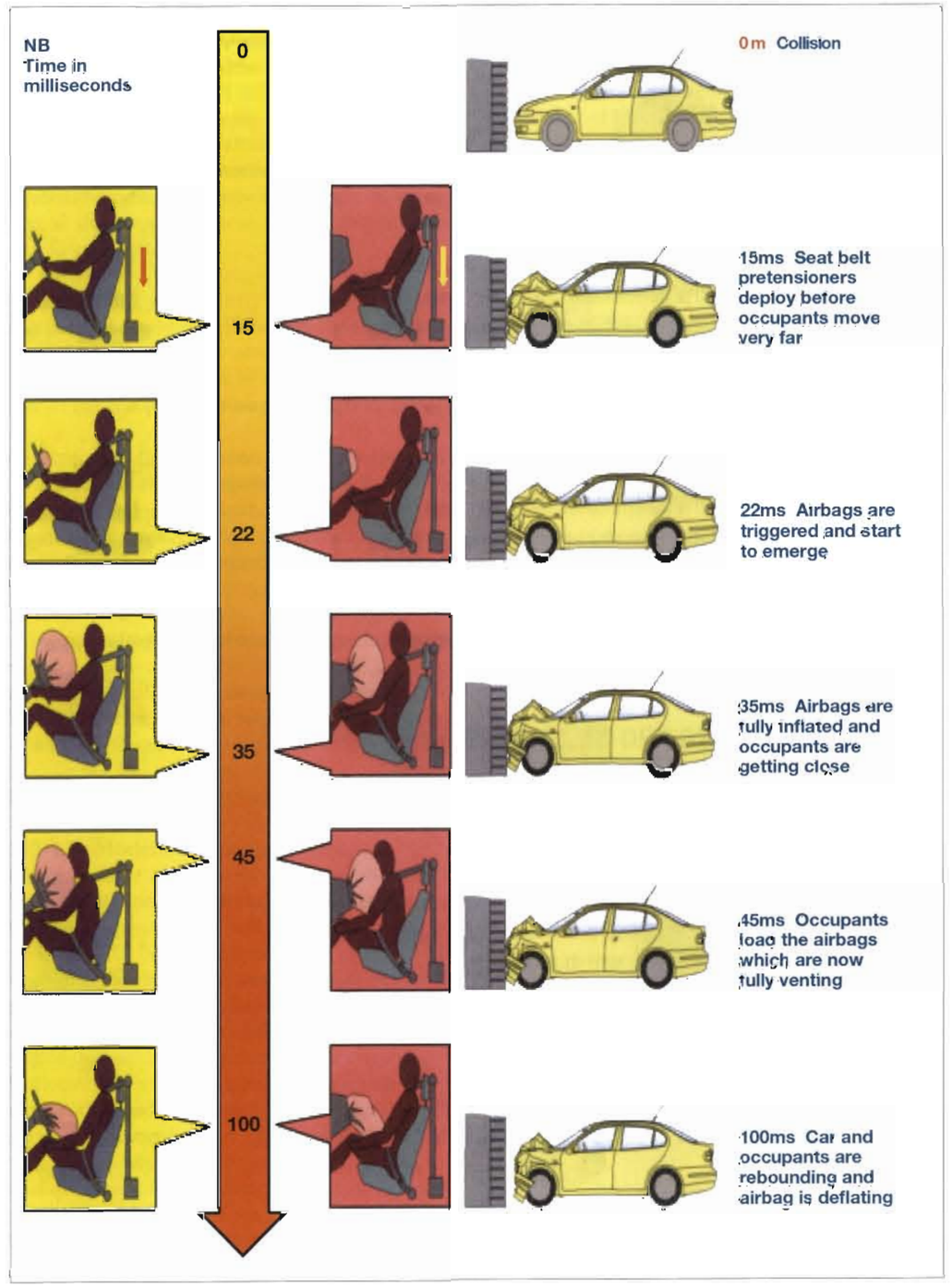



*Figure 1.13 Sequence of Airbag Deployment.*

occupant heavy, the system will deploy in its most powerful manner. If the crash is minor, possibly just the pretension seat belts will deploy. There are a range of alternative ways in which the system may respond to these variables.

- Most vehicles use the ECU to trigger the fuel cut off and a small number also trigger a battery disconnect.

An aide mémoire for SRS can be found at Appendix 3.

### 1.12.3.9 Summary of SRS Protocol

Consideration should be given to:

- Vehicle battery leads should be disconnected as soon as practical, at the scene of an RTC.

  (SRS capacitor discharge times vary greatly with differing vehicle manufacturers, so early disconnection is advisable.)
- Remember the 5,10,15,20 rule
  - 5 inches clear of Side (lumber) airbags
  - 10 inches clear of Driver airbags
  - 15 inches clear of Curtain airbags
  - 20 inches clear of Passenger airbags
- Tear away interior fittings before making cuts.

***On Scene:***

- Survey the vehicle internally and externally for signs of hazards.
- Do not enter the passenger cell until hazards have been assessed (do not delay medical attention unnecessarily).
- Personnel entering the passenger cell must remain outside the deployment range of the un-deployed airbags.
- Avoid using radios inside the crashed vehicle.

## 1.12.4 Seat Belt Pretensioners

The sudden deceleration of the vehicle caused by a frontal or offset front impact is sensed by either a mechanical or electronic sensor. Typically mechanical sensors will be integrated into seat belt pretensioner and electronic sensors will be shared with the airbag system in the ECU. The sensor triggers the unit very early in the crash and is designed to deploy before the occupant wearing the seat belt has moved forward in the seat. The amount of webbing that is pulled in varies from about 60mm to about 150mm.

**Locations**

The seat belt pretensioner may be mounted in two different locations:

**Buckle pretensioner on the seat**

This pulls the buckle downwards, thereby tensioning both the lap and diagonal parts. The height of the buckle is a poor indicator of deployment. Some reveal a coloured flag once deployed, others compress the convoluted cover around the tension cable.

**Retractor pretensioner in the B-pillar**

The pretensioner may be located in the retractor (spool), which pulls the diagonal belt up towards the loop on the B-pillar.

There are a wide variety of different types of retractor pretensioner.

The solid propellant which burns to produce hot gas may provide motive power to the belt in a number of ways.

One common type uses a propellant charge to force a number of balls round a gear on the belt spool, reeling in any slack in the belt. (See Figure 1.15.)

In another type, the hot gases from the propellant drive a tiny gas turbine which is geared down onto the belt spool.

In a third type, three devices are triggered in succession, thus rotating the Wankel rotor and reeling in any slack in the belt. (See Figure 1.16.)

There are also two types of piston & cable systems for retractor pretensioners. The first has a vertical firing tube integrated into the retractor body. A piston is fired along the tube, pulling a cable that is wrapped around the retractor spool. This pulls in the slack from the belt.

The second type is similar in concept, except the firing tube is remote (often located further up the B-pillar) with sleeved steel cable linking the firing tube to the retractor. These firing tubes may be very long (300mm+)

Some modern vehicles may have both retractor and pretensioner types fitted for the front seat occupants. The actual amount removed also depends on the slackness of the seat belt and the bulk of the occupants clothing.

Some rear seat occupants are also beginning to get retractor mounted pretensioners.

**Types of actuator**

The pretensioner in a modern vehicle will almost certainly be a pyrotechnic system, but some early devices were powered by strong springs. The spring powered systems were always mechanically sensed and operated on the buckle only. After the spring system has been activated the seat belt buckle is prevented from being pulled back up to its original position by a ratchet system.

**Types of sensor**

### 1.12.4.1 Mechanical sensing system

Although mechanical sensing is almost completely phased out, there are still a few mechanically sensed spring buckle pretensioners and a large number of mechanically sensed pyrotechnic seat belt pretensioners in service. Of the mechanically sensed pyrotechnic systems, there is about an even split of the buckle type and the retractor type.

Mechanical sensed systems of all types tend to deploy in all crash types (front, side, rear, and rollover) but this is not always absolutely true, so do not rely on this occurring.

The pretensioner is independent from the airbag system. There will be circumstances where one system may activate and the other may not.

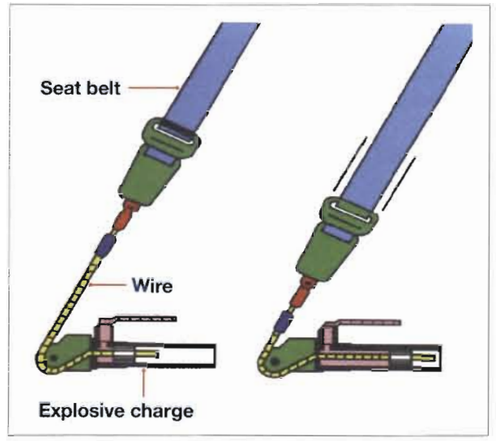



*Figure 1.14 On collision, the seat belt is tightened by means of a wire connected to a piston which is pushed along a track by a small explosive charge detonating.*

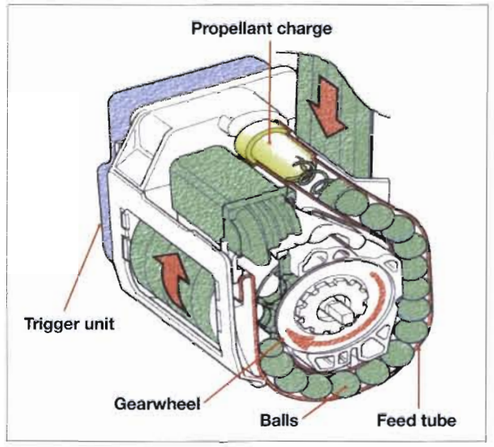



*Figure 1.15 Single Charge system.*

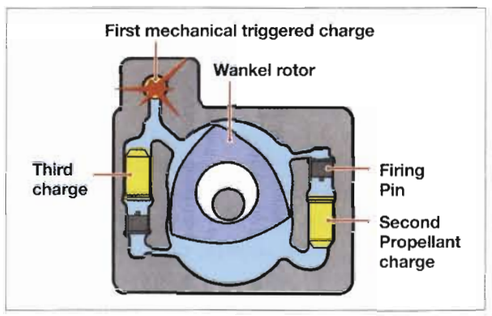



*Figure 1.16 Multiple Charge system.*

This will be, typically, in marginal cases where the impact severity is relatively low. It is also possible in marginal cases for only one pre-tensioner to activate. (See Figure 1.14.)

***Mechanical Sensor Arming/Disarming***
The mechanical sensed system may be armed or disarmed in a wide variety of ways depending on type.

Some mechanically sensed retractors are armed as they are mounted, with the fixing bolt operating an interlock. Some have a "butterfly" catch that arms and disarms whilst in position.

The buckle pretensioners with mechanical sensing may have an interlock which keeps the buckle armed at all times except when the seat tracks are unlatched to adjust the seating position. This action automatically disarms the pretensioner until the seat tracks are re-latched.

### 1.12.4.2 Electrical Sensing System

There are a number of different electrical sensing systems, almost always integrated with the airbag system and all operate pyrotechnic pretensioners. The method of disarming them is the same as for disarming the airbag system, with the same cautionary points regarding capacitor back-up power.

### 1.12.4.3 Summary of operational procedure

There are several locations for the pretensioning systems, lower B post, mid B post, upper B post, inner track of front seat, outer track of front seat with cable to buckle, front of front seat with cable to buckle. At rear seat, the locations may be: rear parcel shelf, Rear seat back (for centre occupant), C-pillar.

### 1.12.4.4 G-Force Limiters

G-Force reduction systems (or load limiters) are installed in some vehicles. These allow the gradual deceleration of the seatbelt wearer, reducing the chances of internal injury during the "third impact" of an R.T.C.

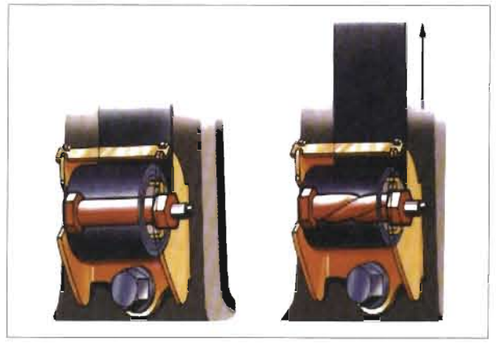


*Figure 1.17 Centre Shaft Type.*

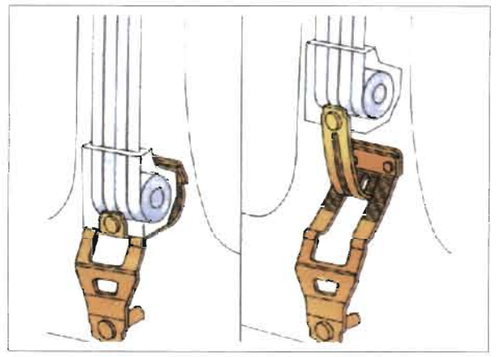


*Figure 1.18 Mounting Tearing Type.*

These may include:

- A "slipping clutch" on the spool shaft.
- A centre shaft which twists under load (See Figure 1.17)
- A portion of the belt mounting which tears away under load (See Figure 1.18.)
- Other variations of these systems exist.
- All systems allow the belt to "give" under load.

The load limiter actuates after the seat belt pretensioner, typically when the airbag is in contact with the occupant, thereby limiting chest injury.

## 1.12.5 Side Airbag Systems

Side impacts result in high mortality rates as there is so little space between the outside of the vehicle and its occupants. To try to combat this problem several systems have been developed, which may be divided into 2 distinct groups: Thorax protection and head protection.

### 1.12.5.1 Thorax Airbags

The thorax airbags are intended to protect the side of the chest inside impact, although there are some variations on this. These airbags are quite small but deploy very quickly, much faster than frontal airbags. They use very energetic inflators, often with compressed reactive gases which get very hot. The airbags are found in two main locations:

***Seat***
The seat mounted thorax airbag is found on the outboard side of the seat back. It may have a moulded plastic cover, or it may be under the cloth or leather cover of the seat, so deploys through a specially weakened stitched seam. Either type should have a marking to show its presence.

There are some variations on the seat mounted thorax airbag, but to date these are rare. There may be a lower, "pelvis" airbag, or a higher, head restraint mounted head airbag.

*Figure 1.19 Seat and Side Cushion Airbag.*

Another variant is becoming popular on some convertible vehicles. They use a large thorax airbag which also extends up, forward of the armpit, then backwards again to add head protection.

***Door***
The door mounted thorax airbag is much larger and is found near the waist rail. The system must cope with the seat in all positions, so deploys as a large "sausage" along the door.

### 1.12.5.2 Head Airbags

Head protection airbags come in two popular types in addition to the rare head restraint type and the head/thorax combined system in convertibles.

These are:

***Inflatable tube head airbag***
This system has a tube shaped airbag which extends from the top of the B-pillar and angles downwards towards the end of the dashboard. It is packaged in the cant rail area and deploys downwards to get into its working position. This system is usually unvented.

There may be a second tubular airbag which covers the rear seat occupant in a similar way.

***Curtain airbag***
This is becoming more popular than the tube airbag. It uses an inflatable curtain which like the tube, emerges from the cant rail downwards. However, the curtain is much larger and extends from the cant rail downwards as a continuous "barrier", rather than having a gap above like the tube. The curtain almost always covers all the seating rows, unlike the tube which normally covers just one. The curtain has multiple chambers which vent into each other, rather than out into the car.

Both the tube and the curtain airbags stay inflated for several seconds, to protect in rollovers (which may last several seconds). Inert, the inflation gas is cold (unheated) otherwise it would melt the airbag. For this reason, inert compressed gas cylinders tend to be used to inflate the airbags and these cylinders can be a hazard to rescuers if severed during a roof removal.

### 1.12.5.3 Side Airbag Sensing Systems

***Electronic Sensing***
The side airbag system is usually sensed using an electronic sensor which sends signals to the

ECU, which then sends an electric firing signal to the airbag. The electronic sensors fall into two categories:

- Accelerometers – these may be mounted on the sill, on the lower B-pillar or sometimes on the front seat cross member. Sometimes they may be mounted on the seatbelt retractor frame.

- Pressure transducers – these are mounted in the door and effectively monitor the volume of the door interior. If a vehicle hits the door, the door volume reduces and the pressure goes up. The transducer sends a signal to the ECU.

The method of disarming electronic sensed side airbags of all types is the same as for disarming the frontal airbag system, with the same cautionary points regarding capacitor back-up power.

***Mechanical Sensing***

Some simple systems, such as the older Volvo S.I.P.S. airbags use a mechanical/pyrotechnic impact sensor.

In the event of a side collision, a pressure plate pushes a firing pin and releasing the ignition charge. Again, these fall into 2 groups:

- Door mounted sensor, firing tube, and airbag.

- Sill mounted sensor and firing system with a firing tube that leads up to the seat mounted airbag. The pyrotechnic sensor systems usually have some sort of disarming interlock.

Such systems should be treated in a similar way to mechanically sensed frontal airbags and belt pre-tensioners.

#### 1.12.5.4 Sensor Unit

The sensor unit is located in a sensor mount at the outer end of the forward S.I.P.S. tube. The mount is the part of the chair that protrudes the most toward the inside of the door.

A pressure plate is mounted forward of the sensor unit. When a collision occurs it is the pressure plate which transfers the force from the inside of the door to the sensor unit.

#### 1.12.5.5 Dealing with S.I.P.S. at a vehicle rescue incident

If the S.I.P.S. bag has been activated then there is no problem dealing with the hazard, except to cut away the exposed bag if it becomes cumbersome.

Because the airbags are separate in operation, after a collision there may be an inactivated front or side bag in the vehicle.

The inactivated S.I.P.S. and S.R.S. bags must be made safe if any cutting or metal displacement is to be achieved within the front passenger compartment. The easiest and quickest way is to disconnect the battery, which will render the system inoperative. The S.I.P.S. bag has no integral stand-by power unit, unlike the steering wheel and passenger air bag, so battery disconnection will eliminate any accidental activation of the airbags. However, due care should still be shown especially if cutting into the upholstery of the front seats.

### 1.12.6 Roll Over Protection Systems (ROPS)

Active rollover devices are generally only found in certain convertible vehicles. They can operate with explosive force away from the bodywork of the vehicle.

These devices, when un-deployed, present serious risk of injury to rescuers if in close proximity.

The dangers posed to the rescuer cannot be over emphasised.

ROPS deploy at very high speeds and with very high forces that can cause serious injury. The direction of deployment is not always apparent from outside the vehicle.

There are two main types in production:



#### 1.12.6.1 Rotating Bar

These devices protect all the occupants and are generally stored behind and around the rear of the seats. The bar may be mistaken for part of the "soft top" mechanism. An example of this is the Mercedes SL. (See Figure 1.20.)

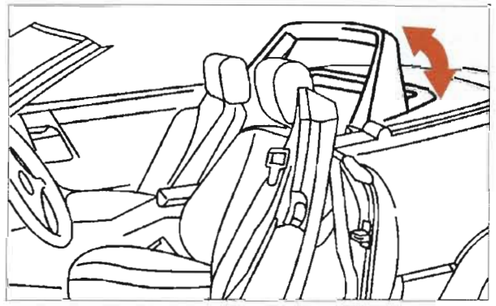


*Figure 1.20 Rotating Bar*

#### 1.12.6.2 Pop-Up Roll Bars

These devices are mounted behind each seat and protect the head of each occupant. They normally deploy at the same time as each other. Some devices are electric, some spring loaded and some


*Figure 1.21 Pop-Up Roll Bars.*

are pyrotechnic. Sometimes the devices are visible as "head restraint" bars, sometimes not. Figure 1.21 shows an example of the visible type.

#### 1.12.6.3 Specific Danger To Rescuers

The specific danger of these devices is to rescuers who may be supporting the head and neck of the casualty from behind, or when removing a casualty on a spine board etc.

This is particularly hazardous when the vehicle is on a slope, especially a lateral slope and the vehicle is close to rolling over. Under such circumstances it is vital that the vehicle is made stable.

An aide mémoire for ROPS can be found at Appendix 4.

## 1.13 Hybrid Vehicles

### 1.13.1 Introduction

Hybrid vehicles make use of both an electric motor and a petrol engine for vehicle propulsion. Electric power is generally used for low speed movement and is powered by a high voltage battery pack, typically located in the rear of the vehicle.

### 1.13.2 Hybrid types

There are two types of basic Hybrid:

- Series Hybrid

- Parallel Hybrid

Series hybrids use a petrol engine to drive a generator, which in turn generates electricity for the electric motor to drive the vehicle. There is no direct link from the petrol engine to the drive wheels.

Parallel hybrids use both the petrol engine and electric motor for power, and switch back and forth between them as the situation demands. In addition to supplementing the power of the petrol engine,

the electric motor can also serve as a generator to recharge the high voltage battery pack whilst the vehicle is in motion.

### 1.13.3 Working Example

Toyota hybrid systems combine the best of both series and parallel technology to create a more efficient power train:

- The vehicle can be powered by the electric motor alone and the petrol engine can be stopped whilst the vehicle is in motion.
- The petrol powered engine and the electric motor can independently provide the force that mechanically drives the engine.
- The petrol-powered engine is also used to generate electricity, which drives the electric motor to drive the vehicle and/or is used to charge the high voltage battery pack.

### 1.13.4 Safety

Toyota hybrid vehicles have G Force sensors in the engine compartment that will automatically isolate the High Voltage from front to rear in the event of a serious frontal collision (similar criterion to that of front airbag deployment).

The High Voltage loop will automatically shut down if there is any interruption to the H.V. power supply i.e., severing of H.V. cable, water submersion or any damage to the vehicle causing a "short circuit" within any of the H.V. components. (See Figure 1.23.)


*Figure 1.22 Toyota Prius.*

### 1.13.5 Summary

In hybrid vehicles, high voltage cables are identifiable by **orange insulation and connectors**. Whilst there is a need to be aware of these cables, they are routed underneath and inside the floor plan reinforcement, in an area that is not generally accessed by rescue personnel.

It is also important to note that hybrid vehicles, that may appear inactive when the petrol engine is not running, may still be in the "ready state" and capable of motion at any time. Always ensure that the main ignition switch is turned off, therefore disabling the electronic drive system. Except for the precautions listed in this section, hybrid vehicles may be approached using standard vehicle extrication principles and techniques. Additional information can be obtained from rescuers guides published by the various vehicle manufacturers.

## 1.14 Vehicle Electrics

### 1.14.1 Introduction

Managing vehicle electrical systems is an important task at the scene of a road traffic collision. A full survey of the vehicle, including central locking systems, electric windows, power seats, SRS systems and power boot/ bonnet release mechanisms should be undertaken before "battery disconnection" is finalised.

In order for firefighters to deal with vehicle electrical systems safely, a basic knowledge of components and materials is required.

### 1.14.2 Vehicle Electrical System

A typical vehicle electrical system has an alternator to generate electrical powe and, large amounts of cabling (sometimes in the form of a thick wiring loom) to distribute the power. Electrical switches and connectors complete the electrical circuit. At least one battery stores energy to start the vehicle and power electrical equipment as required.

### 1.14.3 Vehicle Batteries

Car batteries are generally rated as 12 volts, with two terminals, one positive and one negative.



*Figure 1.23 Always consider disconnection of the high voltage system to afford optimum safety to FRS personnel and any casualty.*

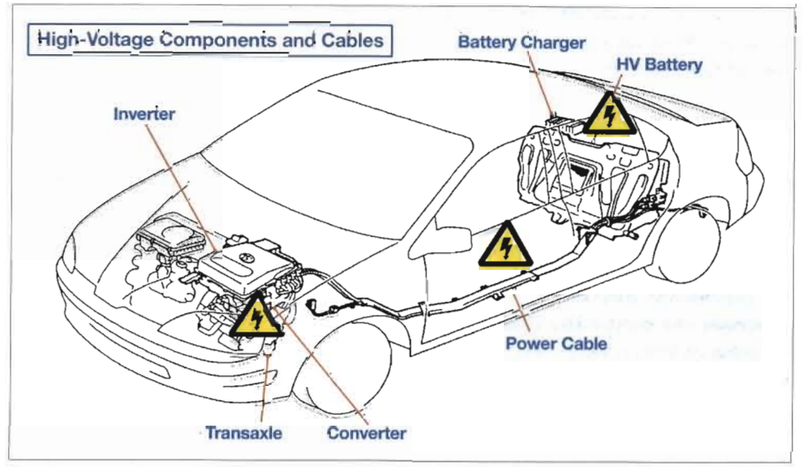



*Figure 1.24 Always use a fire fighting medium that is suitable for an electrical fire.*

*Figure 1.26 Always consider disconnection of the high voltage system. Ensure ignition is switched off and gear shift is in park position.*

*Figure 1.25 Do not extinguish the fire with small amounts of water – risk of electrocution.*

*Figure 1.27 Always wear insulating gloves suitable for the applicable voltage of the vehicle.*

*Figure 1.28 Battery electrolyte is corrosive; use appropriate personal protective equipment.*

*Figure 1.29 Dilute battery electrolyte spillages with **copious** amounts of water.*

Connected to one of the terminals will be an "earthing wire" depending if the vehicle is positively or negatively earthed. This is the terminal that should be disconnected first as it reduces the chance of sparking.

#### 1.14.3.1 Multiple Batteries

Many modern vehicles have more than one battery. Obviously the most common location is in the engine compartment. It is important to be aware of

newer vehicle designs that make use of alternative locations, these locations may include, but are not limited to:

- Under the rear passenger seat.
- In the boot
- In the front wheel arch.

### 1.14.4 Managing Electrics at an Incident

As previously discussed, it is of the upmost importance to survey any vehicle before electrical isolation. When it is safe and appropriate to do so, disconnection can be achieved in one of two ways.

(a) The first and preferred method is removal of the battery lead, by loosening the screw on the appropriate terminal and then pulling it free from the post with a gloved hand or appropriate tool.

(b) The second and less attractive technique of electrical isolation is to cut the appropriate lead, usually with a set of "bolt croppers", thus forming a permanent disconnection.

Method (b) should only be employed as a last resort.

**N.B.** The ignition and any other electrical accessories should be isolated before battery disconnection, as a spark is more likely to occur if the lead is removed when the battery is "under load". It is also important to remove the earthing lead first, as this is the terminal that is most likely to spark. When the electrics have been isolated, ensure that the disconnected lead cannot "spring" back to its original position causing an "electrical short". The disadvantages of cutting the cable instead of disconnecting it are great, the vehicle will be permanently disabled and any reassessment requiring power to windows or seats will not be possible.


*Figure 1.30 Typical battery located in engine compartment.*

In addition this will cause problems for the Police with regard to their investigation and may result in the vehicle having to be re-wired purely to establish the events before the crash.

The "negatively earthed" electrical system, having been disconnected, the negative lead must now be moved away from the terminal to avoid accidental reconnection and sparking. (See Figure 1.30.)

### 1.14.5 Battery Explosion

If a vehicle battery is exposed to excessive heat (such as a fire situation) or a massive short circuit, the battery may explode, causing super-heated sulphuric acid to "splatter" the surrounding area. This phenomenon is more likely to occur with maintenance-free batteries as there is no pressure release mechanism. Full personal protection must be worn when lifting the bonnet at any such incident.

## 1.15 Commercial Vehicles

### 1.15.1 Introduction

During 1989 a total of 478,000 goods vehicles (above 3.5 tonnes) were licensed for use on the roads of Great Britain. This figure accounts for approximately 13% of all motor vehicles on the road. There were also 410,000 foreign freight vehicle visits throughout the year plus 610,800 foreign trailers deposited at our ports for distribution by hauliers based in this country. Whilst the percentage of goods vehicles may appear small, it must be remembered that, compared with many private vehicles, commercial vehicles are intensively used and spend very little time non-mobile.

The previous maximum weight of an unescorted heavy goods vehicle was 38 tonnes; the maximum length of such vehicles was 16.5 metres. The weight limit increased to 40 tonnes on 31 December 1998. However, there is already a strong lobby for the limit to be 44 tonnes. One important consideration in this argument is whether existing roads and bridges can withstand the proposed increases. The size and weight of a vehicle has a direct effect on the severity of a road traffic collision. (See Figure 1.31.)

### 1.15.2 The Vehicles

#### 1.15.2.1 Vans

Vans and light commercial vehicles account for a large proportion of the goods vehicles operating in the UK. A popular range of these vans falls within the limits of 350 to 500kg usually based on standard motorcar chassis. The bodies of these vehicles are mostly constructed of welded steel pressings with larger doors on the side and rear to facilitate loading and unloading.

#### 1.15.2.2 Light Commercial Vehicles

The light, four wheeled rigid commercial vehicle with an unladen weight of less than 3.05 tonnes may be driven legally by a person holding a normal driving licence, making these vehicles very popular with operators in the distribution trades. The frame is usually made from pressed channel sections and the body may be a van or flat backed.


*Figure 1.31 Typical HGV Cab.*

#### 1.15.2.3 Heavy Good Vehicles

These vehicles are more heavily constructed than vans and are specifically designed to carry large loads. They fall into two broad types, either rigid or articulated.

#### 1.15.2.4 Rigid

A rigid vehicle may have two, three or four axles and can be adapted to have a draw bar trailer. The body may be in the form of a platform, a tank, a container van or specially built to suit a particular type of operation. Many commercial vehicles have pneumatic suspension systems that allow a height adjustment of several centimetres. This should be an important rescue consideration, when dealing with such vehicles, particularly during initial stability. For off road work, multi axle rigid vehicles have the advantage that four wheeled drive can be made available at the rear axle, greatly improving traction on soft ground. (See Figure 1.32.)

#### 1.15.2.5 Draw-bar Trailers

A draw bar trailer can be connected to a rigid vehicle in order to increase the size of load conveyed in

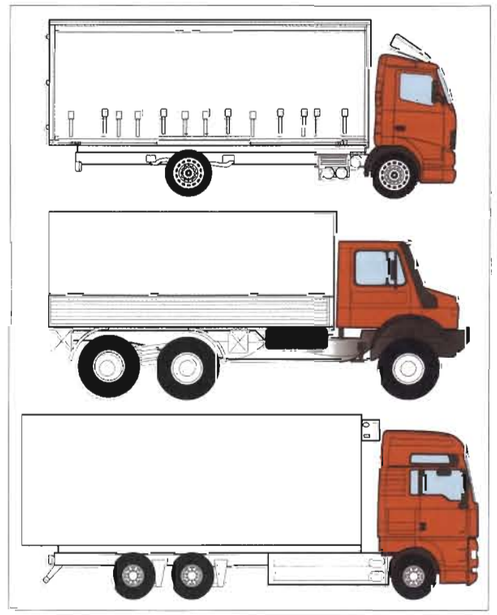


*Figure 1.32 Rigid configuration*

one journey. The draw bar tows and steers the trailer front wheels so that it follows the path of the drawing vehicle. The trailer body will be designed for its intended purpose and more often than not it will be fitted with air suspension units.

### 1.15.2.6 Articulated Vehicles

These are vehicles designed to carry their payload on a semi-trailer. The tractive unit and semi-trailer are coupled together in such a manner that the semi-trailer pivots on the tractive unit allowing the combination to articulate. The great advantage of this type of unit is it can be used with different semi-trailers.

There are two types of coupling used for articulated units:

***(a) Automatic***
This coupling consists of two ramps or runways to take the flanged wheels fitted to the semi-trailer undercarriage. At the front end of the ramps are two adjustable combination rubber spring buffers which absorb the shock of the coupling up and load the two coupling hooks in order to keep the trailer securely locked to the unit.

A retractable undercarriage supports the semi-trailer when detached. The automatic type of coupling is widely used where a lot of exchanging of trailers is necessary, e.g. railway goods yards. However, a limited gross weight of only 18 tonnes is allowable with this type of coupling and so this system is becoming increasingly rare in favour of the fifth wheel type.

***(b) Fifth-wheel Coupling***
This is normally used on tractive units whose unladen weight exceeds 2,032 tonnes (2 tons). It is more robust in construction than the automatic coupling and this makes it suitable for maximum permitted loads on the largest vehicles. The trailers for tractive units fitted with fifth wheel couplings are also equipped with a retractable undercarriage. (See Figure 1.33.)

### 1.15.2.7 Other features of articulated goods vehicles

**Service lines**

These are a facility, which transfers the services from the tractor unit to the trailer. Each line is colour coded for a particular service as follows:

***Service Colour***

Electric – Black

Service Brakes – Yellow

Emergency Brakes – Red

Auxiliary Brakes – Blue
(Not always fitted)

It is not always possible to rely on the colours to reflect accurately the service it is supplying as these lines are exposed and frequently covered with road dirt and grease. However, each service line has a different type of coupling to avoid incorrect coupling.

### 1.15.2.8 Landing Gear

This is the term used to describe the retractable support mechanism fitted to the front end of the trailer unit. The gear is wound down to support the trailer when it is uncoupled from the tractor unit.

**N.B.**
A decision may be taken to utilise landing gear to provide some stability of the articulated unit.

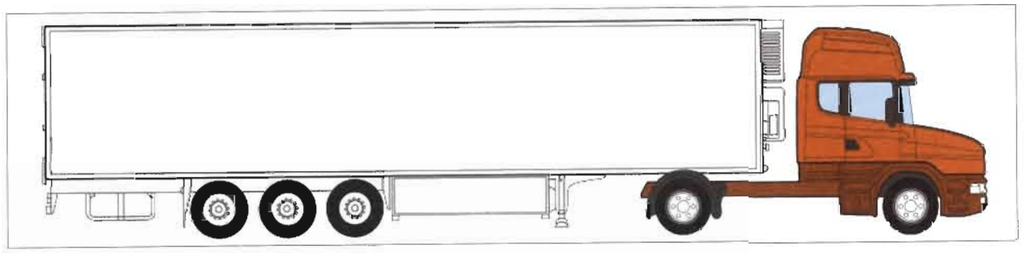


*Figure 1.33 Articulated configuration.*



However, if a request to uncouple the tractor unit is made, due consideration should be given to ground integrity. A fully loaded trailer when supported on the landing gear can puncture a tarmac road surface causing the load to sink.

### 1.15.2.9 Lock-up Wheels

Heavy goods vehicles with a potential payload of over 32 tonnes require a minimum of five axles. However, in an attempt to reduce running costs, manufacturers have incorporated a lock-up wheel system. When the vehicle is carrying less than 32 tonnes, only four axles may be required. Therefore, to save the wear and tear on tyres the fifth axle incorporates a lifting and locking system.

There are three types of system to achieve this: electrical power, air power from the brake reservoirs and hydraulic power. However, sometimes a combination of these is used.

The controls for the axle are usually located in the vehicle cab and they should only be operated by the driver if available or another competent person.

**N.B.** Damage sustained in a collision, or the lack of sufficient/incorrect maintenance could cause the wheels to lower without warning.

### 1.15.2.10 Under Run Protection

***(a) Rear Protection***
As a general rule any motor vehicle with a maximum gross weight exceeding 3.5 tonnes or any trailer having an unladen weight exceeding 1020Kg will require rear under run protection.

***(b) Side Protection***
Side guards are required with gross weight in excess of 3.5 tonnes or on semi-trailers having 4.5m or more between the foremost axle and the centre of the kingpin or where the distance between any two consecutive axles exceeds 3m.

### 1.15.2.11 Braking Systems for Heavy Goods Vehicles

Most modern heavy goods vehicles rely on compressed air to operate their braking system. The air is used to apply the brakes by one of two methods. In the first, compressed air is supplied to the axle actuator when the foot valve is depressed applying the brakes. The second type utilises the compressed air to hold the brakes off. Depressing the foot valve in this case exhausts air from the system when required to operate the brakes. This creates a type of fail-safe system so that any loss of air pressure will automatically apply the brakes. It is achieved by using spring brake actuators, which contain a large spring that works against a diaphragm.

It is very common for damage to occur to the braking system of such vehicles when involved in an accident, as the foot valve is usually at the front of the vehicle. A leak in the supply lines will enable the spring to apply the brakes so the vehicle cannot be moved.

Spring brake actuators permit manual release. Rotating a threaded bar that passes through the diaphragm will allow the brake shoes to move off the drum, enabling a controlled pull. However releasing the brakes manually renders both the foot and hand brakes inoperable.

### 1.15.2.12 Tractor Unit Cab Construction

The cabs on tractor units are constructed using similar methods and materials to those used on rigid chassis vehicles. With the use of these vehicles for long haul journeys the tractor units are being designed with a variety of in-cab sleeping accommodation. Renault have now produced a new style cab for the European long-haul market, the AE 380 and AE 500 series. The integral cab sets new standards for life aboard long-haul heavy-duty trucks in terms of the driver's environment.

### 1.15.2.13 Crush Resistant Cab

The crush resisting cab is framed with structural steel work. Heavy gauge rolled steel channel may run within the confines of the window screen pillar, bulkhead and the door posts and rib at the rear of the cab. The substance of the sheet metal will be of a heavier gauge than normally found in the motor industry.

**N.B. The use of a power ram to support the weight of the roof can assist with cutting especially when using hand tools.**


*Figure 1.34 Typical Crush Resistant Cab Construction.*

### 1.15.3 Extrication from Commercial Vehicles

It should be remembered that heavy goods vehicles are designed for carrying heavy loads as opposed to passengers. To manage these heavy loads, the type of vehicle construction is immensely strong and subsequently requires higher capacity rescue tools for extrication purposes. The large size and weight of these vehicles can present complicated stabilisation problems. Large spaces between the ground and the vehicle, off centre loads, hazardous cargos and odd shaped loads are some of the complications. It is important to know the difference between stabilising the vehicle and load, also the sprung and un-sprung weight of the H.G.V.

When a heavy goods vehicle is on its wheels on level ground it is uncomplicated. In the event that the vehicle comes to rest on uneven ground, or not on its wheels, stability becomes highly technical. A further difficulty is the height of the cabin, sometimes making it necessary to work from a platform. This requires practice and a clear understanding between all team members of what is appropriate in terms of handling tools and casualty retrieval.

Incidents can broadly be categorised as follows:

- Side impact to the cab.
- Roll-over, with subsequent damage to the cab structure.
- Frontal impact with a light motor vehicle.
- Frontal impact with the rear of another Heavy Goods Vehicle, bridge etc.
- Movement of the load into the cab.
- Vehicle off the road, in a ditch, etc.

The major differences between commercial vehicles and lighter road vehicles is the height and strength of materials used in their construction. For the majority of incidents involving Heavy Goods Vehicles, the work will centre around releasing the driver from the cab area. With a vehicle on its wheels, this can involve a combination of power ramming, fixed winching and strategic crushing/cutting.

With the front of the cab trapping the driver, maximum space can be obtained by shearing the 'A' post above the dash, cutting the 'A' post at the floor level and carrying out fixed winching to roll the dash forward. This may have to be achieved using a supplementary power ram to assist moving the dash area forward. A secondary ram can also be utilised in the passenger door opening to increase the effect on the forward area of the cab.

#### 1.15.3.1 The Process

The heavy goods vehicle requires stabilising in two ways.

- Firstly stabilise the load, to ensure crew and casualty safety.
- Secondly stabilise the vehicle trailer and cab to make a secure base to work from.

***The processes involved are shown in the illustrations on the following pages.***



*Figure 1.35*

- Chock the wheels and the cabin; it may be necessary to strap the cabin to the chassis if the locking mechanism is damaged during the impact.

  The use of a ratchet strap to compress the cab, thus removing the free play from the cab's independent suspension, may be a wise option.

  Packing the area between the top of the wheel and underside of wheel arch also assists in the stabilising process.

  Under-run protection, running down the side of the vehicle may provide a stable base.

*Figure 1.36*

- Remove doors using the hinge exposure technique where possible and place ram horizontally.

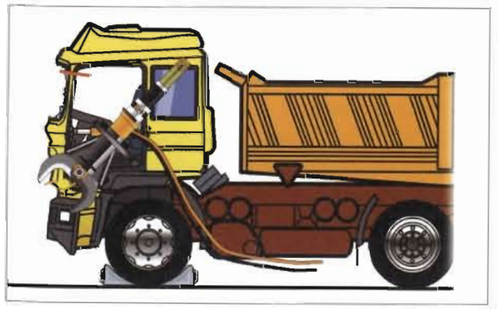


*Figure 1.37*

- Cut the top of the A-post of the cabin and make relief cuts through the base of the A-post and as well as in the strengthening bars to the front of the dashboard area as appropriate.

*Figure 1.38*

- Make a controlled forward dash displacement, ensuring enough space to extricate the entrapped casualty without the need to over manipulate the person.

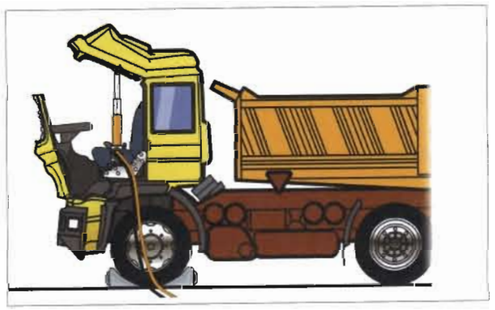


*Figure 1.39*

- If extra space is required, the roof can be pushed upwards by making relief cuts in both sides and then ramming upward. Consider ram support to spread the load at the base of the heel plate.

*Figure 1.40*

- In many cases it may be beneficial to tilt or push the steering column up. This can often be performed using the vehicle's own column shift system or, if required, by pushing it away with appropriate tools.

  Cutting the steering wheel rim, may also assist in making space, remembering that many modern heavy goods vehicles are fitted with supplementary restraint systems.



## 1.15.4 Buses and Coaches

Buses are often put in the category of heavy vehicles but have a different construction when compared with trucks. The bus compartment is very vulnerable in the case of a collision. It is positioned on a chassis consisting of longitudinal beams and a criss-cross pattern of pipes or beams welded together on which the outside cover (steel plate or fibreglass) is fixed. The construction often fails to withstand the forces exerted on it in the event of a crash. This can lead to the potential entrapment of large numbers of casualties. The seats inside the bus often fail due to the forces of the crash, further entrapping casualties.

### 1.15.4.1 Gaining Access

After the stabilisation phase, the next obvious task is to gain access to the bus. This can be achieved in various ways, the simplest of which would be to use the doors, windows or emergency exits on the roof. Gaining access allows the Incident Commander opportunity to evaluate the severity of the incident, and will enable assessment of the number of casualties and nature of the injuries sustained to those involved. It should be ensured that a check is carried out of the luggage compartments as well as the beds and toilets, if the bus is equipped with these.

### 1.15.4.2 Scene Management

Due to the fact that in many bus incidents there are a large number of casualties, it is important to define roles in the rescue team and to detail clear working zones. Effective triage will enable treatment of the most appropriate casualties first.

### 1.15.4.3 Extrication Operations

Extrication operations on such large bus or coach incidents normally consist of creating space for both initial access and casualty retrieval. Once access is gained, the disentanglement of occupants from between the seats can be commenced. Strategic handling of the operation inside the bus should be focused on maintaining clear access and egress routes for casualties and stretcher patients throughout the incident.

### 1.15.4.4 Long Haul Coaches

The long distance luxury coach has developed over recent years allowing holiday travel over great distances throughout continents. Generally, these coaches are well equipped with such facilities as video presenters, drinks machines and on-board toilets.

**Most of the heating systems on such coaches are powered by liquid hydrocarbon fuels** and are activated by timer switches that can power up the system even when the vehicle is empty.

### 1.15.4.5 Driver Sleeping Compartments

To enable long distance coaches to be economically used and to allow almost continuous travel, a driver-sleeping compartment is utilised. Two drivers can then take shifts, one sleeping whilst the other drives.

There is currently no legislation affecting the construction or use of these compartments. However, a code of practice is administered by the Department of Transport. The code advises that driver sleeping compartments should:

- Be sited between the axles.
- Have a communication facility to the driver.
- Have two means of access/egress.

## 1.15.5 Hazardous Substances

The term hazardous substances covers a wide range of materials including chemicals that are dangerous because of their explosive, flammable, toxic or corrosive properties, and substances that present biological or radiological hazards.

**All of these chemicals may be transported on a regular basis, on the UK road network.**

All can provide an environmental pollution issue.

#### 1.15.5.1 Hazardous substances may be carried in:

- Cylinders
- Drums
- Tank containers
- Sacks
- Intermediate Bulk Containers (IBCs) etc.

#### 1.15.5.2 Approaching Incident:

- If possible approach from upwind, from a down gradient. (Wind at your back looking down on the incident.)
- Park in a safe position.

**N.B. Unknown loads should be treated as hazardous until it is known that they are safe.**

#### 1.15.5.3 If hazardous substances are suspected,

- Carriageways may need to be closed.
- Public should be cleared to a distance commensurate with the scale of the incident.
- Take note of the direction of any gas or vapour cloud and stay upwind.
- Remove all sources of ignition.

#### 1.15.5.4 Information Gathering

It is important to gather as much information as possible in order to protect the public and advise the other responders. This information can be obtained in the following ways:

- The vehicle driver should be able to provide detailed information, including, if possible, the transport documents.
- Making use of hazard warning markings.

**NB. No attempt should be made to obtain the transport documents from the vehicle cab if they have not been provided by the driver.**

#### 1.15.5.5 Marking will include one or more of the following:

- Orange coloured plates on the front and rear of vehicles – dangerous goods
- Hazard Diamond (may be more than one) – pictorial indication, e.g. flammable, toxic, explosive Hazchem plates – explained below
- Hazard Identification Number – two or three digits corresponding to the hazard diamond
- 4 Digit United Nations identification number – substance or generic group of substances
- Radioactive trefoil – radioactive material
- European ADR plates.


*Figure 1.41 Radioactive trefoil.*

#### 1.15.5.6 Hazchem plates

Hazchem plates are displayed on UK registered vehicles carrying dangerous goods in bulk within the UK. They show three vital pieces of information for the emergency services:

- Four figure United Nations identification number, identifying the hazardous substance.
- Two/three character code which indicates the immediate action to be taken, including the precautions to be taken. These characters can be de-coded using an Emergency Action Code card. It will give an indication of the dangers and level of hazard, e.g. an 'E' in the code will indicate a possible public safety hazard beyond the immediate vicinity of the incident.
- A company telephone number from which expert advice on the substance/s should be available. (See the current *Dangerous Goods – Emergency Action Code List*.)




*Figure 1.42 A typical hazard warning plate.*

#### 1.15.5.7 Post incident checks

Responders who attend incidents involving hazardous substances should submit a report on the incident for record. It may also be appropriate to seek medical attention if exposure has occurred.

#### 1.15.5.8 Bullet Point Actions – Summary

***Approaching an Incident***

- Always approach from upwind, if possible.
- Always approach from uphill, if possible.

***At the Incident***

- Do not go any closer to dangerous goods vehicles than necessary.
- Close carriageway and keep public clear.
- Obtain information from driver, if possible.
- Obtain information from vehicle markings and emergency telephone number, if available.
- Relay information to Fire Control.

***Post Incident***

- If there is a possibility of having been in contact with hazardous substances, seek medical attention.
- Submit a report for records.

# Chapter 2 – Dealing With Incidents

## 2.1 The Golden Hour

For seriously injured patients, time is of the essence. The direct relationship between definitive (surgical) treatment and the survival of trauma patients was first discovered by Dr R. Adams Cowley of the famous "Shock Trauma Unit" in Baltimore, USA. He found that if the seriously injured patient was in the operating room within an hour of the time of injury, the highest survival rate was obtained (about 85%).

He called this the patient's golden hour. Every action taken at the scene of the incident must have a life saving purpose, as minutes of the 'golden hour' are being traded for the time taken for every action carried out before transport.

| GOLDEN HOUR | |
|---|---|
| **Dr R Adams** | |
| **60 minutes** | |
| **5 Minutes** | Time of incident to notification |
| **10 Minutes** | Time of call to arrival of first appliance |
| **15 Minutes** | Time of arrival to completed extrication of patient |
| **5 Minutes** | Time of patient release and preparation for transport |
| **25 Minutes** | Time available for transport to definitive care |

The Golden Hour philosophy states that 'the patient's immediate needs and condition dictate the method used to extricate him or her'. For the rescue commitment this will mean adopting the most effective methods to release casualties, and training to achieve a quick and safe operation. However, the need to reduce the time spent extricating patients should not be allowed to encourage bad practices such as failing to stabilise the vehicle effectively.

For most collisions the time taken to extricate a casualty should be no more than 15 minutes. This goal is realistic and can usually be safely met by intensive, uniform training, by obtaining up-to-date knowledge of the vehicles and by developing a crew approach to the accident scene. Through practical training, the extrication team can add life-saving minutes to the Golden Hour by learning to work with speed and efficiency.

## 2.2 Multi-Disciplinary Approach to the Incident Scene

### 2.2.1 Introduction

When the FRS are called to the scene of a vehicle crash, they will be attending as part of a team from a variety of separate agencies. For most incidents Fire, Police and Ambulance form the main part of this multi-disciplinary approach. Each service attending the incident is trained separately for its response; the training of each service is essentially different. Although all have the needs of the casualty in mind, the roles of each service also differ. To provide a team approach to the incident it is necessary to appreciate the needs, skills and the roles of the other services. An understanding of each service's work will assist in dovetailing the efforts together to provide an effective integrated response to any emergency. On certain road networks Highways Agency Traffic Officers may also form part of the response.

### 2.2.2 The Role of the Fire and Rescue Service

This section outlines the general roles of each of the main agencies. However, there is a need to maintain effective communication between all of the agencies to enable a well-co-ordinated team approach.

The FRS are often required at road traffic collisions to release casualties who may be physically trapped, or trapped by the nature of their injuries. At these incidents the FRS has distinct roles:

- The rescue of people trapped by fire, wreckage of debris.
- Preventing further escalation of the incident by controlling or extinguishing fires.
- Dealing with released chemicals or other contaminants.
- Assisting the ambulance service with casualty handling.
- Assisting the police with body recovery.
- Taking the lead on H&S within the action circle.
- Whilst carrying out all of the above, will try to preserve the incident scene for the senior investigating officer.

### 2.2.3 The Role of the Police

Any call made to request the attendance of the emergency services will include the police. The incidents the police deal with range from the reported damage of property caused by the collision, to dealing with an investigation into the cause of a death.

At the incident the police maintain overall control, but will liaise closely with the FRS over the management of safety. The roles of the police at an accident scene are:

- Secure and protect the scene, and preserve the life of those present
- Work with the other emergency services to save life
- Coordinate the emergency response with other emergency services and support agencies
- To preserve the scene and maintain control of it to ensure the integrity of it for any subsequent investigation
- Investigate the incident, including obtaining and securing the evidence in conjunction with other investigatory bodies where applicable
- Act as agent for HM Coroner
- Family Liaison

Where a fatality or life changing injuries have occurred there will be the need for the police to conduct a detailed investigation. This will be conducted in accordance with the Association of Chief Police Officrs (ACPO) (2004) Road Death Investigation Manual.

All evidence that can be obtained must be gathered before the road is re-opened. Liaison and co-operation should ensure that vital pieces of this evidence is not lost or damaged, whilst ensuring that life saving takes precedence. As part of this evidence gathering it may be necessary for fire-fighters to provide statements.

### 2.2.4 The Role of the Ambulance and Paramedic Service

The emergency medical service (EMS) are called to all incidents where there is a suspected casualty. Working alongside the FRS the EMS roles are:

- Establishing and maintaining medical personnel/casualty contact throughout the incident.
- Assessing the casualty's condition.
- Prioritising and administering necessary casualty care, including any casualty triage.
- Assessing the need for disentanglement activities to free the trapped casualty.
- Advising rescue personnel of interior entrapment conditions as necessary.
- Properly packaging the injuries and injured casualties.
- Assisting in the extrication of the casualty.
- Transportation of casualty to the appropriate medical facility.

### 2.2.5 A Note on Doctor Services

A qualified doctor may already be at the incident scene, but if deemed necessary the ambulance service (in some Fire Authorities, firefighters also have the authority) will call for the attendance of higher



*Figure 2.1 Joint Co-working on scene.*

qualified medical staff. A doctor can arrive on the scene either from a hospital as part of a medical flying squad, or from a local practice as part of a volunteer medical cover scheme. (e.g. BASICS).

Doctors attending as part of the British Association for Immediate Care Schemes (BASICS) have received additional training in the care of the injured in pre-hospital situation.

A doctor will normally assume responsibility for the casualty's welfare. The doctor may then make decisions regarding the technical aspects of disentanglement or the speed at which to work to release the casualty. The casualty's injuries may also require immediate, on scene, surgical intervention by the Doctor, in which case the utmost co-operation is required.

Having a qualified doctor with paramedic backup at the incident is probably one of the highest standards of pre-hospital care a casualty could receive. However, without doubt the best place for the casualty is within the appropriate medical facility. For this reason the rescue FRSshould work alongside the medical attendance to release the casualties with speed and efficiency, so physical entrapment should not cause any unnecessary delay.

### 2.2.6 The Role of the Highways Agency Traffic Officers (HATO)

HA Traffic officers patrol trunk roads managed by the HA as well as the motorways in England only, with the aim of keeping traffic moving around collisions and making journeys as safe as possible. Their role has been developed with the police. HATOs are not there to enforce the law. However, it is an offence not to comply with their directions or to ignore their instructions.

They carry out their role as follows.

**Patrolling**
HATOs go on high-visibility patrols looking for or being directed to problems such as debris in the carriageway that could affect safety. They also look for broken down vehicles, checking that occupants are safe and that recovery has been organised.

**Stopping and Directing Traffic**
In order to remove debris or safeguard drivers and passengers HATOs can temporarily close roads, stop and direct traffic. They will also undertake emergency traffic management where necessary and may act independently from the Police if no criminality is involved.

**Supporting Police**
HATOs support the police in their duties, e.g. applying temporary road closures if there is a major collision thus allowing the police to concentrate on investigation work. The police are still responsible for managing major incidents and enforcing road traffic offences.

**Removing Vehicles**
HATOs arrange for the removal of damaged or abandoned vehicles that pose a danger to other road users. They can tow vehicles to a place of safety but will not undertake the role of any of the established recovery companies.

**Clearing-up**
They manage the safe clear-up after road traffic collisions.

**Regional Control Centres**
HATOs are supported by a Regional Control Centre (RCC) which is staffed by both the police and the highways agency 24/7.

**The RCC**

- Sends HATOs to incidents.
- Coordinates the response of emergency services and other services providers.
- Manages and monitors traffic conditions with the use of CCTV to provide early warning and response to incidents.
- Puts information on the electronic signs over the road to warn of dangers.

The Chief Fire Officers' Association (CFOA) and the Highways Agency have agreed a Memorandum of Understanding which details an agreed protocol of operations between the two. A copy of this MoU can be found at Appendix 1.

This MoU is not valid in Scotland.

It should be noted that HATOs will not be patrolling all major road networks. In addition to local authorities this includes those sections of roads that are owned/operated by private companies. One such example being the M6 Expressway. Local planning should identify these roads and liaison should take place with the relevant persons.

## 2.3 Commanding the Rescue

Road Traffic collisions that require the attendance of the FRS can occur on any road and are all potentially complicated situations. These incidents need to be quickly and efficiently handled if their casualties are to be given the best chance of survival.

There is a distinct need for the FRS to maintain a well organised system of "on scene command" to handle these potential situations.

Incident Command should be carried out in accordance with the guidance contained in the FRS Manual Volume 2, Operations, Incident Command.

With specific regard to the tactical command of RTC's the following needs to be considered by the Incident Commander.

*Figure 2.2*

The essential criteria for good command at any collision scene are:

(1) A clear understanding of all responding agencies roles and responsibilities.

(2) Good communication, between the Incident Commander and other emergency services on scene.

(3) Good communications between the Incident Commander and other agencies on scene.

(4) Good communications between the Incident Commander and the FRS crews.

(5) Performance of simultaneous operations with a quick and smooth change to alternative methods of release if warranted.

(6) Anticipation of real and potential needs at the scene in order to have the resources ready before required.



## 2.4 Work Concepts

There are two distinct work concepts that crews tend to implement at RTC's. These are:

**In-effective working concept – Many individuals performing the same task.** (See Figure 2.3.)

***Characteristics***

- One rescuer works as others watch.
- This is a time-consuming approach.

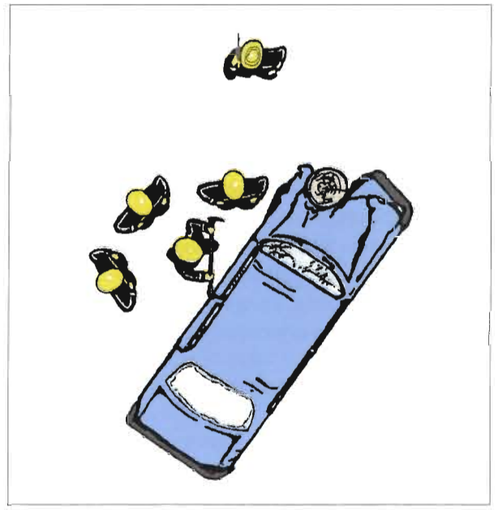


*Figure 2.3 In-effective Working Concept.*

**Effective work concept– All crew members performing their own detailed tasks.** (See Figure 2.4.)

***Characteristics***

- Simultaneous actions by all crew members.
- Tasks are completed quickly and efficiently, no essential personnel standing idly by.

**What is perfectly clear is that implementation of the effective work concept will provide the best chance of survival for those that need to be extricated.**

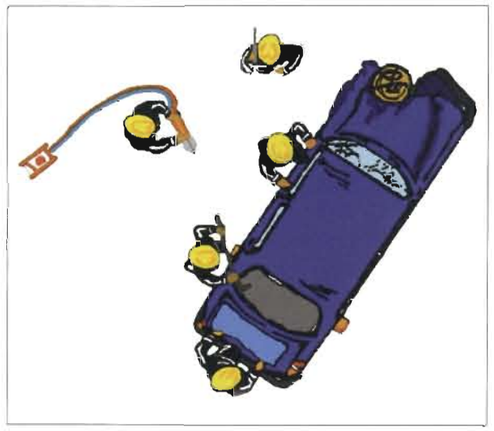


*Figure 2.4 Effective Working Concept.*

## 2.5 Casualty Extrication – Standard Operating Procedure

### Extrication: Definition

Vehicle extrication is the procedure used to remove collision victims who are entrapped in wreckage by either the nature of their injuries or the entanglement within the resulting deformed structure of the vehicle. Extrication procedures may involve the movement of metal around the entrapped casualty, the rescuers access path or the casualty's removal path.

### 2.5.1 Standard Operating Procedures (SOP)

In all cases of entrapment, the primary concern is the safety of life. The casualty's condition, situation, hazards (real or potential) and available resources will influence the method and speed at which the operation can be accomplished.

It should be recognised that a traumatised casualty's recovery from injuries sustained is directly influenced by the pre-hospital care and the time taken to get that casualty to hospital.

The SOP requires good liaison between the services attending the incident. It is an overall procedure that depends on working together to achieve one single aim. When the ambulance, or

doctor, services are in attendance, the casualty is their responsibility. However, their health, safety and welfare will also be the concern of the FRS.

With this in mind the Incident Commander and rescue crews called to the incident must use careful, efficient means to accomplish the Standard Operating Procedure, as described below.

### Standard Operating Procedure

- Establish command.
- Check and control hazards.
- Establish an incident profile by identifying:
  - hazards (real and potential),
  - medical requirements i.e. number of casualties,
  - rescue needs.
- Size up, making preliminary predictions of any rescue pattern and rescue requirements.
- Survey the scene and triage casualties.
- Establish casualty contact.
- Establish a tool staging area and action circle.
- Stabilise vehicles.
- Perform primary casualty survey, establish an airway, breathing and circulation, simultaneously ensure adequate 'C' spine immobilisation and care.
- Create enough space around the casualty for continued support and treatment.
- Perform controlled movement and removal of all metal and or obstructions in order to properly package and remove the casualty without further aggravating the casualty's injuries.
- Carefully release the casualty with due care.
- Prepare casualty for transport without delay.
- Re-stow any equipment used and secure the scene.

**NOTE:**
This procedure assumes that simultaneous actions will be taken as the crew perform the rescue. Dynamic risk assessment may alter the sequence of operations.

Certain commercial products are available that enables hazard information to be attained by attending crews. These assist with the identification and location of likely hazards that may be encountered on a specific make and model of vehicle. This information can assist the Incident Commander and enables informed decisions to be made.

## 2.5.2 Strategy in Accident Rescue

To effectively deal with incidents where persons are trapped within the confines of a motor vehicle. The fire crews and medical teams on the scene should all be aware of the three areas of operations, which need planning, even though they may not be implemented on every occasion.

(a) Immediate release

(b) Rapid accessing

(c) Controlled release

### 2.5.2.1 Immediate Release

The option of immediate release refers to the capability to extricate the trapped casualty in the shortest period of time with the equipment available. This method must shorten the working duration as opposed to that involving controlled release.

Training should be carried out for an effective immediate release that centres around correct and appropriate care for the casualty, even though the time period has been dramatically reduced. Where the release of the casualty is impeded by the superstructure of the vehicle, rescue equipment should be used to make space for immediate release, allowing the casualty to be extricated.



IMMEDIATE CASUALTY RELEASE SHOULD NORMALLY ONLY BE EFFECTED WHERE A CASUALTY'S LIFE IS IN IMMEDIATE DANGER FROM HIS/HER SURROUNDINGS.

EXAMPLES:

- FIRE
  Fire spread from uncontrollable fire
- SUBMERGENCE
- TOXIC FUMES
  High threshold for asphyxiation / toxicity
- HAZMAT
  Direct contact with caustic / corrosive / poisonous through absorption substances
- POLICE DIRECTIVE
  Uncontrolled civil disturbance / terrorist activity
- MEDICAL REQUIREMENT
  Where a casualty cannot be stabilised in the vehicle, i.e. C.P.R.

Where a casualty is trapped by the superstructure, not breathing, with no sign of circulation, and not an obvious fatality, commence in-car CPR using the equipment immediately available (e.g. BA board positioned to rear of casualty, giving stable platform). Attempt to release the casualty by the quickest means possible.

### 2.5.2.2 Rapid Accessing

Emergency Medical Services will require a more active level of participation from the first crew in attendance; this will allow them to give the appropriate care to the casualty. When dealing with a superstructure entrapment where the casualty is seriously injured, space making around the casualty becomes a priority.

The common examples of this are:

- Quick roof removal: this allows advanced airway techniques to be carried out.
- Forced door opening, this allows an intravenous line to be administered.
- When a casualty is crushed by the superstructure, a means of releasing the pressure under the guidance from medical attendance should be implemented.
- Suitable casualty care administration must be carried out immediately on arrival within the confines of the vehicle and not left until the casualty is released. For this to be viable, immediate accessing will provide realistic and suitable access for the medical attendance as soon as practicable.

Therefore, rapid accessing is a necessary pre-function to effective controlled release as associated with advanced vehicle rescue.

### 2.5.2.3 Controlled Release

Where casualties are trapped by the superstructure of their car or by restricted space by virtue of their injuries, the appropriate and safe systematic dismantling of the motor vehicle will give reasonable access for the medical attendance in tending to their casualty and create sufficient space for immobilisation/packaging and casualty handling. Gaining the optimum space in the time available will allow the situation to become more manageable.

Controlled release is the basic requirement for sound entrapment rescue management. Confinement within the compact cars of today makes its adoption the normal approach but in making this statement the rescue effort must be efficient and in tune with the casualties' treatment. Realistic management with a view to casualty care and immobilisation requires the services of knowledgeable personnel who have the capacity to weigh up the situation and act competently in the best interest of the casualty.

## 2.5.3 Approaches to Rescue

The ideology of immediate release and controlled release management must be treated as separate

entities. No confusion must exist between them and all rescue operatives must be made aware of the advantages and disadvantages associated with these options. Wherever possible, the casualty must be given the best chance of making a full recovery. With this in mind, all parties concerned should agree that, where circumstances permit, **the vehicle should be removed from the casualty and not the casualty from the vehicle**. The situation must not be allowed to compromise the casualty's condition.

### 2.5.4 Priorities of Controlled Release

It is essential that the casualty is stabilised at the earliest possible moment and this stability is maintained throughout the rescue. When the FRS is first on the scene, suitable access for the medical attendance can be gained in anticipation of controlled release management. Where necessary the FRS can work around all the personnel already in attendance.

### 2.5.5 Medical Commands

The medical attendance can call a halt in operations at any time during the rescue. Pre-arranged and recognisable commands are necessary to shut down operations quickly and efficiently.

- 'HANDS OFF'

  This signal would require all Fire and Rescue activity on the vehicle to cease in order to prevent any contact jarring or moving of the vehicle.

- 'SILENCE'

  This command is a call for silence and will necessitate the quick and efficient shut down of all generators and engines.

- 'STAND CLEAR'

  This requires both a 'hands off' situation and for all crew members to step away from the vehicle until further notice.

## 2.6 Police and Fire and Rescue Service Liaison at Road Traffic Collisions

### 2.6.1 Introduction

It is important that early contact is made between the Incident Commander of the FRS and the nominated Police Officer in charge at a road collision. This is not necessarily the senior Police Officer present. Under most circumstances, the first Traffic Police Officer in attendance at the incident will assume overall responsibility and will assume the role of Senior Investigating Officer.

A brief update to this Officer, when practicable, will always be appreciated. Information exchanged should include:

- The difficulty, and estimated period, of extrication.

- The direction from which further appliances will be approaching.

- Any specialist teams attending such as Medical Team or Heavy Lifting Gear, etc.

- The involvement of any hazards such as chemical release.

On conclusion of extrication, contact should be made again with the Police to establish if there are any further requirements, i.e. washing down of road surface, lighting etc.

### 2.6.2 Preserving the Scene

Exactly in the same manner that all fire incidents are investigated to establish the supposed cause, all serious road traffic collisions are subjected to a thorough Police investigation.

In the more serious road collisions, particularly where fatalities may result, specialist Police Officers endeavour to reconstruct the scene, position, speed and condition of the vehicle(s) involved immediately prior to the accident using a unique method known as **AIM** (Accident Investigation by Mathematics). The Senior Investigating officer will oversee this work.



Notwithstanding the primary task of rescue, it is vital that FRS crews are aware of, and respect, the needs of the Police Officers completing such investigations.

### 2.6.3 Debris

The position of the vehicles themselves, debris, glass, etc. are vital evidence in any Police investigation and disturbance of such should be kept to a minimum.

**WASHING DOWN OF ROAD SURFACES MUST NOT BE CARRIED OUT UNTIL AUTHORISED BY THE POLICE OFFICER IN CHARGE.**

### 2.6.4 Tyre Marks

Wherever practicable tyre marks should be preserved. Correct positioning on initial attendance would prevent fire appliances having to be re-sited, therefore reducing the confusion of tyre marks at the scene. Depending on the FRS requirements at the incident, parking too close to the vehicles involved in the collision (particularly 'back up' appliances) should be avoided.

### 2.6.5 Tyre Pressures

The condition and inflation pressure of tyres may give vital clues to the Police in the accident investigation.

Deflation of tyres by FRS personnel to achieve 'flat tyre blocking' must only be carried out in exceptional circumstances when all other methods of vehicle stabilisation are not appropriate. When possible, the Police should be informed whenever this procedure has to be implemented.

### 2.6.6 Batteries

In many instances, vehicles involved in serious road accidents are taken by the Police for examination to establish their mechanical condition prior to the accident. In doing so, vehicle batteries need to be re-connected. It is therefore important that, wherever possible, FRS personnel DISCONNECT BATTERY TERMINALS USING SPANNERS rather than cut through battery leads with bolt croppers etc., when making vehicles safe. For further information on batteries and vehicle electrics see Chapter 1, Sections 1.10 and 1.14.

### 2.6.7 Tachographs

When fitted to Large Goods Vehicles, tachographs and their associated charts should be left in situ for the Police Senior Investigating Officer.

### 2.6.8 Lighting Assistance

Additional lighting from appliances or Rescue/Emergency Tender stem lights, can often provide valuable assistance to the Police during investigations, whilst at the same time the Appliance remains 'available' from the incident. If investigations are likely to be lengthy, it may be appropriate to leave portable lighting equipment and generator from the relevant FRS appliance at the scene to be collected at a later time.

## 2.7 Working with Helicopters

### 2.7.1 Introduction

Helicopters are operated by local Police Forces, Ambulance Services, Ministry of Defence, HM Coastguard and several private companies. The FRS will attend incidents where these helicopters are required as part of a multi-agency response. This can be when the FRS is undertaking its firefighting role or rescue function, during incidents requiring rapid medical evacuation or as an aerial observation platform for firefighting purposes.

As these helicopters are owned and operated by different organisations, they follow different operating protocols. However in each case the general operating and safety guidelines remain the same, apart from the communications link (see Section 2.7.3.5 Communications).

## 2.7.2 Police Helicopter

### 2.7.2.1 North Midlands Helicopter Support Unit

This is an example of a typical police helicopter. (See Figure 2.5.)

This Police Helicopter is fitted with:

- Thermal imager.
- "Night Sun" search light.
- Public address system.
- Still photography equipment.
- Video equipment.
- "Heli-Tele".
- Stabilised binoculars.
- Stretcher carrying facility.
- Advisory External Defibrillator (AED).

***Thermal Imager***
The thermal imager operates similarly to hand held devices with the ability to record or switch to normal TV mode. The camera which distinguishes the scene, based on different heat signature, is manoeuvrable and contains a zoom facility. An encrypted microwave downlink facility is available.

***"Night Sun"***
"Night Sun" is a 30 million candle power light with variable beam width.

***Public Address System***
A 700 watt PA system incorporating a siren. Messages can be broadcast from a ground station through this facility, such as the FRS Portable Ground Link.

***Still photography/Video Equipment/Heli-Tele***
A still camera is carried and used by the air observers.

The helicopter is fitted with a daylight camera through which it can provide video footage of any incident it attends. These pictures can be broadcast simultaneously via a microwave downlink to Police control and the FRS portable ground link facility.

*Figure 2.5 North Midlands Helicopter Support Unit.*

***Stabilised Binoculars***
10 x 40 gyroscopically stabilised binoculars.

***Stretcher***
If necessary the helicopter can carry stretcher-borne patients. The ambulance service will decide if helicopter transport is the most appropriate mode of transport for the patient dependent on the type of injuries and location of receiving hospital. If this mode is selected an ambulance person will accompany the patient to the designated medical facility.

### 2.7.2.2 Tasking the helicopter

This particular helicopter is available on request to the FRS to carry out any function where the helicopter can make a productive contribution to the incident. This may include:

- Aerial observation for firefighting operations.
- Searching for missing persons.
- Rescue and support (NO winching facility).
- Aerial PA for evacuation (chemical incidents).
- Public disorder.
- Traffic management.


*Figure 2.6 Lincolnshire and Nottinghamshire Air Ambulance.*





Before accepting a task, the Helicopter Support Unit will need to know the following details:

(a) Nature of incident.

(b) Time since incident occurred.

(c) Exact location (grid reference, e.g. 825906).

(d) What is specifically expected/wanted of the air crew?

### 2.7.2.3 Microwave Downlink

The downlink monitor and specific ground to air radio will be mobilised from Fire Control by an Officer collecting the unit and transporting it to the scene of operations. (See Figure 2.7.)

This equipment will facilitate:

- Aerial observation.
- Video records.
- Thermal image.

### 2.7.2.4 Availability of the Helicopter

The unit is bound by Home Office and Civil Aviation regulations concerning the following:


*Figure 2.7 Microwave Downlink Equipment.*

- Minimum weather conditions at:
  - At its departure base.
  - Whilst in transit.
  - At likely destination.
- A pilot's maximum duty hours.

## 2.7.3 Ambulance Helicopter

### 2.7.3.1 Lincolnshire and Nottinghamshire Air Ambulance

This is a typical example of an air ambulance. (See Figure 2.6.)

The air ambulance operated by Lincolnshire and Nottinghamshire is available on request by the medical attendance to incidents between 0800 and 1800 hours, depending on daylight conditions.

### 2.7.3.2 Advantages of use

The key advantages of the helicopter are SPEED and SMOOTHNESS.

Each of these can make a significant difference to the quality of care provided for patients.

***Speed***
Speed obviously relates both to the initial journey to the incident, and the journey from the incident to hospital. Again, each of these can be vital, particularly when serious trauma is present.

Flying at 140 miles per hour, the helicopter covers over 2 miles every minute.

***Smoothness***
The helicopter has a tremendous advantage over conventional ambulances in being able to provide a particularly smooth ride, without the problems created by acceleration/deceleration forces, cornering, or the inevitable bumps and jolts caused by poor road surfaces or traffic calming measures.

The vast majority of patients can benefit to some degree from air transportation. For certain key groups – e.g. **SPINAL INJURIES, SERIOUS HEAD INJURIES, MAJOR FRACTURES** – those benefits can be **significant** in terms of the reduction in pain and other harmful physiological effects.

### 2.7.3.3 The Patients

The helicopter can be deployed where it can significantly reduce the "therapy free interval" determined by the Ambulance personnel, and where it would add value to patient care by means of rapid response, treatment and transport.

Typically, these conditions would include:

***Trauma***

Multi system trauma.
Amputations.
Head injuries.
Spinal injuries.
Major internal or external haemorrhage.
Long bone fractures.
Burns.

***Medical***

Anaphylactic reactions.
Severe chest pain
Carbon monoxide poisoning.
Respiratory obstructions.
Unconscious patients.
Cardiac arrest.

### 2.7.3.4 Type of Incident

On those occasions when the patient's condition is not known, certain types of incident will indicate a potential for trauma or illness, and therefore deployment of the helicopter is reasonable. These conditions would include the following:

- Multi vehicle rescue.
- Entrapment.
- Falls from a height of greater than 4 metres.
- Agricultural incidents involving heavy machinery.
- Fires with likelihood of burns or smoke inhalation.
- Explosions.
- Drowning.
- Aviation related incidents. (Plane crash, gliding, parachuting, etc.)

***Patients not suitable***

- Maternity cases at an advanced stage.
- Status epilepticus.
- Disturbed, restless or aggressive patients.

***Loading of patients***

- **Danger areas are the main rotor blades and, especially, the tail rotor.**
- Never approach the helicopter from the rear even if the engines are switched off.
- Once the helicopter has landed, always wait for a "thumbs up" from the pilot before approaching the aircraft. If the engines are still running and the rotors turning, noise, heat and blast will be experienced. This is disorientating and makes communications difficult.
- The patient must always be loaded head first.
- Firefighters assisting in the loading of patients must be kept to the absolute minimum.
- Down-draught from small helicopters should not be a problem.
- It is helpful and good practice to clear debris such as plastic bags, tin cans, and other light wreckage from within a 20 metre radius.

### 2.7.3.5 General Operating Guidelines

Helicopters, of the size and type of the two described, can land in an area of flat ground approximately 15 to 30 metres in diameter. MOD and other private craft may need larger areas. A field close to the incident is ideal, but the aircraft can, if necessary, land on roads. The pilot will make the final decision as to the best landing area.

***Communications.***

- All communications to the Air Ambulance must be undertaken by an Ambulance Officer via Ambulance Control.
- A ground to air link for the Police Helicopter will be mobilised by the FRS Control.

***Public***

- Ensure that the public are kept away from the aircraft and the landing area.
- Thumbs up sign from the pilot or the flashing of the aircraft's landing light are an indication that it is safe to approach the aircraft.
- Ensure where possible that animals which the aircraft may frighten when landing and taking off are considered and where appropriate are moved or an alternative landing site is used.



- Rotor blades are very dangerous and will KILL.
- The line of approach and departure following the thumbs up signal will always be within the SAFE AREA.
- The TAIL ROTOR is particularly dangerous and under no circumstances must persons enter the danger area.
- Never approach the aircraft during the starting up or slowing down of the rotors.

***Safety***

- Wear eye protection at all times as down-draft can whip up small items of debris.
- Secure all light equipment, canvas sheets etc. Manage debris particularly at RTCS and secure any hinged sections of vehicles.

This only provides the very basic information with regard to helicopters. All personnel must be familiar with the contents of Fire Service Manual, Volume 2 Fire Service Operations – Aircraft Incidents. Chapter 3 Rotary Wing Aircraft, on Helicopters and the Generic Risk Assessment.

# Chapter 3 – Safety Procedures

## 3.1 Personal Safety and P.P.E.

The safety of personnel and colleagues is of the prime importance at all incidents that the FRS attend. The scene of a vehicle crash contains many hazards; crews must be fully prepared for any situation that may be encountered. Where dangerous goods are involved, PPE as set out in the latest Edition of the Dangerous Goods Emergency Action Code List, should be worn for the initial emergency actions.

Personal protective equipment should be worn by all fire and rescue personnel. Requirements and guidance from the rescue tool manufacturers should also be followed.

### Minimum Requirements (subject to on-scene risk assessment)

- Head protection to be worn at all times
- Eye protection (goggles or safety glasses to correct specification) in conjunction with helmet visor. Goggles or safety glasses alone do not provide adequate protection whilst operating rescue tools.
- Protective gloves should be worn at all times
- Protective clothing (with fire retardant properties) to protect from sharp edges and some reflective material to increase visibility.
- Safety boots with protective toe cap
- Respiratory protection equipment (RPE) as appropriate, e.g. when cutting/breaking glass. (Also retain RPE "post" cutting phase.)
- Reflective surcoat

The following is a list of some examples of appropriate standards for the PPE mentioned on this page.

However, it should be recognised that standards for PPE and RPE are under continual review and development, hence the PPE utilised should be similarly reviewed periodically to ensure continuing suitability for purpose.

**Fire gear**
BS EN 469:2005 – Protective clothing for fire-fighters. (under revision). Be aware that fire gear is primarily designed and tested for structural fire fighting and may not therefore be the most appropriate protection for RTC's.

**Hi-visibility clothing**
BS EN 471:2003 – High-visibility warning clothing for professional use.

**Head Protection**
BS EN 443:1997 – Helmets for fire-fighters (under revision). Be aware that fire helmets are primarily designed and tested for structural fire fighting and may not therefore be the most appropriate protection for RTC's.

BS EN 14458:2004 – Personal eye-equipment. Face shields and visors for use with fire-fighters and high performance industrial safety helmets used by fire-fighters, ambulance and emergency services.

BS EN 397:1995 – Specification for Industrial safety helmets.

BS EN 149:2001 or equivalent – Respiratory Protective Equipment (R.P.E.) dust/mist respirator Type FFP2 or FFP3 c/w valve.

**Footwear**
BS EN 345-2:1997 – Safety footwear for professional use. Additional specifications (to be replaced by BS EN 15090:2006 – Footwear for fire-fighters).

Home Office Specification A29 Fire-fighters' rubber boots (will be reviewed on publication of BS EN 15090)
Home Office Specification A30 Fire-fighters' leather boots. (will be reviewed on publication of BS EN 15090)

**Gloves**
BS EN 659:2003 Protective gloves for fire-fighters
BS EN 374-1:2003 Protective gloves against chemicals and micro-organisms – Part 1: Terminology and performance
BS EN 374-2, Protective gloves against chemicals and micro-organisms – Part 2: Determination of resistance to penetration.
BS EN 374-3, Protective gloves against chemicals and micro-organisms – Part 3: Determination of resistance to permeation by chemicals.
BS EN 388:2003 EN 388, Protective gloves against mechanical risks.
BS EN 420:2003, General requirements for gloves.

**IMPORTANT NOTE**
**Remember that medical oxygen must not be contaminated with grease or oil. Medical gloves should be worn when dealing with casualty care, including oxygen equipment.**

**Distress Flares may be encountered, particularly in some personal vehicle imports. Japanese manufactured vehicles may carry a warning flare in the same way that European vehicles have a warning triangle.**

**Often, the flares are sited in the kick panel (inside – front passenger compartment) within easy reach of the driver in the event of an emergency. This possibility should be borne in mind, particularly in the event of a frontal fire/collision.**

## 3.2 Equipment Safety

It is critically important to read and understand the operator's manual and associated risk assessment, before using any equipment.

Every endeavour to provide the right piece of rescue equipment for the task in hand should be made. It is important to ensure the correct equipment is used for each allocated task, in accordance with best practice. Improvisation should only be permitted as a last resort, and then only following a suitable risk assessment.

**Competent maintenance of equipment, is an essential requirement.**

Basic equipment safety rules:

- When operating a hydraulic rescue tool, personnel should never be placed between it and the vehicle.
- Because hydraulic hoses are susceptible to damage (cuts, abrasion, kinks, burns, chemical contamination, etc.) care must be taken when operating. Damaged hoses should be immediately removed from service.
- The hose should not be used to carry, pull or move the rescue tools or intensifier/power unit.
- Tools should only be carried by, and operated with, their designated handles.
- Never stand on hydraulic hoses.
- Tools not actively being used should be returned to the tool staging area and left in the closed position.
- Hands should never be placed on the arms or blades of any rescue tool.

### 3.2.1 Hydraulic Tool Guidelines

#### 3.2.1.1 Spreaders

The spreader is a powerful tool and, when used efficiently, can be very effective in the extrication process. Spreaders represent a significant crush hazard when used carelessly.

The following points should be noted when using a spreader. The main aspect to be considered is the correct placement on a stable spreading platform. Once the tool begins to spread it supports most or all of its own weight, so from this point onwards it is only necessary to guide the tool and operate the handle.



***Operating Guidelines:***

- Use the full surface of the spreading tips.
- If the tips start to loose their grip, stop and reposition.
- Position the tool so that, when it is in use, relocated metal is pushed outside the vehicle.
- The natural movement of a tool during operation may require the operator to stop and relocate before the tool becomes trapped against components of the vehicle or the operator.
- Hands should never be placed on the arms or tips of the spreader.
- After completion of work, the spreader should always be returned to the tool staging area in its safe position.

#### 3.2.1.2 Cutters

Cutters are more important on the rescue scene than ever before. This is due, in part, to advances in vehicle design and construction and improvements in vehicle technology. The enormous power available from these tools results in a significant cutting or crushing hazard when they are used correctly or incorrectly.

***Operating Guidelines:***

- Always try to position the cutter so that it is at a 90-degree angle to the cutting surface.
- Ensure that the material to be cut is positioned as far into the blade recess as possible. Avoid cutting at the tips.
- If the cutter begins to twist excessively, or blade separation is noticed, stop the cut and reposition the cutter.
- Expose all posts before cutting to avoid hidden air bag inflators or other hazards.
- Never place hands on the blades of a cutter.
- The natural movement of the tool during the cutting operation may require the operator to stop and reposition before the tool becomes trapped against components of the vehicle.
- The operator should not walk around the incident carrying the tool with the jaws in the open position.

#### 3.2.1.3 Rams

Rams are an essential part of the hydraulic tool set. They are invaluable in situations where the front of the vehicle is causing entrapment of the occupants. Due to the loads that the rams can push and hold, sudden slippage due to loss of grip is the primary hazard.

***Operating Guidelines:***

- Attention should always be given to both purchase points. If necessary use a ram support to ensure a good secure ramming platform.
- Provide stabilisation below the lower purchase point before applying pressure.
- Always position the ram in such a way that the control handle is easily accessible.

## 3.3 Casualty Safety

It is important to remember that the main reason for attending an incident where persons are trapped, is to safely release the casualty as soon as practicable, and ensure that no action is taken which could adversely affect the casualty's condition.

Therefore, it is of prime importance that the casualty receives appropriate care as soon as it is safely practical on arrival at the scene of a vehicle crash.

A future chapter deals with pre-hospital care, but the importance of a rapidly performed "primary survey" cannot be overstated.

### 3.3.1 Vehicle Stability

When a vehicle is correctly stabilised, any movement that the casualty will feel is dramatically reduced, and this minimises the chance of further injury. As firefighters climb into the vehicle to cut and relocate metal, it tends to change the weight distribution on the supporting blocks. For this reason it is important to reassess "stability" on a regular basis, ensuring that the casualty's safety remains a high priority.

### 3.3.2 Glass Management

When breaking or cutting glass, the casualty must be protected in two ways:

(a) Respiratory protection in the form of high flow oxygen therapy, usually administered by "re-breather" reservoir mask.
(b) Hard and soft protection in the form of a protection shield and flexible 'sharps' cover.

**Note.** It is not acceptable to shower the casualty with glass whilst attempting glass management.

### 3.3.3 Hard Protection

When cutting/spreading/ramming or performing any other aggressive rescue technique to a crash damaged vehicle, it is always necessary to protect the casualty from these tools and any flying debris that may result. Hard protection, such as a casualty protection shield (tear-drop), should be positioned between the component being cut and the person to be protected. This should be placed as near to the component being cut as possible so as to limit possible projectile travel.

### 3.3.4 Inclement Weather Protection

In adverse or inclement weather, the casualty may require protection from rain and wind. Often, the on scene medical attendance will need to expose various body parts to administer medical assistance. Therefore, the casualty could quickly develop hypothermia and thus reduce the chance of survival. Use blankets and "casualty sensitive" rescue techniques (i.e. leave the last cut of vehicle roof removal until the emergency medical service are ready to release the casualty).

### 3.3.5 Casualty Release

When the rescue phase is nearing completion and all appropriate metal relocation has taken place, it is desirable to package the casualty ready for transport. Often the most suitable method of relocating the casualty from the crash damaged vehicle to the ambulance is by long board or "spine board". The casualty must be securely attached to the spine board before being removed from the vehicle as it has not been unknown for further injuries to be sustained by the casualty because of poor handling.

### 3.3.6 Distress Flares

It is possible that the presence of distress flares in certain types of vehicle(s) may be encountered. These flares are only usually found in imported Japanese or American vehicles and are usually removed by dealers. However, these flares have been found in some other vehicles. The most common type of flare consists of a red plastic tube, approximately 150mm (6 inches) in length, and 30mm ($1\frac{1}{4}$ inches) in diameter.

Those found in vehicles imported from the United States may be encountered in the vehicle luggage space or alternatively, mounted in the front passenger footwell and will normally display operating instructions in the form of a series of diagrams on the outer casing. Flares encountered in imported Japanese vehicles are usually located in the front passenger footwell and display operating instructions in Japanese characters, along with an illustration in pictorial form and a manufacture and expiry date.

The method of operation involves removing the outer casing and using it to strike the top of the inner tube. Special attention will be necessary therefore, whenever these are encountered in a vehicle involved in a RTC as they may well have been affected by the initial impact.

Flares will tend to burn fiercely when involved in fire, but present no known explosion hazard.



# Incidents Involving Rescue From Road Vehicles

Chapter 4

# Chapter 4 – Operational Procedures

**Six elements required to achieve a well-controlled rescue**

- **Scene assessment and safety**
- **Stabilisation and initial access**
- **Glass management**
- **Space Creation**
- **Full access**
- **Immobilisation and casualty extrication techniques**

## 4.1 The 'Crew Approach'

One of the best ways to make the most efficient use of time at the rescue scene is to use the crew approach for extrication. For this, it is necessary to pre-plan procedures and train together as a unit whenever possible and to pre-assign job functions to the individual best suited for each particular task.

The crew approach is not intended to be a rigid plan, set in stone, nor is it intended to be a comprehensive set of actions that attempt to address every conceivable situation. Instead, the crew approach simply helps to organise, in advance, the tasks that are expected to be performed.

When pre-planning for extrication, it is essential to learn as many variables from each situation as possible. Immediately using the most fail-safe technique for each given task to be performed will help to reduce wasted time and effort. While there may be no such thing as a technique that is 100% effective, this should be the bench-mark aimed for. In other words, techniques that work best in most cases should be used in order to save time that might otherwise be wasted.

Utilising the crew approach will create team synergy. Synergy is where a team, crew or group work together effectively as a whole to achieve far more than the individuals working separately could achieve.

### 4.1.1 Watch/crew based trainer and the crew

As a crew undertakes training for vehicle rescue, adopting a crew approach helps provide experience that will assist when carrying out similar tasks at the scene of an RTC.

A large percentage of the time, traditional crews on appliances have five personnel. Turned out to a fire, the crew adopts various roles depending on their nominated seating position on the appliance.

The appliance usually carries an Incident Commander, a driver/pump operator, two breathing apparatus wearers and a breathing apparatus entry control officer.

If the appliance attends an RTC, the provisional roles for the five members of the crew can still apply. The Incident Commander on the appliance can brief the crew to undertake the following roles.

**Tool Operators**

Working as a team, two of the crew members can carry out an inner circle survey, stabilise the vehicle and utilise the rescue equipment disentanglement procedures – all under the direction of the officer in charge.

Everyone should be aware of their own safety and that of the other crew members. Whilst one of the tool operators works, the other can control leads or hoses, watch for hazards and ensure the casualty is protected.

**Back-Up**

Essentially, this person provides the sort of back up support the other crew members need to achieve the rescue.

Performing an outer circle survey, laying out fire-fighting equipment and making the vehicle electrics safe during the set up phase, the 'back up' person can set up a tool staging area providing the equipment for rescue as required. A key role for the 'Back-up' will be assisting the medic as required.

**Casualty Carer**

This crew member will attend to the casualty and work inside with the medical attendant to ensure that the casualty is reassured and cared for during the rescue. They will be responsible for the following:

- Conducting a quick casualty assessment and dealing with any immediate needs.
- Keeping the Incident Commander up to date as to the casualty's condition and entrapment.
- Protecting the casualty from the work.
- Keeping the casualty informed.
- Assisting with manual immobilisation and the fitting of spinal devices.

Other tasks that can be achieved are as follows:

- Removing the vehicle keys and handing them outside.
- Cutting away seat belts.
- Rolling down windows.
- Unlocking doors.

Using a broad based command concept, with each crew member aware of the requirements of the crew commander and the needs of others, a safe, efficient and quick rescue can be achieved.

Although all incidents are different, with good training and the correct communication these fundamental roles allow organisation at the incident to evolve from the time of arrival.

Table 4.1 below shows one possible crew approach to an RTC, bearing in mind the assigning of job functions to the individuals best suited for each particular role.

**Table 4.1** ***Possible crew approach to an RTC***

| Fire Situation | RTC |
|---|---|
| Incident Commander | Incident Commander |
| BA Wearer | Tool Operator |
| BA Wearer | Tool Operator |
| BAECO | Casualty Carer |
| Driver | Back-up |



## 4.2 Accident scene approach and set up phases

### 4.2.1 Establishing command

The Incident Commander must take command of the situation quickly and guide the total effort to the crash scene efficiently. Using the crew approach, communication between crew members and the Incident commander is essential. A preliminary survey with information from the crew and the medical attendance will enable the commander to form a strategy with a priority of actions.

### 4.2.2 Surveying the scene

Once the Incident Commander has determined that no obvious hazards exist, he can decide to task others to carry out a more intensive survey of the scene. This can be achieved by initiating **inner** and **outer circle** surveys.



Performing a circular survey of the incident gives a 360 degree view of the scene and can save valuable time by allowing the rescuers to develop an adequate plan of action.

The Incident Commander should also consider watercourses that are or could be threatened by pollutants from the vehicles involved and to take subsequent action to prevent occurrence. The vulnerability of the potential receiving environment is also a major factor to consider at the same time. i.e. Drinking water supply or fisheries.

### 4.2.3 Inner circle survey

A closer examination of the vehicles can be achieved by carrying out an inner circle survey. One or two rescuers walk adjacent to the vehicles, checking the immediate area for casualties and any hazards. During this assessment a look under the vehicles can help establish the following:

- that there are no further casualties underneath,
- any weak areas of the vehicle due to accident damage that will require additional stabilisation,
- the presence of any fuel or oil from the accident,
- the presence of S.R.S.
- any other situation requiring attention, e.g. the position of catalytic converters.

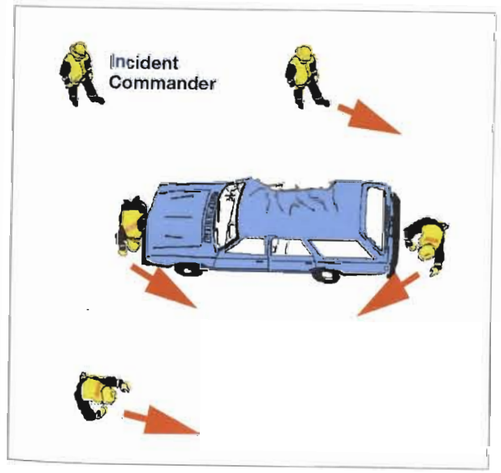



*Figure 4.1 Inner Circle Survey*

### 4.2.4 Outer circle survey

One or two rescuers walk completely around the vehicle. They look in towards the car and out to the perimeter of the scene, checking for casualties, obstructions hazards, and any potential problems while remaining 2–5 metres away from the vehicle. All information gathered should be shared with personnel in attendance.

### 4.2.5 Action circle

During the initial set-up at an incident, an action circle should be established and maintained around the vehicle(s) involved.

The action circle should include an area starting from the vehicle(s) and extending outward for 2–5 metres in every direction. This area must remain free of any tools not in use, of first aid kits or resuscitators, and stretchers.

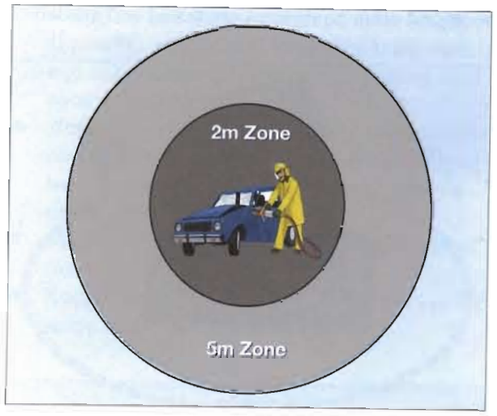



*Figure 4.2 The Action Circle*

Tools and equipment used at the scene should be carried into the action circle, used, and returned to the tool staging area. Any debris removed or cut from the vehicle should be placed outside the action circle, in order to create a working area free of any unnecessary obstructions which may otherwise have become a problem to rescuers working around the incident. However, any debris from the vehicle that could form part of the evidence the police will use in their investigation should be left in situ providing it is not an obvious danger to those at the scene.

The action circle is a theoretical area around the scene that should be kept clear of debris, idle tools, spectators and non-essential personnel.

### 4.2.6 Tool staging

A tool staging area should also be established during the set-up phase. Located at the edge of the action circle, the staging area is usually set up by laying down a salvage sheet upon which the tools, blocks, etc., can be placed.

Such preparation and systematic approach will ensure a designated place where the tools can be found when needed, a clean area for equipment preparation and whilst preventing any kit forming an obstruction around the incident. As the incident progresses, oncoming appliances will also be able to easily locate a position for their tools when they arrive on the scene.

The use of a tool staging area will help keep the tools and other equipment organised and available.

*Figure 4.3 Tool Staging*

### 4.2.7 Summary

The establishment of command, initial scene survey with inner and outer circle surveys, setting up an action circle and the establishment of a tool staging area can all be performed as the crew arrives on the scene.

These few moments spent setting up the rescue scene will ensure an efficient and faster result. The Incident Commander must always make provision for the simultaneous treatment of all casualties. Each minute added unnecessarily to the casualty's time at the scene can directly effect their chances of a quick and full recovery. Safety and efficiency must be the main aim for those committed at the rescue scene.

**Good scene management ensures a safe and efficient working area. It will reduce frustration, congestion and confusion and helps prevent rescuers becoming part of the problem rather than the solution!**

SCENE ASSESSMENT AND SAFETY 2

## 4.3 Collision scene safety

### 4.3.1 Personal protection

All firefighters working inside the action circle must wear full protective clothing. This includes:

- **Full fire fighting gear**
- **Medical gloves**
- **Debris gloves/heavy duty gloves if handling cables etc.**
- **Eye protection. Helmet visors should also be worn whilst cutting.**
- **Hi Visibility Jackets.**
- **Respiratory Protective Equipment (RPE).**

(See Section 3.1 details of PPE Standards.)

Very few situations permit the removal of any protective clothing. The potential for injury is always present when tools are used at the extrication scene. Rescuers (including E.M.S.) who are not protected take unnecessary risks and can become a liability rather than an asset to the situation.

### 4.3.2 Notes on tool positioning and safety

Always warn others when commencing any tool operation. Use the "impact" warning (or some thing similar) prior to the yielding of vehicle sections when cut. This will enable the casualties to be briefed to anticipate the noise before it occurs.

Always handle the tools correctly, positioning hands where the manufacturers intended.



If a hydraulic tool leaks under pressure, close down the power at the unit. Never place yourself near the leak. Hydraulic fluid under pressure can pass through the skin, possibly leading to amputation of the affected limb or, in extreme cases, death.

Remember that impacted metal will become stressed and tear at weak points. Sharp edges of steel can act like a blade, being capable of causing serious injury.

Heavy hydraulic tools tend to turn while operating, seeking the path of least resistance. This reaction can pin a rescuer's body to the vehicle. Therefore, personnel should anticipate the reaction and position themselves accordingly.

Hydraulic spreaders can lose their grip on metal, which can cause the tool to spring out towards the operator.

Rescuers should stand to one side of a heavy hydraulic tool in case it slips. This will also ensure a better posture for support possibly preventing a back injury.

Do not try to brace a door with your body or hands when acting upon it with heavy hydraulic spreaders – the force exerted on the door when it yields can cause injury.

Be careful when cutting "free ends" as they can become a projectile. Protect yourself and others.

When lifting a vehicle always "jack and pack". The blocks or cribbing should be placed under the load without exposing the rescuer to injury (hands on the sides). In areas that are hard to reach, place the block piece in a safe position and push it into the unsafe area with a tool or another block.

Working with extrication tools requires anticipation and proper hand and body positioning.

### 4.3.3 Safe cut philosophy

To be sure that there are no post-mounted supplementary restraint systems (or other hazards) obscured from view by internal vehicle trim, **it is of upmost importance to strip away this trim before attempting to cut the post**.

### 4.3.4 Notes on overall scene safety

- Until the scene is made conspicuous to other road users there is a possibility of further vehicular involvement.
- When coning off a carriageway always face the on coming traffic. Start at the side of the carriageway, walking backwards cone out into the carriageway. Always bear in mind that traffic may still be passing the incident. Stepping out into an uncontrolled carriageway can prove to be a fatal move. The Incident Commander may nominate a Safety Officer to ensure the awareness of rescuers of any passing traffic.
- During the initial set-up at an incident, an action circle should be established that takes account of any hazards or obstructions.
- Always set up firefighting equipment. All firefighters should be aware of the siting of this equipment at the incident and whenever possible one firefighter should stop with it.
- Any hazards at the incident should be identified and the crew warned accordingly. If possible any hazards should be made safe, e.g. disconnection of the vehicle battery, as soon as appropriate.
- Any debris should be made safe. This includes covering sharp edges, isolating glass, securing loose sections and taking any large items of debris outside the action circle.
- Make sure that the casualty is protected at all times.
- Keep the medical attendance and others at the scene safe, 'diplomatically'.

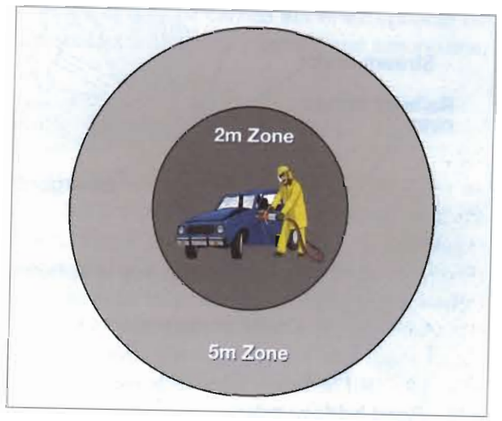



*Figure 4.4 The Action Circle for Safe Working.*

## 4.4 Motorway procedures

### 4.4.1 Introduction

The procedures, laid down in this Manual for dealing with incidents on motorways, have been formulated for the protection of both motorway users and service personnel and it is imperative that strenuous efforts are made to comply with them. Personnel should only deviate from this guidance where it is clear that not to do so will put life at risk.

These procedures apply to both the recognised motorway network and motorway-style roads, e.g. A1, A1(M). The contents of this Manual and the relevant safety aspects apply equally to fires, chemical spillage and any other incidents on a motorway as well as to Road Traffic Collisions.

**For purposes of this Manual, the M1 Motorway, together with the A1/A1M have been chosen as a typical example of the multi-carriage-way road network.**

### 4.4.2 General – Carriageways

- The M1 motorway (being a typical example) consists of a three lane carriageway in each direction, being separated by a central reservation. The northbound carriageway is known as the 'A' carriageway and the southbound as the 'B' carriageway.

- On the nearside of each carriageway runs a hard shoulder, this being separated from the carriageway by a marginal strip. The hard shoulder is the only portion of motorway where vehicles may stop in an emergency (mechanical breakdown or sickness).

- The A1 and A1(M) are very similar in design to the M1 except that in most places there are only two lanes to each carriageway, the carriageways being called simply northbound and southbound.

### 4.4.3 Junctions or interchanges

- These are constructed at intervals along the motorway where certain roads cross the motorway and access between the two is desired,

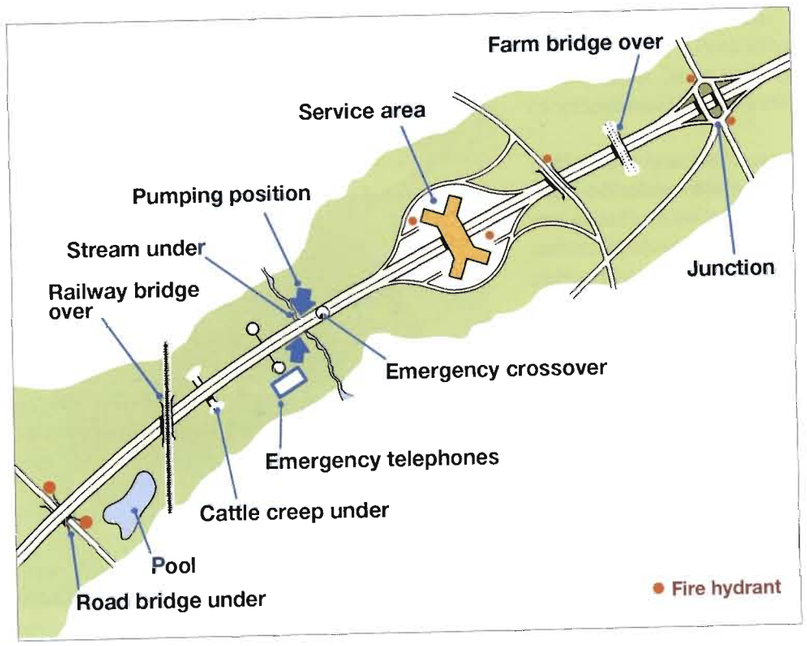
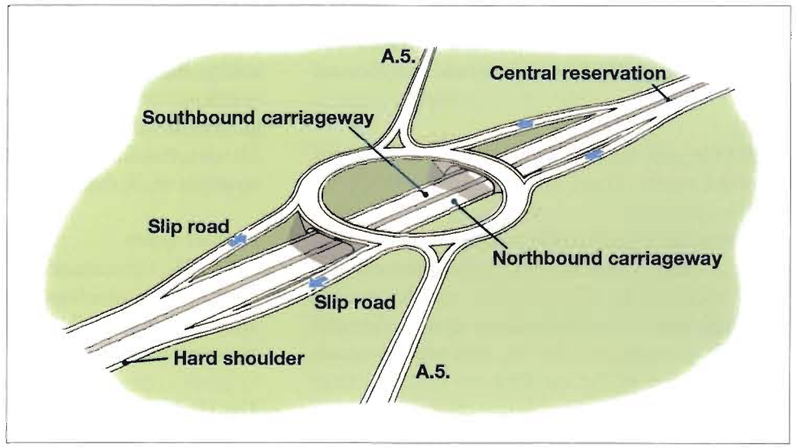



*Figure 4.5 Typical features of motorway design.*



*Figure 4.6 Typical motorway junction showing the means of access and exit.*




e.g. M1 Junction 26–A610 Nuthall. With the M1 they take the form of traffic islands either above or below the motorway with slip roads from the islands that filter onto the motorway.

- Care must be exercised at these islands to ensure that the correct slip road is taken because once committed the appliance will have to proceed to the next junction before it can turn round. Junctions on motorways are identified by a number and/or name, e.g. Junction 27 Felley.

- The situation is similar on the A1 and A1(M) except the access to slip roads may not be from a traffic island but from a normal junction in the road crossing over or below.

Occasionally there are junctions where vehicles have to cross the opposing carriageways to either enter or leave the A1. Junctions are identified simply by name only.

### 4.4.4 Service areas

- A service area is located at Trowell near Junction 26 on the M1. In addition to the normal services it contains a Police post and fire hydrants in both the north and south car parks.

There is also a service bridge where changing over to the opposite carriageway is permitted, if necessary, during an emergency. Access to the bridge is prevented by a coded barrier.

Contact: the appropriate Fire Control can supply the code – **EMERGENCY USE ONLY**.

- Service areas on the A1 are not as defined as on the motorway and may be confined to one carriageway only. There are no facilities for traffic to cross over the opposing carriageway to gain access to services.

### 4.4.5 Emergency crossings

These crossings can be found at intervals in the central reservation. They are kept closed by barriers. Although a member of the FRS, in the exercise of their duty, is exempted from the regulation which make it an offence to make a 'U' turn on the motorway, such a manoeuvre is extremely dangerous, even when the motorway is apparently clear and should only be carried out in exceptional circumstances with police approval and supervision.

### 4.4.6 Emergency Telephones

- Emergency Roadside telephones (ERT's) are provided for use by the public in cases of breakdown, illness and other emergencies. Telephones are located at the side of each carriageway, usually opposite each other at intervals of approximately 1 mile. They are also positioned between the entry and slip roads. Carriageways or slip roads should never be crossed in order to use an ERT.

- ERT's are numbered according to the nearest marker post. They also have the letter that indicates the carriageway, slip road or link road that they are on.

- ERT's are connected to the HA Regional Control Centres.

- There are no emergency telephones provided on the A1 and emergency calls will almost certainly be received by Fire Control via the normal British Telecom or mobile phone system. For this reason it is imperative that full and precise details of the location of the incident are obtained from the caller.

### 4.4.7 Marker posts

- Marker posts are positioned at 100 metre intervals at the side of both carriageways. They can pinpoint particular locations to within 100 metres and should always be quoted when attending an incident.

- They display 2 sets of figures, one above the other. The number on top indicates the distance of that post from the start of the motorway or datum point in kilometres, to the nearest 100 metres. The number beneath indicates 10ths of a kilometre. An additional letter A indicates a carriageway that leads away from the start of the motorway and letter B denotes one returning. Marker posts also indicate the direction of the nearest emergency roadside telephone with a picture and an arrow.

### 4.4.8 Motorway crash barriers

Motorway crash barriers (also known as safety barriers) are designed to prevent vehicles from crossing from one carriageway to the other and to prevent vehicles from impacting or entering roadside hazards. The barriers are also intended to absorb some of the energy from the impact caused by the vehicle striking it and to redirect the vehicle along the line of the barrier so that it does not turn around, turn over or re-enter the stream of traffic. This is called containment.

**Performance**
Safety barriers are tested to European Standard EN1317, which is a standardised performance test. A barrier designed for normal containment would be tested with a vehicle of 1.5 tons (an average car) hitting the barrier at an angle of 20 degrees at a speed of 70mph. High containment barriers would be tested with a heavy commercial vehicle, up to 38 tons, travelling at 40mph, hitting the barrier at an angle of 20 degrees.

**Barrier types**
In the UK, there are several different types of barriers available, which perform differently on impact. They can either be flexible, such as a steel wire rope or a steel beam, or rigid as with concrete barriers.

The Highways Agency has stated that it would be willing to consider other materials or systems if they were to meet ES1317 test standards.

The barrier of particular interest to the FRS is that of the **Steel Wire Rope**.

Following an impact with a light vehicle, the fence is unlikely to need de-tensioning. However, if impact has occurred with a large goods vehicle, de-tensioning of the ropes may have to be carried out, to assist extrication or recovery.

Only if the ropes cannot be removed without causing further disruption to the casualty, should the ropes be cut.

To avoid the risk of injury or damage caused by the ends of the wire ropes flying loose, the tension must be removed by the following procedure.

(1) Reduce the tension in the ropes by going to the nearest rigging screws and loosening them.
   - To do this, two spanners are applied to the octagonal fittings on the ends of the ropes
   - Turn the rigging screw using a 'Tommy bar' or wrench
   - It may be necessary to completely unscrew the rigging screws at both sides of the incident due to the ropes being entangled with the vehicle.

(2) The tension must be removed by the above procedure BEFORE CUTTING to avoid any risk of injury or damage

**ONLY CUT DE-TENSIONED ROPES.**



### 4.4.9 Mobilising – receipt of calls

- Depending on the circumstances an emergency call can be received from the HATO RCC or Police Control or direct from, for example, a passing motorist using the 999 facility. Whichever is the case it is imperative that full and explicit information is obtained.

- This information should include:
   **(a)** Whether the incident is on the A or B, or northbound or southbound carriageway.
   **(b)** The number of the nearest access point.
   **(c)** Whether the incident is north or south of the nearest access point.
   **(d)** The exact nature of the emergency.

- On receiving such a call the police and, if necessary, the ambulance controls will be informed.

### 4.4.10 Typical Response

- The typical response to fires will be two pumps and to special service calls, e.g. Road Traffic Collisions, will be two pumps and a Rescue/Emergency tender.

- The typical response for RTCs will be dispatched as follows:
   One pump and the rescue/emergency tender on the carriageway on which the incident is reported and the second pump from the opposite direction on the other carriageway.

   This dual approach will cover the following contingencies:
   **(a)** The incorrect carriageway being reported in the initial emergency call.
   **(b)** Vehicles being spread across both carriageways following an incident.
   **(c)** Traffic building up over all lanes behind an incident and delaying appliances on the affected carriageway.

### 4.4.11 Crew safety

Full personal protective equipment and fluorescent surcoat must be donned by all personnel except the driver who will do likewise as soon after arrival as possible. Under no circumstances must personnel venture onto the carriageway unless wearing the above mentioned clothing. Personnel dismounting from appliances must do so from the opposite side to passing traffic.

It cannot be over emphasised that there is always danger from fast moving traffic and each crew member must be constantly alert for their own and their colleagues safety. Never step into or cross a lane open to traffic.

Great care must be taken when obtaining equipment from lockers on the 'traffic' side of appliances.

### 4.4.12 Approaching an incident

In the case of vehicle crashes, these often occur during adverse weather conditions. It is therefore vital that incidents are approached with due consideration to the weather conditions. This is not only to ensure safe arrival of the crew at the incident but also to try and obviate a further accident involving passing motorists.

Full use of blue flashing lights, headlights and in foggy conditions, rear fog lights is important.

### 4.4.13 Positioning of fire appliances and other responders

The following procedure has been agreed with ACPO and is the same that appears in the Guidance on Policing Motorways 2006 Manual.

It should be noted that although these procedures have been devised for use in the Motorway environment their principles are strong for use on any road. Also these procedures, and those for Coning, Fend Off and Signing, have been designed for the Police but are seen as good practice and should be adopted by the FRS. The FRS may not have all the appropriate equipment to carry out the tasks as outlined but should be capable of following the basic principles. The Highways Agency will always attend an incident on a Motorway and will be able to take over these roles. See 2.2.6.

The Police will treat an RTC just like any other type of incident and will assume responsibility for the outer cordon and the FRS will deal with the

inner cordon. To this end the Police will park their vehicles at the "outer cordon" and will in fact be the closest vehicles to the non involved vehicles. Figure 4.7 illustrates how all responding vehicles should be positioned.

It is the responsibility of the police in conjuction with the HATOs to provide a safe working area for other services. Emergency services arriving at the scene will be directed to the best position in which to stop their vehicles considering the danger of passing traffic and the needs of those attending to perform their role. Priority is clearly given to life saving and casualty handling requirements. Emergency vehicles will be directed beyond the police vehicle(s) providing advance warning and within the coned off area. The 50m area between the police vehicle and the incident is intentionally left clear for the FRS to position their appliances. This should enable sufficient space for specialist fire fighting or extrication equipment to be deployed. In the event of a fire at which the FRS is in attendance, the responsibility for fighting the fire will be with the senior fire officer. It will be the responsibility of the police to assist with any reasonable request.

The ambulances will usually be positioned beyond the incident. This will allow safer loading of casualties into the ambulances and allow them to leave more quickly.

The co-operation of all emergency and other partners will be required to maintain free passage to and from the scene and to keep traffic moving at a safe speed. The overall control and scene management sits with the police. Police must inform the other partners at the earliest opportunity of any special road conditions at the scene.

All services must share information that is relevant to the safety of personnel at the scene and the effective command of the incident.

**Note** The FRS Incident Commander should determine the best operational position for the appliances and should discuss this with the Police. If further fire appliances are required it may be appropriate to position these in front of the Highways Agency and Ambulance vehicles.

If the police are not in attendance on arrival and no warning signs or traffic cones are in position, an appliance should be positioned as a warning to approaching traffic in a 'fend off ' position 50 m to the rear of the incident. This is the distance recommended to give adequate warning to fast moving traffic and should be adhered to whenever possible.

At incidents in lane one of three lane motorways, one FRS appliance should be positioned in the 'fend off' angle in the lane approaching the incident. A second appliance, on arrival, should proceed beyond the incident and stop on the hard shoulder.

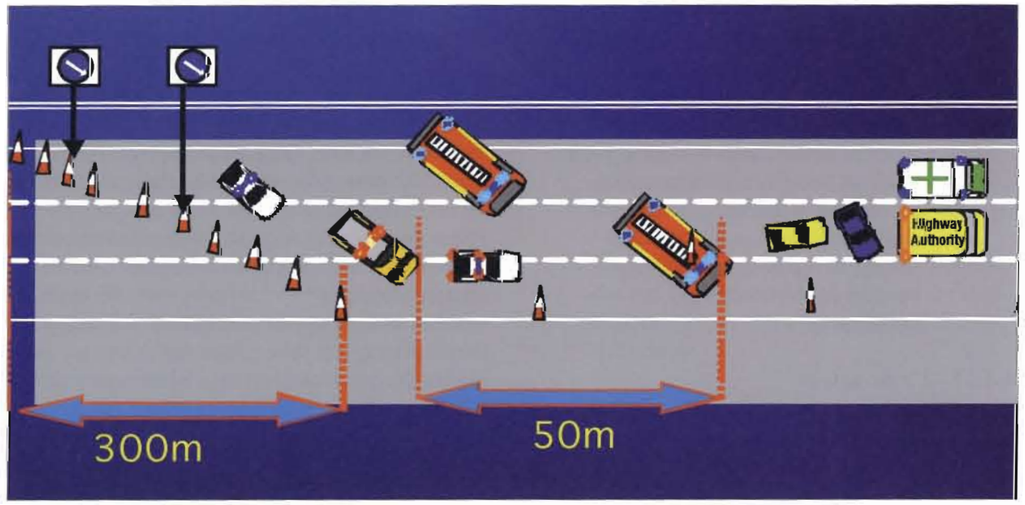



*Figure 4.7 Obstruction of Lanes One and Two.*



At incidents in lane one and lane two, two appliances will be required for the 'fend off ' angle and should be parked in lane one and lane two.

At incidents in the lane two only, on no account should an island be formed with traffic passing the incident on either side. Two appliances should be positioned in the 'fend off ' angle in lane two and lane three leaving lane one and hard shoulder as running lanes.

When the incident is in lane two and there are stationery vehicles on the hard shoulder in close proximity to the incident, lanes one and two should be cordoned off leaving lane three as the running lane

At incidents in the lane three, one appliance should be positioned in the 'fend off ' angle in the lane approaching the incident. Other appliances should be parked beyond the incident in lane three and not on the hard shoulder so, if equipment is required, it is not necessary to cross the flow of traffic.

If the incident involves both the lanes two and three, two appliances will be required to divert traffic into lane one and the hard shoulder. The appliances should be positioned in the 'fend off ' angle in lanes two and three.

### 4.4.14 Fend Off

There are two main methods of positioning emergency service vehicles in the carriageway. Both of the following procedures are in use by the Police and local planning will assist you in identifying the one that the police force in your area uses.

- 'In-line' – The emergency vehicle is parallel to the running lanes on the carriageway. This maximises rear facing lighting due to the size of the car compared to the carriageway. Patrols should be aware that to the approaching traffic the stationary 'in-line' vehicle could appear to be moving with the traffic.
- 'Fend-off' – The police car is angled, pointing front end towards the carriageway in the direction the traffic should pass. This method will effectively fill the lane to be closed and act as a visual reinforcement of the cone taper. It will appear stationary to the approaching traffic but the effectiveness of the lighting will be reduced

### 4.4.15 Coning

Cone tapers must be at least one hundred metres per lane closed with one police vehicle in each closed lane, where possible. The object of the exercise is to cause traffic to change lanes gradually before reaching the obstruction. If the taper is too severe, further collisions could occur through vehicles being forced into the path of traffic using adjoining lanes.

- Always cone a complete lane, never part of a lane.
- Never make an island with the cones, i.e. do not isolate yourself between two lanes of live traffic.
- Coning should start at the point of the taper. In stationary traffic it may be necessary to work back from the police car clearing the cone area of vehicles in the process.
- It is preferable to leave the hard shoulder open at a motorway incident to allow the emergency services access into the scene.
- Only the rearmost police vehicle in each lane closed should display full emergency rear facing lighting. Crews should consider the purpose of this vulnerable police car and view it as a 'line of defence'. When parking in the 'fend off' the police car must be angled in the same direction as the cone taper.
- Use direction arrow signs to reinforce the cones.
- If available, additional lighting should be considered particularly in reduced visibility.
- The excessive and inappropriate use of emergency warning lights at the scene of an incident can have an adverse affect on the traffic. It is suggested that only the rearmost vehicles, protecting the scene and any control vehicles, display blue warning lights to the traffic on the affected carriageway only.

### 4.4.16 Signing

When attending an incident consideration should be given to:

- Is it necessary to close the lane(s), given the prevailing conditions?
- A hazard zone of a minimum of 2 metres around the collision scene is required. If the scene reaches the outside edge of any lane the next lane will need to be closed to ensure the integrity of this hazard zone.
- Ensure all signs and other equipment are undamaged and in a serviceable condition.
- Carry out a risk assessment prior to erecting equipment, paying particular attention to weather conditions. Be aware that in bad weather (e.g strong winds, heavy rain etc) equipment may move and cause obstruction/hazard on a live carriageway.
- If advance signing is necessary it should start at 900m prior to the scene and then at 300m intervals, i.e 900m/600m/300m. Sight lines of approaching vehicles must be considered.
- Signs will normally only be placed on the hard shoulder.
- 'Police Slow' signs should be placed at 900/600/300m.
- Always watch the approaching traffic.

### 4.4.17 Emergency lighting

Excessive use of blue flashing lights at an incident is not advised. The rearmost vehicles protecting the scene should display warning lights to the traffic in the affected carriageway only. In fog, rear fog lamps provide an additional useful warning.

At night or during fog, a searchlight should be erected on a tripod behind the rearmost appliance in order to illuminate it. Where fitted, remember to make full use of a telescopic floodlight mast. This will also assist in giving warning to traffic.

The use of vehicle hazard warning lights can be useful, but it is important to ensure they do not obscure the visibility of the blue flashing lights.

### 4.4.18 Water supplies

The supply of adequate water for fire-fighting at incidents on motorways and major roads can be a major problem. Fire Service Manuals detail the types of hydrants that can be found on or close to motorways and major roads but it is imperative that exhaustive pre-planning for water supplies is undertaken. In-cab data systems/information are invaluable when trying to locate water supplies, local knowledge is also essential.

### 4.4.19 Spillage of dangerous substances

Appliances must not, under any circumstances be driven through a spillage of flammable, corrosive, toxic or other dangerous substances unless the Incident Commander has first ensured that the spillage has been neutralised or otherwise dealt with. Should a spillage occur, the police vehicle protecting the scene will take up a position further to the rear than is normally the case, so as to permit fire appliances to stop between the incident and the protecting police vehicle.

### 4.4.20 Operational procedure

The Incident Commander will need to take a large number of factors into consideration when making his assessment of the situation on arrival. Other Fire Service Manuals cover many of these factors but it is useful to reiterate the following points in this Manual:

- Taking into account the resources available or mobile to the incident the Incident Commander should adopt a plan of action and implement it at once.
- Requests for assistance should be made as soon as possible.
- It is important not to keep chopping and changing the plan of action. For this reason it is imperative that a thorough assessment is made of the whole incident before any of the above decisions are taken.

### 4.4.21 Liaison with other services

At present, if the incident in question is a fire, then the Senior FRS Officer in attendance is in charge. If the incident is other than a fire, e.g. RTC, spillage of chemicals, then the police are overall in charge. (Note, current legislation passing through parliament may alter this in the near future.)

Whatever the incident and whoever may be in charge it is essential that close liaison is maintained at all times between all emergency services and other support services, such as the relevant Environment Agency if spillages are involved..

This liaison is essential to ensure the maximum efficiency in coordinated efforts to rescue trapped victims, extinguish fires and render any other possible situation safe.

This liaison is a duty in Scotland under the Fire (Scotland) Act 2005, Section 10.



**STABILISATION/INITIAL ACCESS 1**

## 4.5 Vehicle stabilisation

### 4.5.1 Purpose

At the scene of a vehicle rescue incident – the geographic layout may be less than obvious. The presence of a hill or slope may be a reminder to secure the vehicle, but an insignificant gradient may go unnoticed.

The vehicle may well be secured by collision damage but it should be remembered that ramming, cutting away or pulling during operations can release the vehicle allowing it to become a runaway. Not only would this situation be abhorrent but also it would cast obvious and fair blame on the attending Rescue Service.

Where the casualty is seriously injured or otherwise in a critical deteriorating condition the vehicle must be secured and stabilised. This simple action will yield several benefits some of which may never be obvious to the attending rescue team. Proper stabilisation will prevent flexing of the floor pan and movement or rocking of the vehicle particularly when personnel climb into or onto the vehicle.

It is important to note that if a firefighter climbs into or onto a collision-damaged vehicle prior to realistic stabilisation, they may be subjecting the casualty to increased crushing. The body weight of personnel within the car may be directly supported by the casualty's trapped legs, particularly where the windscreen pillar has given away under impact, or is cut during the rescue.

Securing the vehicle in a realistic manner will help to avoid rocking when carrying out certain techniques and suppress jarring when operating equipment, especially where a part may be jettisoned under load (e.g. forced door removal). It will also ensure that the medical attendance have a sound base of their pre-hospital care, which could involve CPR.

There is seldom any feedback about the person who was trapped but it is known that Post Collision Trauma is potentially lethal. Being released from a correctly secured vehicle must be considered as less traumatic.

### 4.5.2 The logic

Before beginning any work on the vehicle, it must be completely stabilised in order to prevent further injury to the casualty and to protect the rescuers.

The properties of a good stabilisation method are:

- It must safely secure the vehicle.
- It must completely immobilise the vehicle, preventing it from any movement at all and reducing the casualty's chance of further cervical and spinal injury.
- The method should be simple, being able to render a given vehicle stable in a position as found upon arrival of the rescue crew.
- The method should not take a long time to set up.

Although a damaged vehicle may be found in many positions after a motor vehicle accident, the features most resulting in the need for stabilisation are:

- **Stabilisation of a vehicle, resting on inflated or deflated tyres** on a horizontal or inclined surface with a functional suspension system.
- **Stabilisation of a vehicle on its side** with the inflated tyres in contact with the ground.
- **Stabilisation of a vehicle on its side** with the roof in contact with the ground.
- **Stabilisation of a vehicle on its roof** with the bonnet or boot area in contact with the ground.
- **Stabilisation of a vehicle on the roof** with neither the boot nor bonnet in contact with the ground.

### 4.5.3 Stabilising of a vehicle resting on its wheels

Before the commencement of operational involvement it is essential to secure the vehicle/s.

A minimum of three points of stability must be used but four and five points, if possible, are strongly advised. The stabilisation blocks should be strategically placed to ensure maximum stability as seen below. (See Figures 4.8 and 4.9.)

**Note:** If the vehicle is not on its wheels, block and secure from a minimum of three structural strong points.

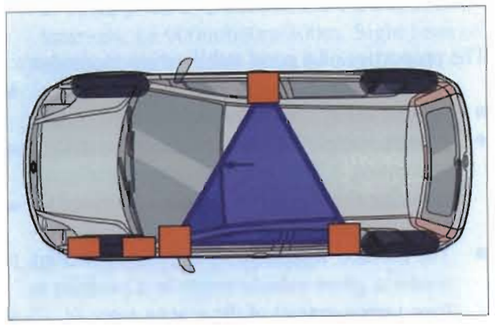


*Figure 4.8 A minimum of "3 point" stability is required*

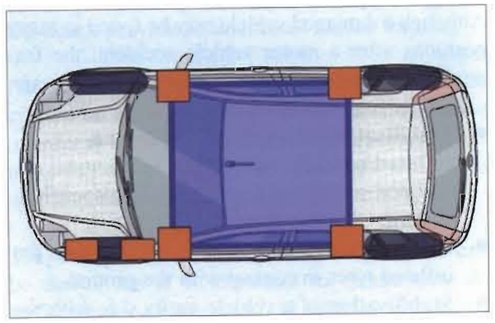


*Figure 4.9 "4/5 point" stability is considered best practice ("5 point" if the casualty is to be taken out through the rear of the vehicle).*

**(a)** Chock the wheels with appropriate "wedges and blocks" to eliminate any lateral movement, which must be achieved every time, not only when working on a gradient.

**(b)** A minimum of one wheel, but preferably two – diagonally, is considered best practice.

**(c)** Block to the rear of each sill around the jacking points ('4 points'). Add further stability (5 points) to the rear as required.



**(d)** Block the front seat cross member at the sill. When necessary, block around damaged sill section. (This will help support a fractured sill, a must if the roof is to be removed.)

**(e)** "4 or 5 point" stability best practice achieved, the extrication "phases" can continue.

**Note:**
During operations the blocks should be checked. As various loads are released, they may be dislodged.

### 4.5.4 Flat tyre blocking

The reason for flat tyre blocking is that it gives a very stable platform from which to work. Blocking is placed under the frame of the car and then the tyres are deflated, the car then sits firmly on the blocks.

This method can be utilised when victims have suspected spinal injuries to the back or neck and have to be extricated. It can also prove beneficial when the casualty has severe trauma injuries and the Ambulance Service or Doctors have to attend to them in situ.

However, in a fatal crash flat tyre blocking can destroy vital evidence for the police, i.e. tyre pressures. It is because of this that many Fire and Rescue Services have adopted the policy of only employing flat tyre blocking if absolutely necessary.

If it is to be used the police officer in charge of the incident (normally the first attending officer) must be informed of the actions to be taken.

**Problems with flat tyre blocking are:**

- Destroys police evidence (tyre pressure).
- Damaged vehicle cannot be moved easily at the accident scene and provides a problem with regard to towing.
- Deflating the tyres is not always as effective when working on inclines or uneven surfaces.
- The vehicle will have to be raised after the rescue to recover the blocks.

### 4.5.5 Blocking – standard method

This is where blocks are positioned as before.

They are introduced to the sill with a wedge following.

Once the ground and metal contact have been achieved, the wedge should be pushed in carefully, or **tapped** in place with a rubber hammer as appropriate.

**Disadvantages**

- Chassis may move.
- Over exuberance can lead to unnecessary rocking of the car.
- Not as effective as flat tyre blocking.

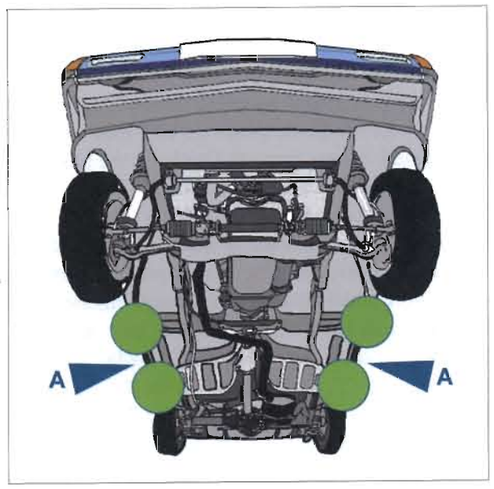



*Figure 4.10 This diagram shows the points of blocking under vehicle.*

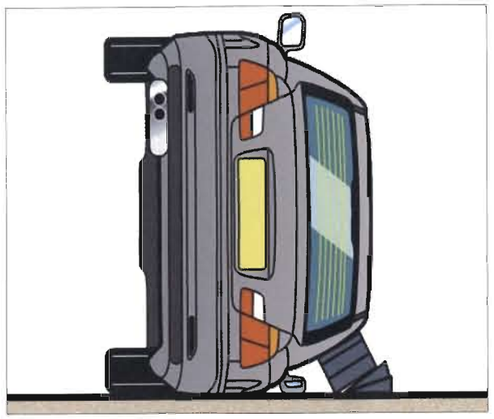
### 4.5.6 Vehicle on its side

A vehicle that comes to rest on its side can be in one of the most difficult positions to stabilise, with the possibility of "roll" movement and danger to the medic, who may try to enter the vehicle before initial stability is achieved.

**Note:**
Consider possible egress required as use of lines may pose a problem with obtaining a clear path.

**Vehicle on its side with the boot or bonnet in contact with the ground, points to consider here are:**

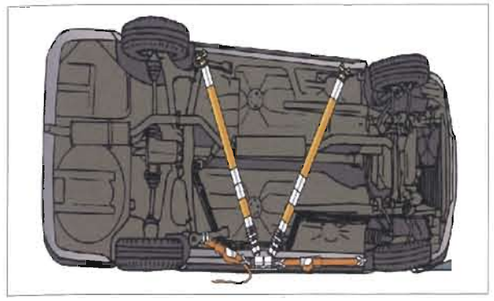
- Is the roof damaged or does it need to be cut or removed for access or egress purposes?
- Again, block under strengthened parts, i.e. bulkhead and jack up under either the bonnet or boot, depending which one is not in contact with the ground, until a solid base is achieved.



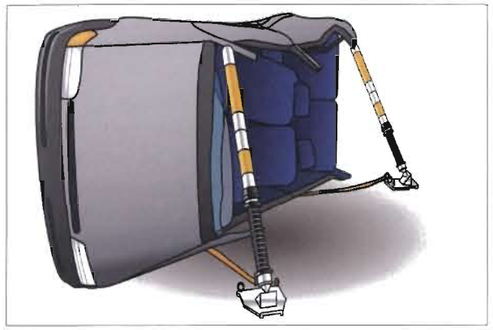
**(a)** Support and chock under strengthened parts of the vehicle 'A', 'B' and 'C' post where the gap can be seen on the ground. Think ahead; avoid placing stabilisation in areas where you are likely to cut.

**(b)** Shore on the under side (the dirty side) with mechanical struts (wood, metal), or pneumatic struts. Ladders may be used to achieve comparable stability.





**(c)** Fasten the struts in place using tension belts or by use of a mechanical mechanism. Ladders can be secured with "ratchet straps", if available, or lines if not.



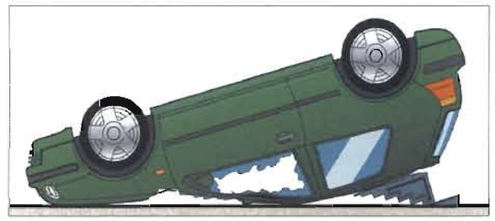
**(d)** Depending on the situation (i.e. limited access), it may be necessary to use shoring to stabilise the roof side of the vehicle. (Including, or instead of, the underside.)

**(e)** When best practice is achieved, the vehicle will now have a stable base, allowing continued extrication utilising the next phase of rescue.

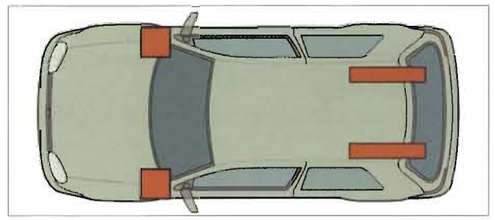
### 4.5.7 Vehicle on its roof

Vehicles that come to rest on their roof, may be unstable in more than one direction, i.e. "pitch & yawl" and it has been known that the casualty may be still held in place by their seat belt, therefore also requiring stabilising!

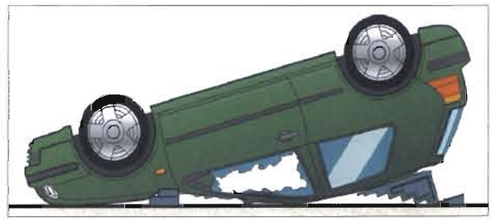
**Note:**
Vehicle on its roof with neither the bonnet nor boot in contact with the ground is harder to stabilise because the vehicle is susceptible to 'yaw' especially in icy conditions or if glass is under the roof.



**(a)** Chock the space between the back of the vehicle and the ground. Note, on this occasion inverted step blocks perform their function better.



**(b)** Most cars have their engines mounted in the front of the vehicle, therefore tend to lean forwards; utilising the "4 point" stability rule is often the best solution.



**(c)** Add extra blocks to the space between the engine compartment and the windscreen for added stability.

The vehicle will need support under the bonnet and boot to stop a rocking action. Do not over do, so that the roof loses contact with the ground unless that is planned for in the extrication technique.

### 4.5.8 Summary

Firefighters must practice and train as a crew to achieve effective stabilising with different vehicles in a variety of locations, e.g. soft ground, ditches, etc.

Everyone must know and be aware of the importance and speed required to stabilise, and to be aware of the ways the objective can be reached.

### 4.5.9 Vehicle movement

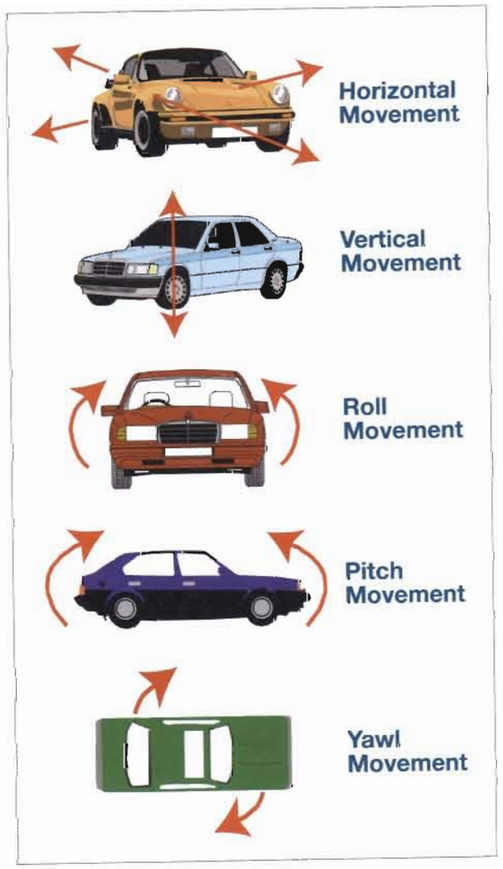



*Figure 4.11 Vehicle movement.*

**Horizontal Movement**
~ vehicle can roll forward, backward, or slide left, and right

**Vertical Movement**
~ vehicle moves on suspension

**Roll Movement**
~ casualty may be tossed from side to side

**Pitch Movement**
~ occurs whenever a weight or load is applied over the front or rear of the vehicle

**Yawl Movement**
~ especially possible when on snow or icy surfaces and on broken glass in particular when on its roof.

**STABILISATION/ INITIAL ACCESS 2**

## 4.6 Casualty triage

When attending vehicle rescue incidents casualty care must be high on the list of priorities. It is important to establish the number and severity of casualty injuries as soon as possible after arriving at the scene, one well-established method of establishing casualty priority is to perform "Triage".

### 4.6.1 Multiple casualties and the use of triage

Triage comes from the French meaning 'to sort' or 'sort out' and was first used by a French army surgeon during the Napoleonic Wars. The objective then was not so much as who could be saved by quick attention to injuries but who could be quickly patched up and sent back to battle.

When faced with an overwhelming amount of injured persons, the principle now is to classify casualties according to the seriousness of their injuries, i.e. who should be treated first, and therefore maximise survivors by concentrating the available medical help on these casualties.

FIRST PRIORITY

The casualty has a life-threatening emergency and will die if there is no immediate intervention.



Immediate treatment to be given in the following:

- Airway obstruction.
- Cardiac arrest.
- Respiratory arrest or severe breathing difficulties (<9 or >28 breaths/min).
- Burns involving the respiratory tract.
- Uncontrolled bleeding (Obvious or suspected internal).
- Severe head injuries.
- Chest trauma.
- Abdominal trauma.
- Severe shock.
- Unconsciousness.

SECOND PRIORITY

- Severe burns.
- Injuries to the spine (including cervical spine).
- Moderate bleeding.
- Conscious casualties with head injuries.
- Multiple fractures.

LOWEST PRIORITY

- Minor bleeding.
- Minor fractures and minor soft tissue injuries.
- Moderate and minor burns.

*Figure 4.12 Important Initial Considerations: "C" Spine Immobilisation and Oxygen administration.*

## 4.7 Glass management

### 4.7.1 Removing glass

Once the vehicle has been stabilised, and the casualty has been accessed and protected, the next task is to remove the glazed areas as required. If the roof is to be taken off completely this may involve removing all the glass. Glass fitted to motor vehicles is usually either **toughened or laminated**; although armoured/polycarbonate glazing can be fitted for exceptional security, on specialist vehicles.

All types of glass present a hazard to rescue workers and casualties alike (glass in an open wound usually requires scrubbing clean). To prevent this, and the danger of cuts and possible contamination, all glass should be managed properly. This involves following certain guidelines.

Laminated glass is used on the front and rear screens with toughened glass down the sides. However, designers in an effort to create slicker looking cars with low drag factors (and better protection from crime) are utilising laminated glass in other areas.

### 4.7.2 Management application

There are three main approaches for managing glass:

- Controlled removal
- Controlled breakage
- Leave alone

### 4.7.3 Removing toughened glass

Toughened safety glass is made by pouring molten glass into a mould and cooling it rapidly. This causes a degree of tension across its outer surfaces. When hit hard enough to release this surface tension, the glass disintegrates into small pieces approximately 5 mm in diameter. If the window section remains in a frame the broken glass will generally remain in place. If, in the case of roll down windows, the glass is free to expand out it will result in a shower of small glass pieces.

*Figure 4.13 Removing the "gasket" seal.*

*Figure 4.14 Using a spring-loaded Centre Punch.*

Whenever possible, and if time allows, fixed toughened glass should be removed intact. This is achieved by cutting around the seal and removing the outer portion that holds the glass in place.

If the glass is to be broken two possible methods are:

(i) This is the preferred method; a spring-loaded centre punch or similar sharp device (i.e. glass hammer) can be used to break the glass. When using a centre punch, position it in a corner over the rubber weather strip or seal. Applying pressure with a gloved hand will break the glass in situ. (See Figure 4.14.)

(ii) With power shears – this can be achieved with some control, by slowing down the closing action of the jaws until the points' just bite, then closing through after giving a warning.

**NOTE: With either method protection should be provided.**

**Once the glass has been broken the fragments should be pushed outwards away from the vehicle, with a tool, not a gloved hand.**

Thought should be given to the debris as it can still be a slip or cut hazard (emergency medical services may have to kneel on the floor when working on the casualty). Any glass debris on the ground should be removed or sheeted over.

Whenever a door is to be forcibly removed the glass should be removed first. This can be done by rolling down the glass leaving a little exposed, covering the top with a sheet and punching the glass. The glass will then drop into the bottom of the door. If the glass is left in place, forced door removal operations can break the glass causing a fragment shower, even if the glass is below the bottom of the weather seal. (See Figure 4.15.)

### 4.7.4 Removing laminated glass

Laminated windscreens usually consist of multiple layers of glass and plastic sandwiched together to produce the finished product. Most of the laminated glass used in motor vehicles consists of an inner and outer layer of glass with a plastic laminate material between the layers.

In a collision, laminated safety glass is designed to fracture into large sections yet remain together. Impacts to this type of glass produce a spider web of cracks (see also mechanisms of injury).

*Figure 4.15 Allowing the glass to break inside the door skin.*



Laminated windscreens are often set in a mastic type of adhesive or glued in place with an epoxy glue, making it difficult to remove the window intact.

One of the following methods can be used to remove this type of screen safely:

- Using a specialised bonded windscreen tool (Kent tool) the bonding can be separated from the screen. **This is a difficult and time-consuming operation.** Various tool manufacturers provide a range of blades for different cars.
- Whilst protecting the casualty, cutting through the screen can be best achieved using a glass saw. As large amounts of glass dust are created, **respiratory protection, i.e. a dust filtration mask**, is a necessity whilst carrying out this technique, and for some time afterwards.
- The glass can be chopped through close to the metal frame. To do this use either a large axe or aircraft axe. Start in the centre of the screen at the top and control the chopping motion towards you. Then chop down next to the screen pillar, after doing the same from the other side the screen can be folded out and the final cut to release made.
  Note: This method again produces lots of air borne glass particles and should not be the first choice of operation.
- Simultaneous screen removal. With this strategy, screen removal is not a single operation but one that incorporates partial or complete roof removal. When flapping the roof rearward the bottom of the screen has to be cut across. The major disadvantage with this operation is that the glass is raised over the casualty. Care should be taken as the glass can move away from the roof section. With total roof removal the roof section can be brought over the front thus breaking the seal at the bottom edge of the windscreen allowing the rescuers to remove the section completely.
- If a laminated windscreen is intact, best practice dictates leaving the glass alone and fold the roof forward just behind the "A post" alleviating the need for breakage.

### 4.7.5 Notes on glass removal

- Always wear full personal protection.
- Always, without exception, protect the casualties when you are breaking glass.
- When practical, control the glass when you break it.
- **Respiratory protection**, in the form of a particulate filtration mask is required for all persons within the 2-metre action circle and any rescuers inside the vehicle.
- When striking glass do so near the window framing.
- Warn others when breaking glass.
- Use a tool, not your hand, to bring the glass outward when broken.
- Roll down door glass, cover and break in situ.
- Any glass debris on the ground should be removed or sheeted over.

**SPACE CREATION 1**

## 4.8 Seat reversal and reclining

### Forced seat reversal

### 4.8.1 Purpose

One of the easiest methods available to create space around a front seat casualty, is to reverse their seat on its sliding mechanism.

Damage during the collision to the floor pan or the sliding mechanism may make operating the levers and pressing rearwards an impossible task. Some cars have electrically operated seats that are moved by depressing various switches. If, in those vehicles, the power supply is damaged the seats cannot be moved rearward.

An alternative method can be used to press the seat backwards using hydraulic powered spreading tools.

### 4.8.2 Preparation phase

- Visually check the 'A' post at the bottom, for damage.
- Completely stabilise the vehicle, ensuring any weakened sills are fully supported.

- Make sure the casualty is stabilised and protected from the "work".
- Connect up appropriate spreading tool.

### 4.8.3 Relocation phase

During this phase the side of the seat, closest to the side of the vehicle, will be forced back. The side to the centre,of the vehicle, will tend to stay in place. If the seat release lever can be operated simultaneously the whole seat can move rearwards.

(i) Open the spreader placing the tips against the bottom of the "A pillar" and the front of the outside sliding mechanism.

(ii) Push the seat side rearwards by opening the spreader (controlled movement).

### 4.8.4 Notes

Pushing effort must be angled to match that of the front seat structure regardless of the tool being used. Proper angle ensures that the seat will move down and back. If the pushing angle is too horizontal, the seat will be lifted or tilted.

Spreading against electrical powered seats will usually require more effort and may compromise the seat mounting.

As the seat moves it has a tendency to twist assisting egress, but this must not be allowed to affect the spinal stabilisation or other injuries the casualty may be suffering.

SPACE CREATION 2

## 4.9 Cross ramming

### 4.9.1 Purpose

When a vehicle collides with a solid obstacle, the resultant transfer of energy often relocates the metal trapping the casualty in the car. As professional firefighters we are aware of the necessity for making the "hole fit the casualty" rather than making the "casualty fit the hole". Therefore, it is of the upmost importance to create space, this not only allows for a more controlled extrication, but it also affords the emergency medical services access to the casualty. Unfortunately, many rescuers have tended to overlook this important technique and have tried to extricate the casualty without making the required amount of space.

### 4.9.2 Preparation phase

- Visually check the posts for damage.
- Completely stabilise the vehicle, ensuring any weakened sills are fully supported.
- Make sure the casualty is stabilised and protected from the work.
- Connect up the appropriate hydraulic ram tool, ensuring that you have measured the space and it fits!

Normally "cross ramming" as the name implies, is used to push apart a crushed vehicle, often taking it past its original design position.

### 4.9.3 Relocation phase

In the relocation phase the displaced metal will be pushed past its elastic limit allowing the metal to reposition appropriately, giving you the space to work.

**(1)** Place the ram between the components to be displaced, ensuring that there is as little "free space" as possible and the ram heads have a secure base to push from.
**(2)** Extend the ram, observing the movement of the metal, ensuring that the ram heads do not slip when under tension.

*Figure 4.16 Ramming to create space.*



*Figure 4.17 Cross ramming.*

**(3)** On completion of ramming, it is often possible to remove the ram, without compromising the safety of the incident, if in doubt, leave in place.

In Figure 4.17, the ram is positioned between "B" posts, this cross ramming technique is most suitable when making space in a vehicle that has sustained a side impact or "T" bone.

The wooden blocks are in place to reduce the "dead space" between the closed ram and the side of the vehicle, thus ensuring the ram is working efficiently as possible allowing maximum extension.

FULL ACCESS 1

## 4.10 Removing doors

### 4.10.1 Purpose

The decision to open, remove or displace doors will be one of the most frequent taken at the collision scene.

Opening vehicle doors can provide a large area to access the casualties inside. Totally removing or displacing the doors will provide a better working area, and a path to release the casualties.

### 4.10.2 Preparation phase

One of the most unpredictable aspects of vehicle rescue work is forcing open or removing the doors. There are several variables that must be considered before any door is opened. These variables are the damage from the impact, the condition of the metal around the door, the amount of rust present, and the construction of the door itself. With practice, the rescuers will become familiar with the different doors and the tools required to displace or remove them.

Prior to door removal:

- If not for immediate access purposes ensure the vehicle is correctly stabilised. (This can include extra blocking under the floor pan as the integrity of the vehicle may only be maintained by the closed door).
- Try to open the door manually. Unlock the door, and try to operate the inside and outside handles simultaneously, before declaring it jammed.
- If the door is jammed and forced removal is to be undertaken ensure that the casualties are protected.
- Consideration should be given to the door glass. Without doubt the best method is to role down the glass, cover it and break it so the debris falls into the door bottom.

### 4.10.3 Cutting phase

#### Exposing the door latching mechanism

If a door is in relative good shape after the collision but cannot be opened using the handle alone, one option is to expose the internal mechanism. Once the Nader latch/lock mechanism is exposed the device can either be operated manually or the second skin cut leaving the latch set on the 'B' post.

To achieve this:

**(1)** Correctly stabilise the vehicle.
**(2)** Protect those inside the vehicle.
**(3)** Warn others that cutting is commencing.
**(4)** With a panel chisel starting at the rear of the door above the handle, cut a large section of

the outer skin including the handle. If the second skin has to be cut the larger outside access will make the operation easier.

**(5)** Once the panel is removed operate the latch mechanism manually.

### 4.10.4 Notes on door removal

- When using hydraulic power tools to remove a door do not stand between the tool and the vehicle (if the dead man's handle becomes lodged against your body, it will carry on opening until the door or you break).
- Never try to brace the door or stand in its path.
- Before the door is finally released give a warning. The rescuer inside can then inform the casualty about the forthcoming noise.
- When removing doors start spreading from the top and work down.

### 4.10.5 Removing doors

Because cars are designed to have only small gaps between each panel and their doors, placing a powered hydraulic spreader between the two becomes a problem. Forcing the spreader in is not an option. Therefore, various other methods should be adopted to provide the initial gap required.

- **Using a pry bar/Halligan tool**
- **Spreading the door window frame**
- **Opening the spreaders and placing one of the tips in the gap, closing to clamp the door and then pull back.**

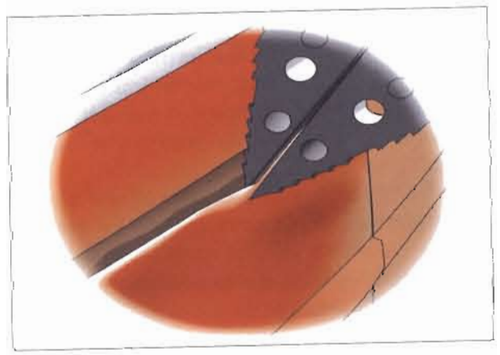


*Figure 4.18 Opening the shut line by clamping the spreader tips.*

### 4.10.6 Forced door removal

If the door is to be removed forcibly utilising hydraulic powered spreaders there are two options of attack, **latch side** or **hinge side** first.

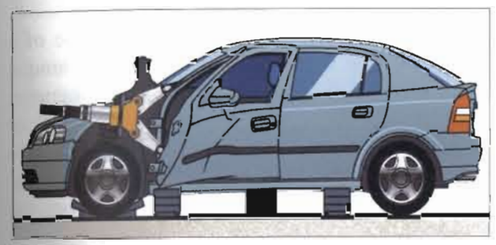
### 4.10.7 Latch side first method

(i) Ensure the vehicle is stabilised.
(ii) Protect those inside the vehicle.
(iii) Take care of glazed areas.
(iv) Warn others that cutting is commencing.
(v) Make a purchase point for the spreaders just above the latch. This can be done with hand tools such as a large axe. It can also be achieved by opening the tips of the spreader slightly and peeling back the metal to introduce the full tips. Spreading between the cantrail and the top of the door to achieve a purchase point can result in the outer and inner skin being separated making door removal more difficult.
(vi) Introduce the spreaders and control the spread until the tips are above the latch itself, then spread the door open.
(vii) Once the door is open either remove completely or bend to the wing and secure.

### 4.10.8 Hinge side first method

**(a)** Pinching the front wing with power spreaders to expose the hinges.

**(b)** Make use of a stable spreading point above the top hinge, insert tips and spread, relocating tool as required to reduce door skin ripping.



**(c)** Only attack one hinge at a time; do not begin between the hinges. The retaining strap will also have to be cut or spread.

**(d)** Now remove the door by repeating the spreading process above the "Nader" pin, with a rescuer stabilising the door as the lock is burst.

**Note**
An alternative technique utilises the spreader to expose the hinges and "Nader" pin, and then cut through them with a dedicated cutter, instead of spreading.

### 4.10.9 Exposing hinges

**(a)** An alternative method of exposing the hinges, to cut or spread, is to first cut the wing with dedicated cutter.

**(b)** Then clamp on to the wing and relocate the metal so it exposes the hinge area.

**FULL ACCESS 2**

## 4.11 Side removal

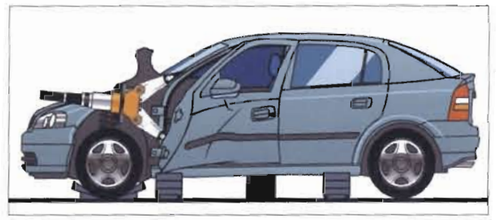
### 4.11.1 Purpose

**Creating a larger opening in the side of the vehicle that can be used for casualty care or immediate release as appropriate.**

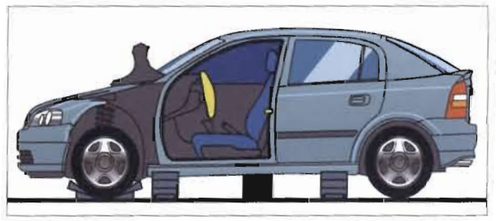
### 4.11.2 Traditional Technique

The first task is to gain entry to the vehicle, by opening/ removing a door, in a similar manner to that described in the previous section.

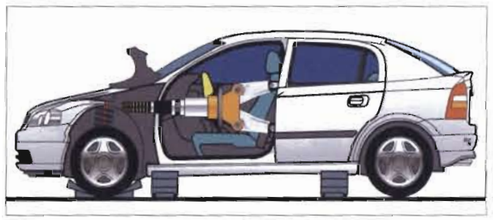
**Note:**
It has been assumed that all normal precautions, such as, correct stabilisation and protecting those trapped in the vehicle, have been taken.



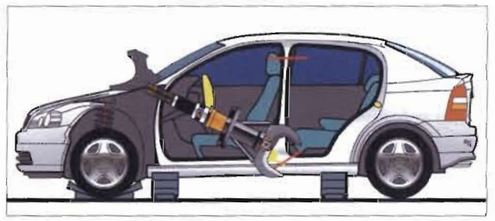
**(a)** Remember to expose and investigate all pillars or roof rails before cutting.



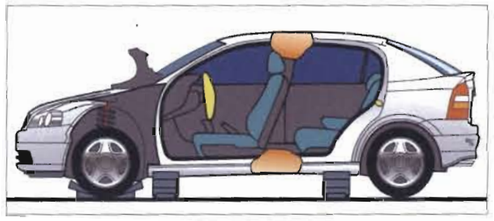
**(b)** Firstly remove the front door, (in this example) using one of the techniques previously described.



**(c)** Remove the back door by cutting or spreading the exposed hinges, remember to attack one hinge at a time and deal with the retaining strap.



**(d)** Cut the top and bottom of the "B" pillar to remove it. Making the higher cut last will reduce the chance of the post moving inward and contacting the casualty.



**(e)** Remember to use sharp edge protection, as appropriate.

### 4.11.3 Alternative method: B-Post Rip

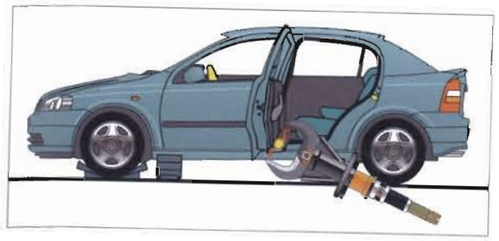
An alternative method of removing the side of a 4-door vehicle is the "B" post rip. This technique is most suitable where there is side impact damage, traditional techniques reliant on forcing hinges or locks generally result in bodywork being forced in towards the casualty. The "B" post rip has the advantage of only forcing metal away from the casualty.

### 4.11.4 B-Post Rip

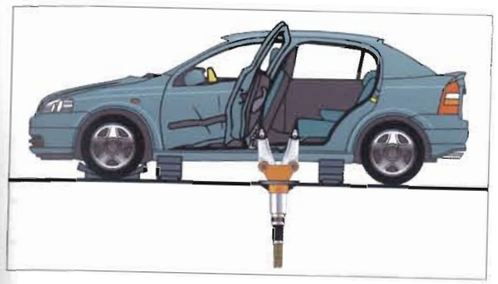
**(a)** Starting at the back, squeeze the door in order to create an insertion point for the tips.

**(b)** Now spread the door until the lock fails and the door opens. Always control the movement of the door ensuring that it does not come into contact with the rescuer, or push against the ground causing the vehicle to move.

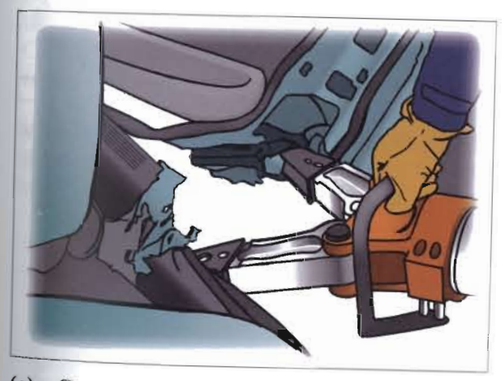




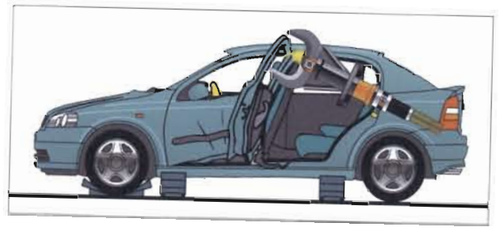
**(c)** Working in the rear door-opening make a deep relief cut (remember to expose all trim) in the lowest part of the "B" pillar to weaken it.



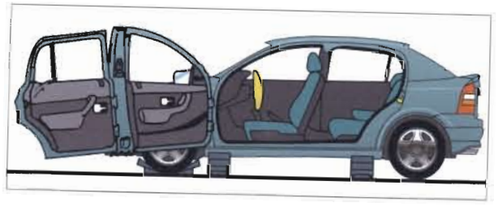
**(d)** Set one of the tips of the spreader on the base of the back seat. Open it slowly while watching the stability of the support point and position the other tip against the lowest part of the "B" pillar. Now spread the pillar outwards tearing it from the sill.



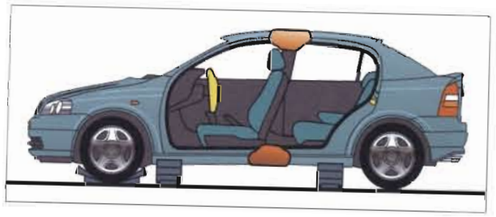
**(e)** Continue spreading by repositioning the spreader tips until the "B" pillar is separated from the sill or enough room has been created to complete the operation with a cutter.



**(f)** Remove the "B" pillar by making a cut at the top of the pillar as high as possible.



**(g)** "Walk" the door back as shown and then remove the front door from its hinges while other rescuers support the doors.



**(h)** Always ensure sharp edge protection.

**FULL ACCESS 3**

## 4.12 Third door conversion

### 4.12.1 Purpose

The purpose of a third door conversion is to create an opening in the side of a two door vehicle that can be used for patient care or extrication as appropriate.

**Note:**
It has been assumed that all normal precautions, such as, correct stabilisation and protecting those trapped in the vehicle, have been taken before commencing the third door conversion. It may not be advisable to use this technique if a dash-board roll is required later.

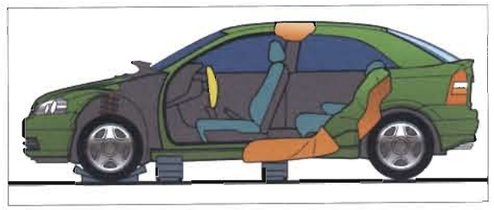
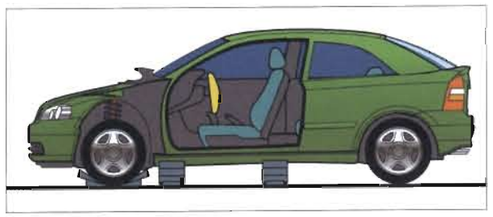
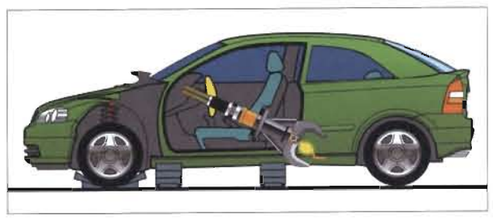


*Figure 4.19 The Completed Third Door Conversion.*

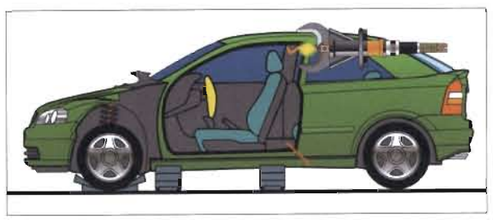
### 4.12.2 The process



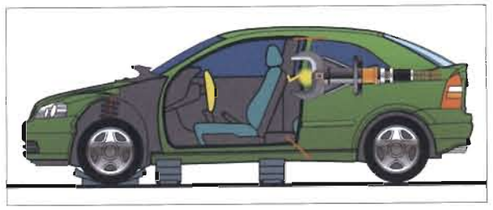
**(a)** Firstly remove the front door using one of the previously discussed techniques. Remember to remove trim to expose any SRS before cutting commences.



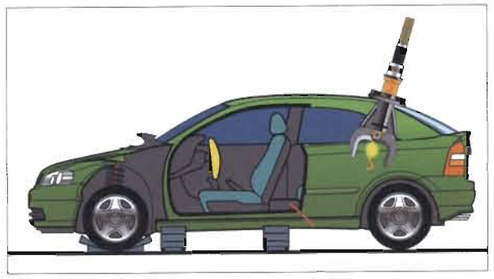
**(b)** Make a deep relief cut at the base of the "B" post, it may be an advantage to squeeze this area first before cutting



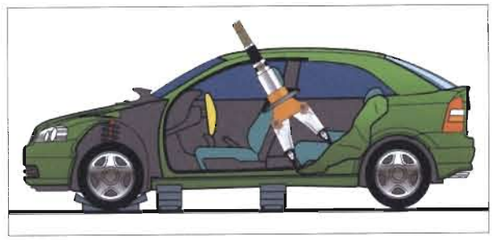
**(c)** If the "B" post extends to the roof, cut through the top of the post.



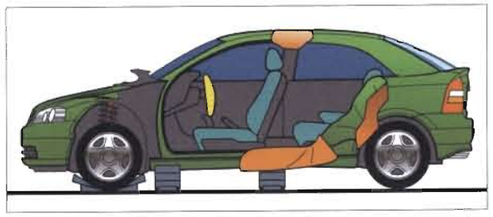
**(d)** It may be safer to remove the "B" post completely.



**(e)** Make a vertical relief cut in front of the "C" pillar.



**(f)** Position the spreader tips into the relief cut at the base of the "B" pillar. Open the spreader to push the panel out and away creating the "Third door".



**(g)** Always apply sharp protection covers to protect casualty and rescuers alike.



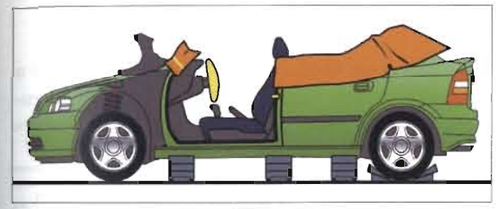
FULL ACCESS 4

## 4.13 Dash Roll

### 4.13.1 Purpose

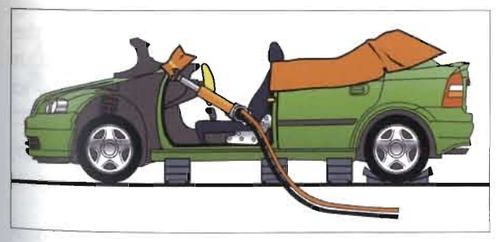
The most common type of road traffic collision entrapment is that involving a frontal impact. Rescuers are invariably faced by a casualty trapped by the steering wheel, dashboard, front fascia and firewall. One of the most effective methods of rescuing a casualty from this type of incident is the **dash roll**.

**Note:**
The technique of pulling the steering wheel with a spreader and chains is no longer advisable, as the forces acting on the steering column may cause the joint to break thus injuring rescuers and casualty.

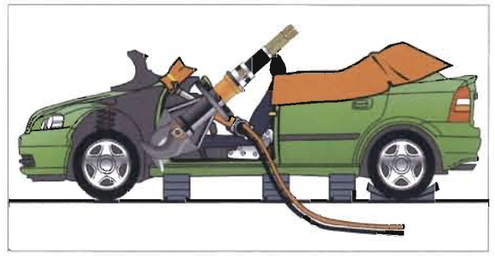


**(a)** Completely stabilise the vehicle, adding additional stabilization directly below the "B" post. Consider the use of a ram support to distribute the forces acting on the base of the post.

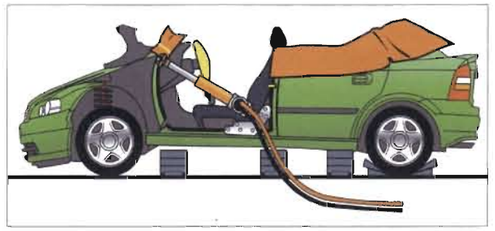
**Note:** The roof and doors have already been removed/managed.



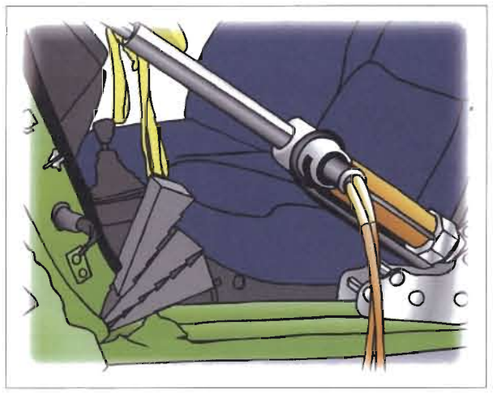
**(b)** Position the ram and secure it in place using a small amount of pressure. This will stop the dash dropping due to the relief cut. Position handle outwards to enable easy operation.



**(c)** Make a relief cut through the base of the "A" post, where space is limited, it may be necessary to make this cut before positioning the ram.



**(d)** Controlled ram extension may now begin. Be sure to monitor all purchase points during operation. Dashboard reinforcement in modern vehicles may require the use of a ram on each side of the vehicle.



**(e)** Remember to check stabilisation throughout this procedure, making any required adjustments. Wedge blocks work well in the opening of the relief cut.

FULL ACCESS 5

## 4.14 Dash Lift

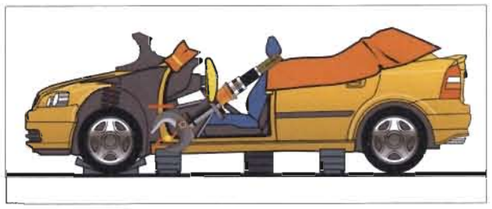
### 4.14.1 Purpose

To displace the dashboard directly upwards away from the casualty.

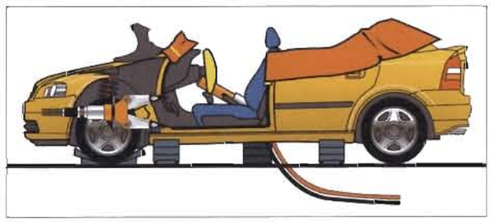
This technique is particularly helpful in those situations where the entrapment is caused more by the downward displacement of the dash rather than a rearward movement.

As with all extrication techniques it is imperative to complete all appropriate precautions such as stability and casualty considerations before entering the "cutting phase".

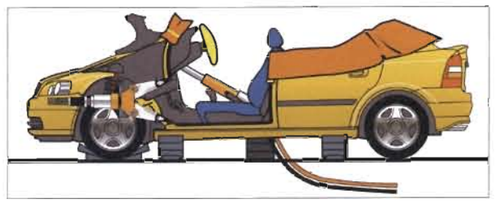
**Note:**
Remember to investigate and expose all pillars or roof rails before cutting.



**(a)** Cut an insertion gap for your spreader tips, as per footwell entrapment. Place appropriate blocks directly under the "A" post.



**(b)** The spreader tips are placed directly into the insertion gap allowing lifting to begin. Locate a ram (and support) in the opposite side of the vehicle.



**(c)** Operating simultaneously with the ram, lift the dash slowly, continually assessing the point of contact between the spreader tips and the vehicle.

FULL ACCESS 6

## 4.15 Roof Removal

### 4.15.1 Purpose

To remove the roof structure, in order to allow greater patient access and ease of extrication from a crash damaged vehicle.

As professional rescuers we should always adopt a "casualty-centred" approach, therefore the argument in favour of removing the roof first becomes difficult to challenge:

- Maximum amount of space in the minimum amount of time.
- It gives unrestricted access to the casualty.
- It facilitates the placement of spinal immobilisation devices.

### 4.15.2 Full Roof Removal

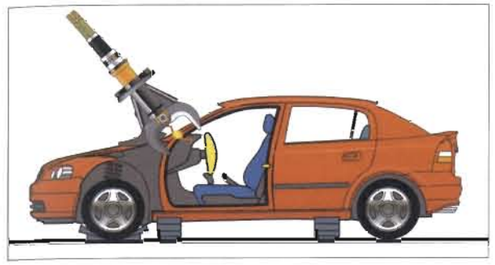
Where possible consideration should be given to total roof removal rather than merely flapping them, however depending on the nature of the impact and the tools readily available to hand, it may not always be appropriate or possible to remove the roof completely.

Other ways of dealing with the roof include:
- Forward roof flap
- Back roof flap
- Side roof flap

Each of the techniques has its own advantages and disadvantage that have to be quickly evaluated when deciding which will be best in any given situation.

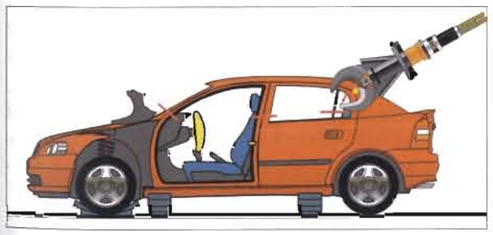


**Example**
Bonded/laminated windscreen with glass intact – a forward roof flap is considered good practice.



**(a)** Prepare for extrication in the normal manner, including stability, glass management and casualty care. If a bonded windscreen is fitted and it is still intact, cut the "A" pillar above the dash on each side.

**(b)** Cut the windscreen from one side to the other, ensuring that the cut joins both incisions in the "A" pillars. Remember to protect both patient and rescuers from glass fragments.



**(c)** Continue by cutting the "B" and "C" pillars as appropriate.

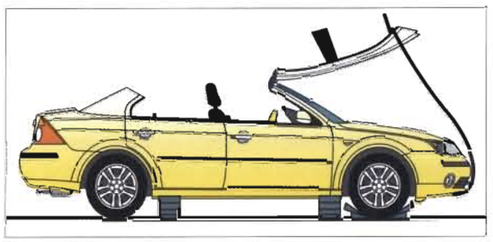
**Note:**
All cuts should be made as low as possible ensuring that pillars are exposed before cutting to search for SRS and other hazards. Best practice dictates leaving the last cut to be made nearest to the casualty, ensuring that there is no danger of an unsupported roof dropping and causing injury.

**(d)** The rescuers can now lift the roof and carry it to the designated parts dump, remembering to ensure that all sharp edges are covered.

### 4.15.3 Forward Roof Flap

**(a)** First cut the "B" and "C" pillars. This should be done while other rescuers support the roof.

After ensuring adequate glass protection is in place, make relief cuts on both sides of the roof just behind the windscreen.



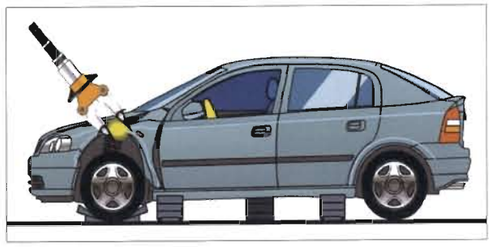
**(b)** Rescuers can now fold the roof forward. It may be necessary to use a bar to assist in folding.

**(c)** A strap must be used to secure the roof in its folded position. All sharp edges must be covered.

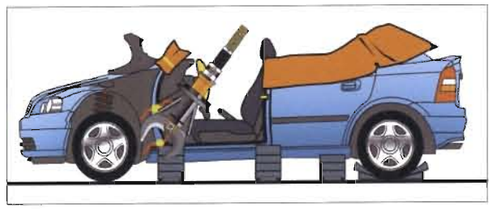
FULL ACCESS 7

## 4.16 Footwell Entrapment

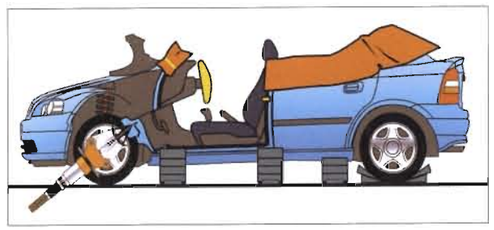
Following many head on collisions, casualties are often found with their feet trapped by the relocation of the pedals. This may be accompanied by unwanted movement of the dashboard and fascia completely restricting access to the casualties lower limbs. A well recognised method of gaining access is detailed below.



**(a)** Method of exposing "A" post/pillar.

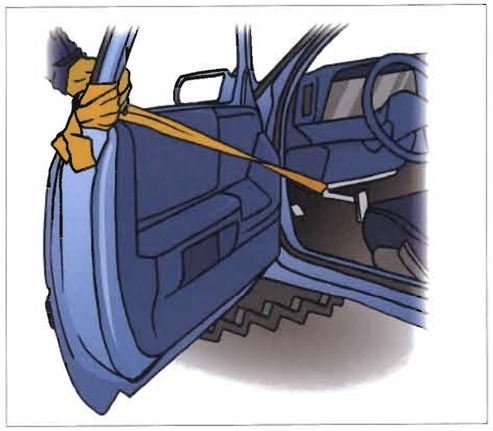


**(b)** Cut and peel the wing away to expose the "A" post/pillar. Make two deep cuts into the pillar, one just above the sill and the other just below the fascia.



**(c)** Clamp a hydraulic spreader onto the resulting piece of metal and using the weight of the tool bend the metal through 90 degrees and expose the footwell.

**(d)** Carefully introduce pedal cutter and cut away pedals as appropriate, remembering to control the loose end of the pedal to ensure it does not fly off in an uncontrolled manner.



**(e)** If a pedal cutter is not available, or judged undesirable for a particular incident, then consider a forced pedal pull. A length of seat belt is attached to the appropriate pedal by a clove hitch, the door is then closed almost to and several turns of the running end of the seat belt are made around the door pillar/post. On opening the door the pedal is forced upwards and away from the casualties foot. Either door can be used depending on which pedal is desired to be forced.

FULL ACCESS 8

## 4.17 Vehicle on its roof

### 4.17.1 Purpose

Gaining access to casualties in vehicles that have come to rest upside down, can be difficult. There are two basic options:

(1) Gain entry through the driver and passenger side doors
(2) Gain access through the rear hatch or window.

### 4.17.2 Door access

The decision to open, remove or displace doors will be one of the most frequent taken at the accident scene.

Opening vehicle doors can provide a large area to access the patients inside. Totally removing or displacing the doors will provide a better working area, and a path to release the patients.

### 4.17.3 Preparation phase

One of the most unpredictable aspects of vehicle rescue work is forcing open or removing the doors. There are several variables that must be considered before any door is opened. These variables are the damage from the impact, the condition of the metal around the door, the amount of rust present, and the construction of the door itself.

With practice, the rescuers will become familiar with the different doors and the tools required to displace or remove them.

Prior to door removal:

(1) If not for immediate access purposes ensure the vehicle is correctly stabilised. (This can include extra blocking under the floor pan as the integrity of the vehicle may only be maintained by the closed door).

(2) Try to open the door manually. Unlock the door, and try to operate the inside and outside handles simultaneously, before declaring it jammed.

(3) If the door is jammed and forced removal is to be undertaken ensure that the patients are protected.

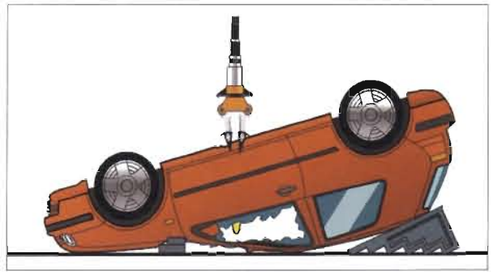
(4) Consideration should be given to the door glass. Without doubt the best method is to role down the glass, cover it and break it so the debris falls into the door bottom.

### 4.17.4 Side removal

Once the door has been removed it may by appropriate to create extra space by removing the side of the vehicle.

This can be achieved by repeating the process and removing the second door if working on a four door vehicle or creating a third door conversion if working on a two door.

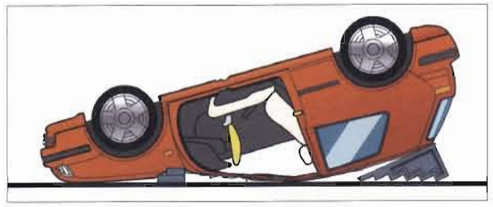
### 4.17.5 Door removal on an upside down vehicle



**(a)** Squeeze the sill in order to create enough space for the tips of the spreader.

**(b)** If necessary, increase the opening by pinching the metal of the bottom of the door and folding downward.

**(c)** Spread the door outwards away from the body, reposition the tips of the tool if the inner and outer door skin start to separate.



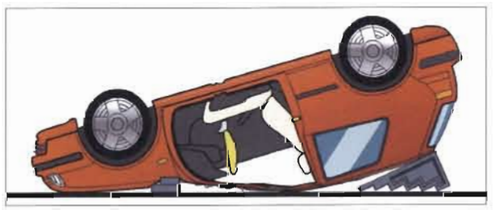
**(d)** Once the door is open after breaking away from the lock, cut or spread the hinges and remove it.

**Note:**
Modern cutting tools allow hinges and door locks to be cut rather than forced if desired.

### 4.17.6 Alternative method

**(a)** An alternative method of door removal involving a upside down vehicle is to attack the door lock.

**(b)** Use the tips to pinch and fold and make an opening on the lock side of the door.



**(c)** Use the spreader to break the lock mechanism by spreading the door away from the body, and continue with removal as described above.

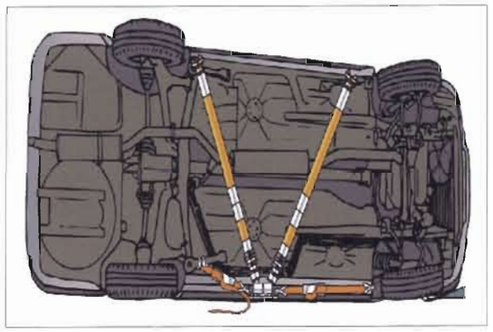
FULL ACCESS 9

## 4.18 Vehicle on its side

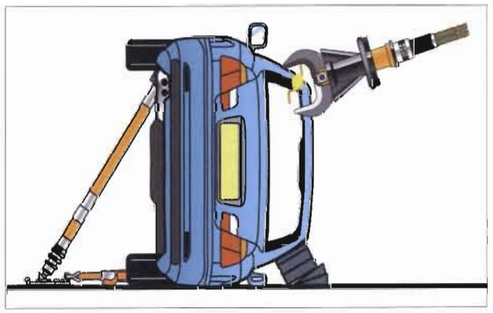
### 4.18.1 Purpose

Rescuers faced with a vehicle coming to rest on its side following a collision often view this as a difficult rescue. Surprisingly, it is one of the easier to achieve. As with other extrications, the priorities are very much on stability, rapid initial access to casualties, then space creation (maximum space in the minimum of time). The easiest answer in these circumstances is to cut and fold the roof down.

### 4.18.2 The Process



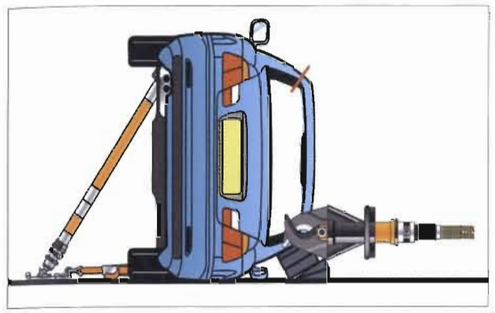
**(a)** View of stability, using air props, from the rear.



**(b)** Cuts are made to the upper A, B and C posts/pillars, remembering to strip the inside of the post/pillar to check for hazards, such as SRS, before cutting. Side windows should be rolled down into doors if possible prior to cutting.



**Note:**
These cuts should be made high rather than low, as in a conventional roof removal.



**(c)** As the casualty's position frequently precludes the cutting of the lower A, B and C posts, two relief cuts are then made in the roof front and rear header rails close to the A and C posts.

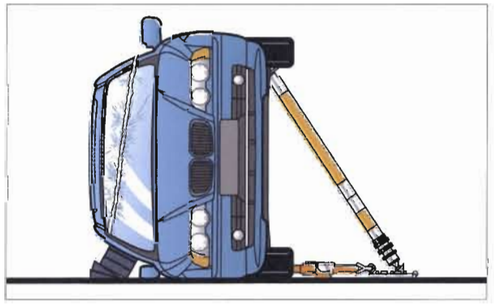
**(d)** If a bonded laminated screen is fitted then there are two options:

(i) The position that you cut the A post can be used as the starting point to cut the windscreen.

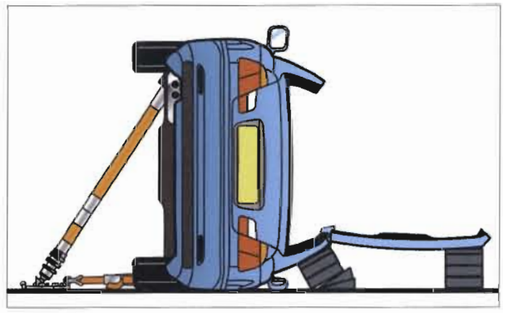
(ii) Leave the glass intact and cut down the metal panel with a power saw or impact cuter a couple of centimetres behind the front header rail.

**(e)** If you decide that the first method is more appropriate, then use the incision made by the hydraulic cutters as the starting point to saw down the screen, ensuring that anyone inside the two-metre action circle has full P.P.E. including respiratory protection.

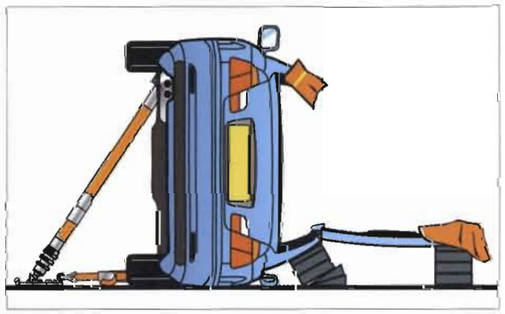
**Note:**
It is assumed that the casualty will be on oxygen. If not, then he/she too should have respiratory protection.



**(f)** Whilst sawing the screen ensure that the cut from the A post meets the relief cut in the header rail or the roof will not be free to fold down. Tape or a lubricant such as water or shaving foam can be utilised to reduce glass dust from the sawing process.



**(g)** The roof is then folded down, ensuring that the casualty is supported throughout this part of the extrication process and, having cut the posts "high", there is no trip hazard present.



**(h)** All sharp edges are now covered to protect rescuers and casualties alike. A long board (often termed a spine board) can now be introduced and the casualty carefully manoeuvered on to it and then away to definitive medical care.

**Safety Note**
**Always re-check stability after cutting any structural metal and cover "sharps" as you go, to reduce the risk of injury.**





# Chapter 5 – Extrication Equipment

## 5.1 Pneumatic Equipment

Air supplies for pneumatic tools can be provided from:

- Air tool compressors, on certain pumping appliances and on many Rescue/Emergency Tenders.
- Air brake bleed systems on some pumping appliances also allow tool usage.
- Compressed air cylinders in conjunction with a valve reducing group.

Commonly used pneumatically operated rescue tools include:

- Reciprocating Saw
- Impact Cutter (Zip Gun)
- Chipping Hammer
- Angle Grinder
- High Pressure Airbags
- Low Pressure Airbags

### 5.1.1 A Typical Pneumatic Reciprocating Saw

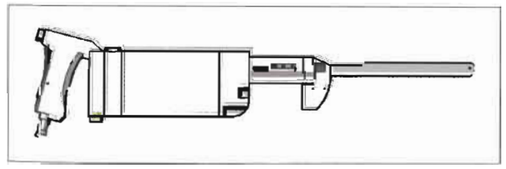


*Figure 5.1 Typical pneumatic reciprocating saw.*

#### 5.1.1.1 General Description

This saw is a lightweight reciprocating pneumatic power saw which is designed to use 12.5 mm hack-saw blades. It will cut most materials but is best suited for rigidly held solid structures. The saw blade is automatically lubricated during cutting operations providing the silencer guard is set at the wet cut position.

#### 5.1.1.2 Advantages

(1) Will cut most materials such as those used in motor manufacture.
(2) Little vibration.
(3) Will cut in any direction (blade will invert)
(4) Will reach most places.
(5 Visible automatic lubrication.
(6) May be used with 12.5 mm hacksaw blades (even broken blades).
(7) Reasonably silent in operation (silencer fitted).
(8) Easily maintained.
(9) Variable cutting speed.

#### 5.1.1.3 Technical Data

- Approximate weight 2.5 kg
- Operating pressure 7 bars
- Length of stroke 45 mm
- Variable speed 0 to 1200 strokes per minute
- Consumption of air 180 litres/min. Therefore, one cylinder of 1800 litres should last approximately 10 minutes.

#### 5.1.1.4 Components of a typical saw kit

- Reciprocating Saw unit complete
- Hacksaw blades
- Allen keys (2) for blade replacement
- Can of Green Oil (1)
- Carrying case

#### 5.1.1.5 Operating Instructions

**It is important to remember to disconnect the saw from the air supply, prior to making any attempt to insert or remove a blade. Failure to observe this safety precaution could result in injury should a tool be accidentally operated.**

When stowed in its box, ensure that the speed regulator is in the closed position.

When operating the equipment, where conditions allow, an assistant can help by exerting pressure on the structure to prevent binding of the cutting blade.

#### 5.1.1.6 General Points

- Ensure that the wick in the visual oiler is green in colour at all times. This indicates that the oiler contains sufficient Green Oil.
- Allen screws must be securely tightened at all times to prevent air leaks.
- After removing blade, ensure that the two securing Allen screws are not left proud of their sockets by screwing them down.
- Keep the saw clean.
- Never clamp the body of the saw in a vice.

#### 5.1.1.7 Bi-metal Blades

The blades are constructed of two metals: the "harder" is for the teeth and the "softer" is for the main body, to allow pliability.

### 5.1.2 Impact Cutter (Zip Gun Pneumatic Chisel)

#### 5.1.2.1 General Description

The Impact cutter consists basically of an air-operated pneumatic hammer, shaped rather like a pistol, which can be fitted with a number of readily-inter-changeable special chisels for cutting the sheet metal bodywork of motor vehicles.

*Figure 5.2 Impact cutter with chisel set.*

The Impact cutter derives its cutting power from the impact of an air powered free piston on the base of the actual cutting chisel. The piston return relies on received action and is NOT air powered.

#### 5.1.2.2 Advantages

- Simple to operate.
- Easily portable (even with power unit)
- Suitable for use in confined spaces.
- Fast in operation.
- Reduces risk from sparks (a hazard where fuel is spilled).
- Robust and easily maintained.

#### 5.1.2.3 Technical Data

- Approximate weight 1.6 kg
- Operating pressure 7 bars
- Consumption of air 110 litres/min. Therefore, one cylinder of 1800 litres should last approximately 16 minutes.

#### 5.1.2.4 Components of Impact Cutter Kit

- Impact cutter unit complete.
- Retaining spring: Beehive only.
- Panel cutting chisel (1)
- Rivet cutting chisel (1)
- Carrying case
- One adaptor for air hose, which is either:
  (1) Fixed to the gun handle, or
  (2) In the form of a short (2 m) air hose with the adaptor at one end.

#### 5.1.2.5 Operating Instructions

**It is important to remember to disconnect the gun from the air supply, prior to making any attempt to insert or remove a chisel. Failure to observe this safety precaution could result in injury should a tool be accidentally operated.**

Whenever possible, care must be taken to avoid free running of the gun. If the chisel is not held firmly against the work, serious damage to the chisel sleeve will result.

**To make ready:**

(1) Remove Impact cutter from carrying case.

(2) Unscrew the spring retainer from the tool and insert a suitable chisel fully into the orifice of the tool.

(3) Place the retainer over the chisel and screw home onto the tool.

(4) The spring retainer must not be over-tightened, as it has a tendency to tighten in use and if originally over-tightened, may seize onto the tool.

(5) Connect the Impact cutter to air hose.

(6) Open main valve from the air supply (cylinders, compressor or brake system).

(7) Check that the compressed air supply is adequate and that operating pressure is 7 bars.

(8) Test the operation of the tool by placing the chisel blade against some solid object (e.g., a block of wood); press the trigger and operate the gun for a few seconds.

(9) The Impact cutter is now ready for use.

**Wear goggles and heavy duty gloves when cutting**

**To operate:**

(1) Place the cutting edge of the chisel firmly against material. The gun is held in one hand and steadied with the other.

(2) To make the initial cut, the tool should be held at approximately 45 degrees to the work surface.

(3) Immediately the chisel penetrates, the rear of the gun is lowered to an angle of 25 to 30 degrees for continuing the cut rotating the handle as is necessary.

(4) On completion of the cut, the gun must be shut off immediately to avoid damage by free-running.

(5) To withdraw the panel cutting chisel, pivot the gun over the nose of the chisel.

#### 5.1.2.6 Maintenance

- Store in such a way as to prevent oil from running out.
- Keep the Impact cutter clean.

## 5.2 Lifting Bag System

### 5.2.1 General

The idea for using compressed air to support and lift weights has been with us for some considerable time, in the form of pneumatic tyres. The load carried by compressed air contained in a flexible rubber container can be great and this blends its use in the rescue field, for lifting and spreading.

The history of airbags came from a need for aircraft recovery, where working on soft ground and lifting of the aircraft without damaging the construction of the plane was a necessity. Manfried Vetter was the inventor of the high-pressure bag in the 1960's and its use was widespread in industry and later on when safety features were added in the rescue field, dealing with building collapses, mining, derailment and H.G.V. rescue and recovery. Two types of bags, high pressure and low pressure, each with important similarities but different in design and operation:

- **High Pressure Airbags: 8 bar internal pressure (known also as mats)**

- **Low Pressure Airbags: 0.5 bar internal pressure (known also as aircushions)**

Each one has different uses and they complement each other in their effectiveness and capabilities for either lifting or spreading.

A new European Standard titled "Lifting Bag Systems for FRS Use" is currently being prepared, which when published will become the British Standard for both types of air bags.

Recent research suggests that extreme caution should be exercised when considering the use of pneumatic air lifting units in an explosive atmosphere.

### 5.2.2 Design of typical air bag

A high-pressure air bag used by many Fire and Rescue Services is the Vetter system, such as the V24II air bag.

The high-pressure bag is more rugged and tougher than the low-pressure type and consists of four basic components.

#### 5.2.2.1 The Bag


*Figure 5.3 A typical high-pressure air bag.*

**To calculate the maximum lift capacity.**

**LIFT =**
**SURFACE AREA × INTERNAL PRESSURE**

**V24II is 52 cm × 62 cm × 8 bar = 24,000 kg.**

**Hose Connections**

The female collar is to be forced forward to release the first lock then pulled **BACKWARDS** to release the female completely from the male nipple.

In effect this provides high security from accidental dislodgement of the female slide back.

Two 5 metre lengths of hose are provided which are colour coded yellow and green to assist in recognising which bag is connected to which side of the controller.

Hose is designed to burst before the bag so a controlled descent is achieved safely.

The hose is cold-resistant and will work in most weather conditions.

#### 5.2.2.2 Safety Controllers

Safety controllers are responsible for the inflation and deflation and have a harness for use by the operator, if required.

They have two built in safety devices: the Safety Release Valve; and the Dead Man's Handle.

(1) Safety Release Valve

The 'SAFETY RELIEF VALVE' monitors the pressure in each air bag and when a pressure of 8 bars (+/-10%) is reached the valve limits the supply by operating the relief valve.

(2) Dead Man's Handle

The regulator lever is spring-loaded and is operated by pushing forward to deflate and pulling back to inflate. When the lever is released, the spring returns it back to the neutral position so avoiding excess pressure when not required.

Two pressure gauges, one for each bag, 2 Vetter outlet safety couplings and one inlet quick action coupling complete the controller.

#### 5.2.2.3 Pressure Regulator – 200/300 BAR

Fire and Rescue Services generally rely on compressed air cylinders for their supply of air, as used in BA. From 207 bar maximum in the cylinder, this must be reduced to a more manageable pressure.


*Figure 5.4 Safety Controller.*



System Components:

- Pressure Gauge inside cylinder
- Pressure control reading (the amount reduced)
- Shut off cock (on-off for air)
- Regulating Knob (9 bar)
- The hose is 2 metres long and connects to the controller by a spigot nipple (PUSH IN).

**USE**

- Open and shut off the cock slowly to avoid damage to the diaphragm.
- Finger tighten the connector to the cylinder.
- The amount of air used is in proportion to the resistance encountered.

#### 5.2.2.4 Ancillary Equipment

A rescue belt and ratchet (8 metres long) is used in conjunction with HP bags.

**USE** – Safety is paramount.

**Only use compatible equipment**

(1) PPE must be worn (gloves and goggles).

(2) Clear the area of unnecessary personnel.

(3) Ensure a safety zone of at least 8 metres is kept clear of all personnel.

(4) Never drop the load onto the bag and avoid angles in which the bag is likely to slip.

(5) Ensure the area in which the bag comes into contact with is free from heat and sharp edges.

(6) The controller should be in a position to see at least one bag and another appointed to give orders, this avoids confusion. A reference to coloured hose should be used:

e.g. **Up on green – down on yellow**.

(7) Chock up to the surface area.

(8) Use 2 bags together and no more.
- If stacked, this increases height, but the lift capacity remains the same.
- Inflate the bottom bag first and then both together to ensure a safe and stable lift.
- If side by side, this will double the lift and the height remains constant.

*Figure 5.5 Typical cribbing arrangement.*

(9) As the bag is inflated, the surface area, lift capacity and the stability are reduced. If two bags are stacked, the best use of the capacity lift is utilised.

(10) Chock and block. Never work beneath a load unless solid blocks are in place.

(11) Never place objects between airbags, only the bottom or top. Avoid hollow surface crib block as blocks will be pushed out. Use solid base, hard wood blocks to increase the height. The bag should conform to the underside of the vehicle.

(12) Be aware of moving cargo and try to use it to your advantage.

(13) If used in icy conditions, consider problems with surface adhesion.

(14) Plan ahead, chock up as you lift.

(15) Use a cover if working close to the bag.

### 5.2.3 Cleaning

- Mild soap, to wash oil or other contaminants and a stiff brush for awkward residues.
- The surface should not be treated as this will result in a loss of grip.
- Rubber should be dried naturally and silicone spray used if needed to lubricate the female slide back connector.

### 5.2.4 Low Pressure Airbags

The main advantage is that more height is achieved with low pressure bags than with high pressure bags.

Using air and a large surface area, heavy lifts can be achieved even though the internal pressure is low compared with the high pressure units. The bags are made up by a cold vulcanization process which involves placing the sheets together and gluing with epoxy cement. Many FRS use the MFC series 'B' low pressure air lift system which are specially designed for FRS use although some recovery operators may use them for LGV work.

The types of situation where they may be of value and are intended for, are the rescue of trapped persons in a variety of operational situations.

They perform especially well when thin-skinned, light-walled vehicles such as aluminium truck trailers, tanker vehicles, buses or aircraft require lifting or moving. This is because they exert a uniform and distributed lift pressure against accepted weak parts of vehicles, e.g. sides, roofs, wings, bonnets etc.

Other unusual instances for use may be trench collapses, animals bogged down in pits or ponds. The high and low pressure bags are designed to complement one another and both hold advantages, where conventional jacking methods would prove difficult or impossible without lengthy preparation such as soft, irregular or rubble-strewn ground during snowy or icy conditions.

#### 5.2.4.1 Construction of MFC 'B' Bag

The air bag is made from 220 g/m$^2$ of neoprene coated nylon fabric, the top and base are integrally reinforced with 5 mm neoprene coated conveyor belting. Restraint webs 25 mm wide with a breaking strain of 1088 kg (achieves shape). Moulded neoprene flange with a claw coupling make up the inflation part.

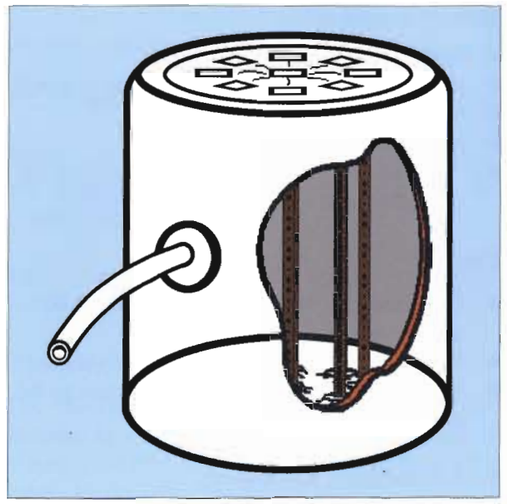


*Figure 5.6 Low-pressure air bag.*

#### 5.2.4.2 MFC Series: Delivery Hose

- 25 mm bore, fabric reinforced rubber hose.
- Maximum working pressure is 12 bars.
- Length of 3 metres.
- The air supply hose is larger in diameter than high pressure systems and has a build-in spiral to reduce kinks or sharp bends. Air fittings are a twist type of unit with a metal interlocking claw feature (MFC couplings are called Atlas Copco).
- The large outlet connection moulded into the air cushion makes for rapid deflation of the bag if a hose disconnects while the cushion is under load. For this reason all airbags should be used in pairs.

#### 5.2.4.3 Dual Controller Type 311

This allows 2 bags to be inflated at the same time, but with independent control maintained for each one. Safety features are incorporated and these include safety relief valves for each bag to prevent over inflation.

Pressure Relief Valves are pre-set to 0.5 bar and are audible in operation.



#### 5.2.4.4 Regulator Type 646 (single stage)

This, as with the High Pressure system, allows the air in a BA cylinder to be reduced down to a more manageable pressure. In low-pressure systems, this is 2 bars.

#### 5.2.4.5 0.5 Bar – Low Pressure Air Lift Systems 'B' Type

**TYPE 'B'**

- Diameter: 76 cm
- Lift at Max Pressure: 2325 kg
- Maximum Pressure: 0.5 bar
- Height Inflated: 59 cm
- Height Deflated: 5 cm
- Air Requirement: 450 litres
- Weight Packed (2): 34 kg

#### 5.2.4.6 Advantages over High Pressure Systems

(1) Produce greater lifting heights.
(2) They do not lose their surface contact area at these increased heights and achieve maximum capacities only when fully inflated.
(3) Lower pressure inside allows the cushion to easily mould itself around uneven surfaces or objects placed in contact with it.
(4) Can be repaired.

#### 5.2.4.7 Disadvantages over High Pressure Systems

(1) More vulnerable to physical damage during lifting evolutions due to the thin walls (protect from sharp objects or heat which could puncture).
(2) Hose disconnection will lead to rapid deflation.
(3) More space is required to get them into a lifting position.
(4) More contact area is needed.

#### 5.2.4.8 Operating Instructions

- Assess the situation.
- Ensure sidewalls are folded inwards in a regular fashion and that the upper working surface is 'square' with the lower by reference to the web loops placed at quadrant positions (avoid twisting).
- Avoid contact with sharp or jagged surfaces particularly on the side walls
- Hot exhaust systems should be covered if they cannot be avoided.
- Ensure the hose is not kinked.
- Position cushions as far as practical under load.
- Ensure the levers are in an 'off' position.
- Connect the hose to the controller maintaining a clear line to each cushion.
- Couple the control unit to the air supply.
- Before actual inflation, consider the likely effect on stability the lift will have. A 3-point lift is the safest, i.e. one side of the vehicle is in contact with the ground and 2 bags are used in tandem.
- Inflate and balance both the bag and pressure gauges together by looking at the bag inflate and using the pressure gauges.
- Pack and block as the lift proceeds.
- Web loops are provided to 'hang' the cushions between shuttering and collapsed trenches etc.
- Airbags have been known to raise submerged vehicles and boats etc.

**Safety Points**

- **Use only manufacturer's approved equipment.**
- **Keep clear of unsupported load.**
- **Keep clear of the direction of anticipated thrust.**
- **Do not disconnect the hose coupling.**
- **To reposition, always deflate using the controller.**

## 5.3 Electrical Reciprocating Saws

Reciprocating saws are rapidly gaining in popularity amongst the fire and rescue services worldwide. Currently, cordless reciprocating saws are manufactured by various companies.

### 5.3.1 A brief comparison of two leading 18v reciprocating saws

Reciprocating saws get their name from the fact that, during operation, the saw blade moves back and forth to cut the material. This distance, known as the saw's stroke, measures between 7/8 of an inch and an inch, depending on the individual manufacturer. Essentially a saw's stroke determines that portion of a blade that will be doing the most aggressive primary cutting.

Along with a saw's stroke is another important measurement referred to as its strokes per minute (spm). The saw blade travels one complete cycle back and forth as it cuts through the material. The number of these complete cycles per minute is the saw's spm. One type of saw has a variable rate of 0–2,800 spm as controlled by the squeezing of the trigger. Another unit's trigger control allows for a 0–2,000 spm. A reciprocating saw with a variable speed trigger runs faster as the trigger is pressed more fully. Both tools feature a safety lock trigger to prevent accidental saw operation. As a safety feature, there are no provisions on either saw to lock the trigger in the "on" or "run" position.

The blade clamp holds the blade in the working end of the saw. Reversing a blade in the clamp of a reciprocating saw may be necessary for unique situations where there is very limited access for cutting. Although the blade is reversible in both saws tested, meaning it can be positioned with the teeth facing up or down, there are important differences in the method by which the saw blade is secured in each saw; both tools use a keyless chuck design.

The table alongside compares the main features of two typical saws which are currently in general use.

The FRS is becoming increasingly familiar with the operating capacities of reciprocating saws. They are being used in a unique way at incidents such as structure fires, building collapse rescue incidents and vehicle extrications. To use these saws effectively, however, we must also keep abreast of advances made recently in the design and manufacturing of the reciprocating saw blades themselves.

**Typical Saw Specifications**

| | Saw A | Saw B |
|---|---|---|
| Weight of saw with battery | 7 pounds | 8 1/2 pounds |
| Length of saw w/o blade | 17 inches | 18 inches |
| Stroke Length | 7/8 inch | 1 inch |
| Strokes/minute | 0–2,800 spm | 0–2,000 spm |
| Trigger safety lock feature | Yes | Yes |
| Reversible blade capability | Yes | Yes |
| Keyless chuck type | Lever type | Twist barrel |
| Shoe/foot adjustable | No (flexible) | Yes (3 positions) |
| Battery type | 18 volt | 18 volt |
| Housing/handle | Plastic | Plastic |
| Battery shoe design | Prong inserts into handle base | Slide rail design |
| Battery release button | Twin buttons on sides of battery | Twin buttons on sides of battery |

### 5.3.2 Cutting Procedures

Here are some general guidelines to consider when working with a reciprocating saw at fire-rescue incidents:

- Hold the saw firmly with both hands, but only by the insulated gripping surfaces, when performing a cutting operation. Unintentional contact with a 'live' energy source, such as a wire of the vehicle's electrical system, can energize the exposed metal parts of the entire tool. This will cause shock to the saw operator if you hands are incorrectly placed on the bare metal of the tool.
- If using a variable-speed reciprocating saw, select the proper speed for the material being cut. As a general rule, with harder metals such as cast door hinges or Nader pins, a slower saw speed will be more effective.



A lower speed setting, approximately 1,500 strokes per minute, is good for most metal cutting. Increasing the motor speed to full does not get a significant improvement in cutting speed. Slowing the blade speed down increases blade life and does not reduce overall cutting time.

- With a variable-speed feature on your saw's trigger, "feather" the speed to give you the best performance. If you have to work only at the high-speed setting on your saw, adjust your grip to a moderate pressure on the material being cut. Relaxing the pressure slightly will actually allow the blade to cut faster and to last through the entire cutting action.
- Whenever possible, the saw shoe must be held firmly against the material being cut. This will prevent the saw from jumping or vibrating and will minimize damage to the blade's teeth. Not keeping the foot of the saw in contact with the material being cut is the number one reason for ineffective reciprocating saw cutting at crash scenes.
- Do not force the tool or bind the blade. This diminishes battery life on cordless reciprocating saws. Create a rocking action by moving the body of the saw up and down as you cut while the foot remains in contact with the material being cut. Maintain the appropriate pressure against the material for the most effective cutting action.
- Protect yourself and your patient during the operation of the saw. Rescue personnel should don appropriate personal protective equipment (PPE), including safety glasses or goggles. Patients should have "hard" protection such as a "tear drop" placed between them and the cutting blade.
- Blades are hot immediately after operation. Do not grab a used blade by the working end. Open the blade clamp and allow the blade to fall out of the end.
- Avoid accidental saw starting. Be sure the safety switch is in the locked position before making adjustments to the tool, inserting a fresh battery pack or changing the saw blade. Store the saw with the safety in the "locked" or "on" position.
- Do not operate a corded or cordless power tool in an explosive atmosphere. Power tools create sparks internally and externally, which may ignite dust or flammable vapours present in the area.

*Figure 5.7 Electrical reciprocating saw with battery and charger.*

### 5.3.3 24-Volt Reciprocating Saw Features

The nine-pound saw operates at two speeds: 0–2,400 strokes per minute on one setting or 0–2,900 at the second position. Each stroke moves the blade a distance of 1 1/8 inches. The moment the saw operator releases the trigger, an "instant stop" feature activates an electronic brake to halt all blade movement.

This 24-volt saw has been "ruggedized" for FRS use. In a UL drop test, the saw functioned properly after a one-metre (39-inch) fall onto a hard surface. 110-volt corded unit presents an electric shock hazard if it were to be used in a wet atmosphere. Although not recommended, the 24-volt cordless saw can be used in rain or under other wet conditions. As long as it is cordless, it has no electrocution possibility for the operator. A wet saw can be dried out with a hair dryer after use.

The 24-volt saw comes equipped with a three-position adjustable shoe that extends the guide shoe from its retracted position a distance for 1 1/2 inches. This lets the operator instantly concentrate the cutting action on different teeth along the saw blade.

Originally, reciprocating saws were provided with a separate chuck key to release the saw blade. This changed when a lever-action keyless blade clamp was provided on corded and cordless saws. One 24-volt model incorporates this blade clamp release lever, allowing for blade changes in seconds.

With the blade clamp release lever, the operator was able to remove the old blade and have the new saw blade ready for use in just three seconds. With

this system, the operator averaged six complete blade changes in the same 25 seconds that it took a saw operator to change one blade using the chuck key attached by a rubber strap.

### 5.3.4 Battery and Charger Unit

The 24-volt battery is larger in size than the 18-volt unit because there are now 20 cells inside, compared to the 15 found in an 18-volt battery. The three-pound battery uses a new slide rail system to attach to the handle of the saw. A single button at the rear of the handle allows the battery to be released.

The low-profile 24-volt charger unit incorporates a read LED light to indicate charging status. The unit also has a patented Tune-Up mode that, when activated, equalizes and balances all individual cells in the battery to their peak capacity. This option takes from three to six hours to complete compared to a standard recharge time of one hour. If used every 10th battery charge, the Tune-Up mode will increase battery life by 20% and increase battery performance.

The 24-volt saw gave consistently good performance under all tests conducted. The "no load" test time, where the saw was allowed to run without cutting anything until the motor action stopped, averaged between 17 and 18 minutes.

A series of 24-volt battery endurance times measured during aggressive, constant cutting tests of vehicle A-pillars ranged from five minutes, 18 seconds to six minutes, 39 seconds.

## 5.4 Hydraulic Rescue Tools

The availability of powerful rescue tools allows rescuers greater options when planning extrications as they greatly reduce time taken during 'space creation'.

BS EN 13204:2004 "Double acting hydraulic rescue tools for FRS use – Safety and performance requirements" now exists.

**Two main types:**

- **Hand operated**
- **Powered.**

### 5.4.1 Hand operated:

- Requires the operator to manually operate a pump by means of a lever or handle
- 'EPCO', and 'TANGYE' are examples of the type available.

### 5.4.2 Hydraulic Powered Tools:

These systems utilise a power unit, usually petrol or diesel driven to pressurise the system.

Power units can be single or two-stage, the latter offering speedy off load operation with slower more controlled under load operation.

Common tools of this type are:

- Dedicated cutters
- Spreaders
- Combi-tools
- Rams
- Pedal cutters.

All hydraulic tool systems consist of the following main components:

- A reservoir containing hydraulic fluid
- A means of pressurising the fluid (a pump)
- High pressure tubing
- A means of relieving the pressure.

#### 5.4.2.1 Dedicated Cutters

*Figure 5.8 Dedicated cutter (1).*

- Cutting forces between 34.7t (3020) and approximately 92t (4050)
- Will cut 28 and 30 mm thickness respectively
- Weight 12.4 kg (3020) 19 kg (3040)



It is important to remember that the shearing action of the cutters imparts energy to the item being cut

At the moment when the cutter completes the cut pieces can separate with great force.

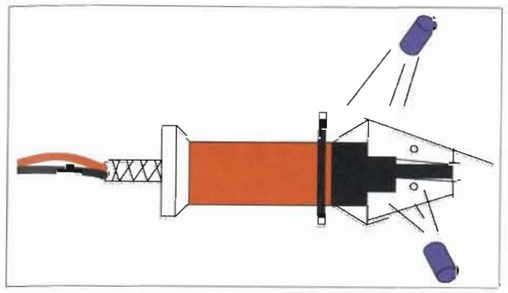


*Figure 5.9 Beware of flying debris when cutting.*

*Figure 5.10 Dedicated cutter (2).*

When using cutters, follow these basic rules to ensure safety:

- Always use appropriate P.P.E
- Always provide adequate protection for the casualty
- Be alert for the tool shifting
- Work 'outside' the tool.

#### 5.4.2.2 Spreaders

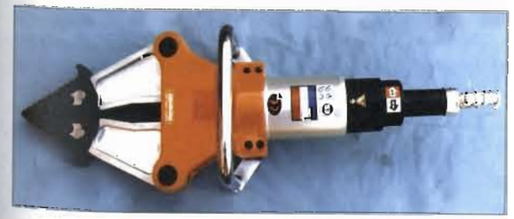


*Figure 5.11 Dedicated Spreader.*

- Spreaders often weigh 30 Kg or more and usually require a team of two operators.
- One to place and operate the tool and an assistant to help support the weight of the tool.
- Spreaders can be supplied with accessories such as chains, hooks and securing pins to allow pulling operations to take place utilising the power of the tool.
- Securing pins if not of the lockable type should always be inserted from the bottom side of the arms
- Chains should always be attached to hooks so that the free end is accessible on the top of the arms to ensure a balanced pull.

When using spreaders the following should be adopted to maintain safety and efficiency:

- Adopt a balanced body position
- Place hands only on the tools handle and operating lever
- Be aware tool can kick back under load
- Work 'outside' the tool
- The tool arms are not designed to spread or crush, only use the tips
- When using tool accessories, ensure hooks have the open side facing out or away from the arms.

#### 5.4.2.3 Combination Tool

*Figure 5.12 Combination Tool (1).*

- Primarily designed to be used as a rapid intervention tool capable of cutting, spreading, pulling and crushing due to this versatility, in widespread use throughout the country.
- Often performs less well than dedicated equipment. This is balanced by the tool's versatility.

*Figure 5.13 Combination Tool (2).*

As dedicated equipment arrives on the incident ground it should be got to work as soon as possible.

The safety procedures and general operating procedures for "combi" tools are the same as for task related dedicated equipment.

*Figure 5.14 Combination Tool (3).*

#### 5.4.2.4 Powered Rams

- Can be used to lift, spread, pull or assist with stabilisation
- Light enough to be operated by one member of the crew

*Figure 5.15 Single-acting Ram.*

*Figure 5.16 Dual-acting Ram.*

- Two types, single or double piston.
- No circumstance exists where rams would provide the sole means of stabilisation or of lifting a load
- They will always be used in conjunction with chocks and blocks
- Rams have the least structural integrity when fully extended
- Heavy loading can stress the ram to the point of being damaged
- Avoid allowing the ram to extend over a round object as this can deflect the ram and cause the tool to fail.

#### 5.4.2.5 Hydraulic hoses

Care of Hydraulic hoses is important to prevent injury to firefighters; the following precautions should be taken:

- Do not stretch hoses
- Do not excessively kink the hoses
- Do not create bites of too tight a radius
- Do not twist hoses
- Do not drag hoses over sharp or jagged edges
- Do not support tool with the hoses: use handle provided

- Ensure ferrules are in place
- Ensure anti-kink springs are in place
- Ensure hoses hoses kept free from dirt, grit, oil, etc.

After use:

- Clean tool
- Examine for wear / damage (particular care should be taken when inspecting hoses)
- Check ram pistons for dirt and scoring
- Top up fuel levels
- Ensure couplings are clean and replace dust caps.

Any obvious signs of damage should be reported and the maintenance engineer contacted for the item of equipment to be serviced/repaired.

## 5.5 Winching Techniques

### 5.5.1 Introduction

It may be necessary to move heavy vehicles, rolling stock or cars at various types of vehicle rescue incident, i.e. assist gaining access to carry out a rescue or simply to recover a vehicle from a ditch.

Many Fire and Rescue Services provide equipment on their appliances to carry out such operations in the form of Tirfor winches, vehicle winches and pulley blocks sometimes called snatch blocks. It is essential to be able to understand and demonstrate the basic principles of winching.

The FRS is not responsible for the removal of crashed vehicles from the rescue scene.

The equipment we carry is capable of use in more applications than may be immediately apparent.

### 5.5.2 Simple Machines

The simplest machine of all is the lever which enables us to change mechanical energy involving a small force into mechanical energy involving a large force.

For example: a tyre lever enables the exertion of a greater force than that capable of with the fingers.

Mechanical Advantage (MA) when using levers can be explained by use of diagrams.

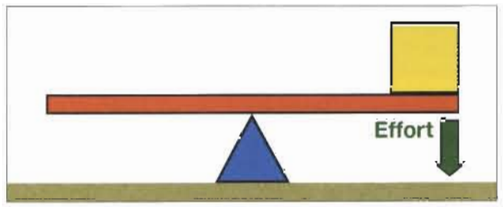



*Figure 5.17 Lever with no Mechanical Advantage.*

In this particular arrangement the situation is balanced by virtue of fact that the Fulcrum is situated at the centre point of the lever, therefore the effort required to move the load would be identical to the load itself. In this situation there would be no mechanical advantage; also, to move the load a distance of 1 metre, there would have to be movement of the effort by 1 metre.

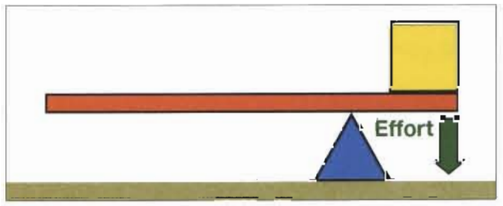



*Figure 5.18 Lever with Mechanical Advantage.*

The situation has now changed by virtue of the fact that the Fulcrum point has been moved nearer to the load; we have now gained a MA in that it will require less effort than the load to actually move it. In Figure 5.18 we have been able to exert many times the original force on the load, making it possible to move the load easily.

### 5.5.3 Change of Direction

This is used when no MA is needed, i.e. the equipment being used at a particular incident is capable of performing the task without any MA, the only problem being that a straight pull cannot be achieved with the winch because of some obstruction. By using a pulley block attached to fixed anchor point a "change of direction" of pull can be achieved.

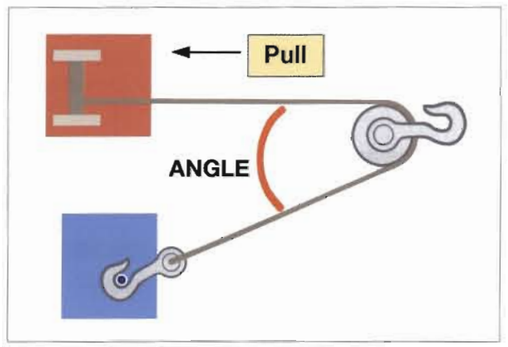



*Figure 5.19 Change of Direction.*

### 5.5.4 Load on Anchors

When the equipment is used for change of direction a problem to contend with is the load acting on the anchor point to which the pulley block is fixed, i.e. as the angle of the pull decreases so the load on the anchor point increases.

| Angle° | Pull |
|---|---|
| 0 | 2 × P |
| 30 | 1.97 × P |
| 60 | 1.73 × P |
| 90 | 1.41 × P |
| 120 | 1 × P |

### 5.5.5 Mechanical Advantage

Sometimes, though, weights to be moved are beyond the capabilities of fixed or portable winches in which case a MA must be gained if the load is to be moved. To gain MA when using block and tackle we must have a moving pulley block; we can then determine the MA by the number of falls from the moving block, as shown in Figure 5.20.

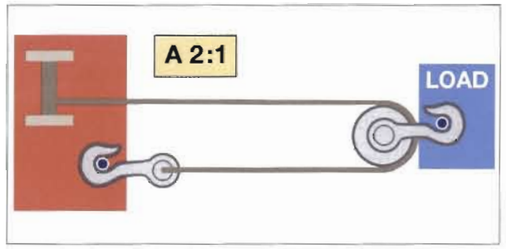



*Figure 5.20 2:1 Advantage.*

The **MA** is calculated by the number of falls from the moving block. In Figure 5.20 there are only **two**, giving a **MA of 2:1**.

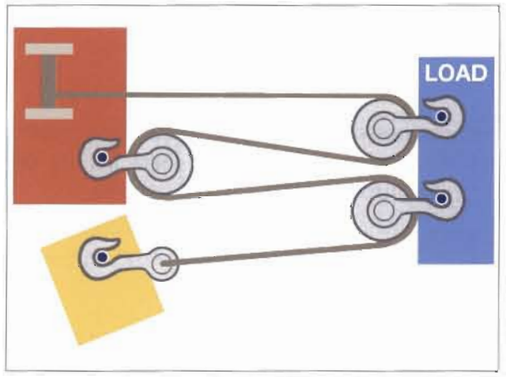



*Figure 5.21 4:1 Advantage.*

In Figure 5.21 there are **four**, giving a **MA of 4:1**. When setting the equipment up in Figure 5.20, even more **MA** could have been gained – as indicated in Figure 5.21.

### 5.5.6 Factors affecting the total pull required to move a vehicle

- Rolling Resistance
  The resistance to movement of the casualty.
- Gradient Resistance
  The angle of slope of the ground over which the vehicle has to be pulled.
- Damage Resistance
  Resistance caused by damage.
- Safety Factor



### 5.5.7 Rolling Resistance

Depends on the gross weight of the vehicle and the type of ground it is to be pulled over, i.e. the Ground Factor.

### 5.5.8 Ground Factor Table

#### 5.5.8.1 Type of Ground Resistance

- Smooth **W25**
- Grass **W7**
- Hard wet sand **W6**
- Soft wet sand/gravel **W5**
- Loose dry sand/shingle beach **W4**
- Shallow mud **W3**
- Deep mud/soft blue clay **W2**
- Rolling Resistance = Weight of Vehicle = **W**

#### 5.5.8.2 Gradient Resistance

Depends upon the angle of slope.

All slopes up to 45°

$$= \frac{\text{Weight of vehicle} \times \text{Angle of slope}}{60}$$

All slopes over 45°

= Weight of vehicle.

#### 5.5.8.3 Damage Resistance (DR)

To estimate – take the number of wheels the vehicle has and divide into the number which do not work, i.e.

4 wheeled vehicle – 1 wheel damaged
= $^1/_4$

8 wheeled vehicle – 1 wheel damaged
= $^1/_8$

Multiply weight of vehicle by this fraction and this will give damage resistance in tonnes.

i.e. **DR**

= **20** × $^1/_8$

= **2.5** tonnes approx.

#### 5.5.8.4 Safety Factor

When all other factors have been calculated they should be added up. **The total should then be increased by 25% to give a safety factor.**

### 5.5.9 Righting Overturned Vehicles

When a vehicle is on its side the pull required to right it is $^5/_8$ of its total weight.

If a vehicle is upside down and has to be rolled over, the pull required is $1^1/_4$ times the total weight.

### 5.5.10 Check Tackle

In addition to the pull required to right an overturned vehicle – a steadying pull in the opposite direction is also needed. Once the point of balance is reached the vehicle can be gently lowered on to its wheels. Steadying pull is provided by check tackle, i.e. another portable winch.

### 5.5.11 Safety Points

(1) Carry out a thorough reconnaissance – plan the job.
(2) Trained operator on winch at all times.
(3) Ensure blocks are lubricated and free from dirt and grit.
(4) Check strops and cables for kinks and "needling".
(5) Haul Steadily – do not impose shock loads.
(6) Cables should lie in straight lines with the sheaves to enable smooth running.
(7) Hooks and shackles should be "moused" to prevent unshipping.
(8) Taut cables should not be stepped over and should be clearly indicated.
(9) A salvage sheet should be placed over the cables (as a safety feature) on all occasions.
(10) A five metre exclusion zone should be set up before winching commences.

### 5.5.12 Anchorages

Firm anchorages are essential for all recovery work: NATURAL ANCHORAGES often provide the most secure fixings, then artificial, followed lastly by manufactured. When using a vehicle,

apply brakes and chock the wheels to prevent undue strain on the vehicle.

EXAMPLES

(1) NATURAL
Trees (require protection) 0.5 metre diameter tree will carry up to 20 ton.
(2) ARTIFICIAL
Quayside bollards
Deadman anchor (up to 20 ton)
Shearweight Anchor (second vehicle).
(3) MANUFACTURED
Earth or Ground Anchor.

Capacity of anchor must be in excess of the pulling capacity of winch and/or load to be moved.

## 5.6 Hand tools

"Best practice" dictates simultaneous activity at the scene of an "RTC". The importance of hand tools in this situation can never be over stated, not only as a vital accompaniment to hydraulic equipment but in their own right as a stand-alone tool. Hand tools are generally categorised "as requiring no external power source" to operate. Therefore, the rescuer provides the main supply of energy required to operate.

Hand tools are often grouped according to their prime function:

- Forced entry tools
- Cutting tools
- Pull/push equipment
- Small gear
- Safety gear
- Stability equipment

There follows a description of each category, giving examples of equipment and an indication of their usage, this list is by no-means exhaustive. It should always be ensured that the tool is suitable and can be used in a controlled and safe manner.

### 5.6.1 Forced Entry Tools

These tools are invaluable at the rescue scene, allowing "shut lines" to be spread – thus providing space for hydraulic tools to operate. Relocating metal, in a controlled manner, is the forte of this equipment.

Familiar tools in this category include:

- Halagan tool
- Crow bar
- Pry bar
- Heavy gauge screw driver
- Lock blade knife

### 5.6.2 Cutting tools

Most RTCs require hand-cutting tools to progress the extrication – even if only in the form of a seat-belt cutter. Glass may have to be cut; plastics and even metal may be best dealt with by the use of hand tools. Severing a "door stay" may be achieved successfully with the use of bolt-croppers.

Familiar tools in this category include:

- Hacksaw
- Glass saw
- Lock blade knife
- Axe
- Halagan tool (with tin snip)
- Bolt-croppers
- Pliers
- Medical shears (scissor style)
- Seat belt cutter

### 5.6.3 Pull/Push Equipment

Many inexperienced rescuers neglect pull/push hand tools and, until quite recently, many FRS did not carry them. Probably the most common types are the "come-along" (hand winch) and ratchet straps. The practicality and cost effectiveness of these tools cannot be beaten – securing a relocated door or roof with a ratchet strap is both easy and quick.

Familiar tools in this category include:

- Hand winch (come-along)
- Ratchet strap
- Ropes/line
- Hand hydraulics and jacks etc.



### 5.6.4 Small gear

A vast array of equipment can be included in this group, everything from a glass punch to an industrial socket set. Cutting the vehicle seat off its rails can be avoided if the 4 star drive bolts can be accessed.

Familiar tools in this category include:

- Socket set
- Star drive set
- Variety of screw drivers
- Glass punch
- Feeler gauge
- Allan keys
- Duck tape
- Tape measure

And many more items, forming a comprehensive tool kit.

### 5.6.5 Safety Gear

Protection is the key word in this category. Hard and soft protection in the form of a "tear drop" and "sharps protection" are now every day items found on most rescue vehicles. It must be remembered that the safety of the "rescuer" must be of "paramount" importance together with any casualty on scene.

Familiar tools in this category include:

- Tear Drop – hard protection:
- Sharps protection – soft protection
- Windscreen sheet
- Fire extinguisher
- Dust masks
- Ram support
- Airbag restraint
- Tool sheets
- Cable ties
- Duck tape

### 5.6.6 Stability equipment

Hard wood blocks or purpose built manmade material blocks are the first line of defence when dealing with unstable vehicles.

Familiar tools in this category include:

- Step blocks
- Crib blocks
- Jacks
- Side stability systems (such as Stab-fast)
- Hand hydraulics (as above)
- Ropes/lines
- Ratchet straps

### 5.6.7 Hand tool summary

The intention of this section of the manual is to reinforce the importance of hand tools, as they are equally important at the scene of a vehicle rescue, as any hydraulic cutting equipment, powered reciprocating saw or pneumatic tool. Correct choice of equipment and sympathetic stowage will increase desirability of these tools, make the scene safer and progress the casualty extrication to every ones benefit.

# Chapter 6 – Medical Considerations and Trauma Care

## 6.1 Trauma Preface

This chapter has been written primarily for the firefighter who has to undertake the role of immediate care provider whilst attending RTCs.

The subject matter does not detail individual trauma conditions, nor does it concentrate on specific diagnosis, which can be confusing and difficult particularly in the pre-hospital setting. The focus is on the more relevant primary survey assessment skills, which will direct the firefighter to the casualty's immediate care priorities.

The chapter is concise without reference to individual practices and procedures. The emphasis is on the basic trauma care interventions that can make the greatest difference to survival outcome. These include:

- Airway Stabilisation
- Ventilation Support
- Shock & Haemorrhage Control
- Skeletal Immobilisation
- Resuscitation

The topics covered are divided into four key elements. The first part describes scene assessment and initial casualty contact. Part two details the essential aspects of casualty primary survey. The third part explains casualty handling, extrication and packaging. The final part states the important aspects of 'on scene' resuscitation.

The content text uses a format and style to facilitate its use as ready reference. Information contained within the chapter is based on guidelines, criteria and standards set down by the following organisations:

- Royal Colleges of Surgeons and Physicians
- International Liaison Committee on Resuscitation
- European Resuscitation Council
- Resuscitation Council (UK)
- Royal College Of Nursing
- Nursing & Midwifery Council
- IHCD
- Joint Royal Colleges Ambulance Liaison Committee
- The Health and Safety Executive
- United Kingdom Rescue Organisation

### 6.1.1 General Introduction

The firefighter's role has evolved in recent times and now incorporates, in some instances, first medical response at road traffic incidents. Firefighters may be called upon to provide initial care to casualties suffering life-threatening medical conditions. It is important, therefore, that the care provided incorporates the vital skills necessary to assess and manage the injured casualty in the initial phase, until hand over to the ambulance/medical services.

### 6.1.2 Principles of Initial Care

The principles of initial care can be categorised as follows:

- Assessing the scene and situation
- Not incurring further harm
- Stabilising airway, breathing and circulation
- Giving treatment within the scope of your skill level
- Referring to pre-hospital definitive care

### 6.1.3 Roles and Responsibilities

When providing assistance to a casualty it is important that the assistance provided is appropriate and safe. The firefighter must understand his/her role as a trauma care provider. These include:

- Looking after your own personal safety, the safety of your colleagues, casualties and by-standers
- Providing basic appropriate casualty assessment and care
- Respecting the casualty's legal rights, privacy and human dignity
- Liasing with medical experts
- Maintaining medical equipment
- Completing and keeping documentation

## 6.2 Immediate Care Provider Risks

### 6.2.1 Introduction

Scene assessment begins prior to arrival at the incident. The dispatch controller, police, by-stander or other units in attendance provide information about the incident and the casualty's condition. On arrival the priority in any emergency is scene safety, the emphasis being placed upon the firefighter not becoming another casualty. Never put your own life, or the life of other firefighters in danger.

**Scene assessment begins prior to arrival at the incident.**

### 6.2.2 Scene Risks

There are numerous dangers firefighters deal with at RTCs, many of which have been addressed in previous sections, therefore, this chapter will concentrate specifically on the risk of cross-contamination between the firefighter and the casualty.



### 6.2.3 Contamination/Infection Risks

The close contact necessary between a firefighter rescuer and a casualty means that there is a risk of contamination by body fluids. It is almost impossible to know who may be carrying blood borne viruses or bacteria. Therefore, standard safety precautions, such as hand washing, wearing gloves, minimising mouth-to-mouth contact during artificial ventilation and the careful handling of sharp objects should always be observed.

### 6.2.4 Hand Washing

Hand contact is one of the main ways in which infections are transferred from one person to another. If time permits, wash your hands immediately before putting on protective gloves and clean your hands thoroughly after dealing with the casualty. Always cover any cuts or abrasions on your skin with a waterproof dressing.

### 6.2.5 Personal Protection Equipment (PPE)

Wear gloves when dealing with any body fluids. Always discard them after dealing with the casualty. A visor or goggles can protect the eyes from flying contaminated debris. If your clothing is contaminated or if there are any fluid spillages, follow your local protocol for cleaning or disinfecting the contaminated area. Always report spillage incidents. Clinical waste materials should never be discarded with normal rubbish, use special biohazard waste bags.

### 6.2.6 Mouth-to-Mouth Contact

Although there have been a few documented cases of infection transmission during mouth-to-mouth resuscitation, the likelihood of transmission of infection between a casualty and a rescuer still remains minimal. Despite this, protection such as ventilation facemasks, plastic face shields or bag valve mask devices should be used when available.

**Always follow body substance isolation precautions.**

### 6.2.7 Sharps Injury

Sharp contaminated objects represent a risk to the crew, i.e. hypodermic needles (found in casualties pockets or used by doctors, nurses and paramedics for medical procedures) and broken contaminated glass or metal. Handling sharp objects should always be avoided unless absolutely necessary.

If accidental sharps injury occurs, ensure the following action is carried out:

- Encourage bleeding of the puncture site
- Thoroughly wash (do not scrub) the puncture site with soap and tepid (room/body temperature) water
- Cover the injured area
- Report the incident and refer to medical help as soon as possible.

**Scene/personal safety is foremost in pre-hospital care.**

## 6.3 Mechanisms of Injury

### 6.3.1 Kinematics

Knowledge of the history of the injury and events leading up to it is of enormous benefit to the medical team in determining the extent and seriousness of the injury and, consequently, the treatment to be given.

In vehicle crash situations the rescuers need to 'read' the accident and understand the physics involved and what to look for in gathering evidence, which would indicate injuries likely to have been sustained by the casualties.

### 6.3.2 Physics

Motor vehicles involved in traffic accidents will be subject to the natural laws of physics that govern all objects.

Definitions of the words which are used to describe the forces involved:

- **Velocity (V)** – Speed of the object i.e. miles per hour, metres per seconds etc.
- **Acceleration (A)** – The rate of change of velocity when velocity decreases it is expressed as DECELERATION.
- **Gravity (G)** – The force of earth's gravitational pull on an object expressed as 9.81 metres/second (or multiples may be expressed in **G**. forces).
- **Kinetic energy (KE)** – Energies associated with bodies in motion, expressed mathematically as:

  $KE = {}^1/_2 \times MV^2$ (where M = Mass of the body; V = Velocity)

  When two objects collide, e.g. car *v* lamp post, the Kinetic energy of the moving car does not just disappear, it must be absorbed. The amount of energy absorbed by each object involved in the impact will be determined from the changes in velocity and the masses involved.

We know instinctively that if there is a big difference in mass between the two objects, the smaller object will absorb the greatest amount of energy. If we take as an example a L.G.V. colliding with a small car, the latter having the smaller mass will sustain greater damage by absorbing more kinetic energy. Just as when a person falls from a height and hits the ground, the person, having the smaller mass than the earth, will absorb a much greater proportion of the kinetic energy generated by the fall.

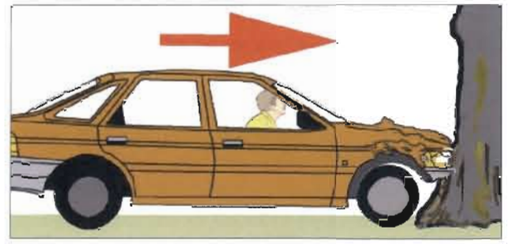
An important physical law which applies to trauma is Newton's First Law of Motion.

#### 6.3.2.1 Newton's First Law of Motion

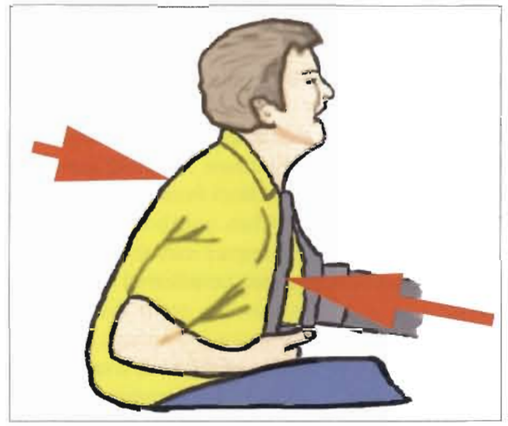
"A body will remain at rest or in motion at a constant velocity unless acted upon by an outside force".

This means that a vehicle travelling at 70 m.p.h. will continue travelling at that velocity unless some outside force acts to speed it up (wind) or slow it down (road frictions, or a sudden encounter with a lamp post). This means that the accident can be broken down into three separate impacts each transferring kinetic energy.

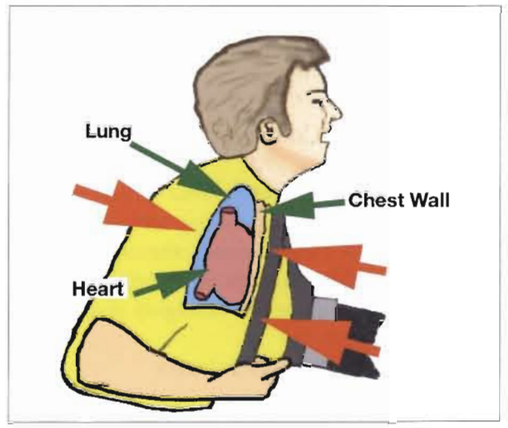
**First Impact**
Vehicle is brought to an abrupt stop. Kinetic energy is absorbed by deformation of the vehicle and the motion of the car is arrested by bending its frame.



**Second Impact**
When the occupants of the vehicle, who are also travelling at the same speed as the vehicle, collide with part of the vehicle's structure i.e. steering wheel, windscreen, dash, seatbelt, etc. their motion continues until energy is absorbed by the structure of the car (denting that structure) or by bending of the occupants' bodies.



**Third Impact**
This occurs when the organs within the occupant's body are hurled against body structures as the body decelerates, e.g. brain thrown forward inside the skull. Heart and lungs thrown forward violently into the chest wall.




It can be seen that the second impact can be avoided by the use of restraint systems and technology to absorb some of the deceleration, e.g. S.R.S. airbags.

The casualty's position in the vehicle will also have an effect on the second impact. The driver may come into contact with the steering wheel, steering column, front wind shield, side windows, dashboard plus the roof and posts. The front seat occupant may also come into contact with the roof headliner, posts and/or the dashboard.

Rear seated occupants are also thrown forward but unlike the front seat occupants they are less likely to come into contact with the dash area (unless seated in the middle of the rear bench unrestrained), those that are restrained can still make contact with the back of the front seat as it may be displaced rearward by the collision forces. They are also in danger of being hit by objects placed on the rear parcel shelf or in the boot.

Lap belts only as a means of a restraint can cause injury in certain cases, particularly front impacts.

Deceleration stresses induced by these systems may damage internal organs such as the spleen, kidneys, bowels and stomach, any of which may rupture and hemorrhage. The occupant's pelvis may also be severely fractured, resulting in internal hemorrhaging. Patients who have received such internal injuries may appear stable upon visual examination, only to subsequently suddenly deteriorate.

People who realise that a collision is imminent will spontaneously tense all their body muscles, instantly inhale and hold their breath through the brief crash scenario. All these reactions stem from our basic animal instinct for survival and occur almost automatically. When you hold your breath, your lungs are inflated. The energy from a collision impact may then cause these hollow organs to rupture violently. Sometimes this may be referred to as the "paper bag effect" in the medical world.

The instantaneous tensing of the body's muscles can result in fracture and dislocation injuries (because the body is 'rigid' on impact). It is usual to find that the driver has his foot braced down onto the brake pedal rigid. This would lead to indirect fractures or dislocation of the leg and hips. If skid marks are seen all the way to the collision impact area this would be a good indicator to look for these types of injuries.

## 6.3.3 Types of Collisions

### 6.3.3.1 Head-on Impact

When there is a frontal impact, the unrestrained occupant is hurled forward and brought to a sudden halt against objects within the vehicle – either by sliding down and under the dashboard or sailing up and over it.

### 6.3.3.2 Down-and-under Injuries

When the unrestrained front seat occupant slides forward, the first impact is often that of the knee against the dashboard, which may produce a fracture of the patella (kneecap). If the impact occurred at high velocity the kinetic energy of the impact may, in addition, be transmitted back along the shaft of the femur to cause it to fracture or a dislocation of the hip to occur.

After the knee hits the dashboard, the top of the driver's body continues moving forward until it is brought to a halt against the steering wheel, perhaps the most lethal object in the vehicle. The steering assembly is comprised of a semi rigid metal ring (the wheel) fixed to a rigid post (the column) and together they constitute an



exceptionally efficient battering ram. Whenever there is structural evidence of steering wheel impact – front end deformity of the vehicle, displacement of the steering column, or damage to the steering wheel ring – be alert for any of the "ring of injuries" that impact with the steering wheel may have produced.

- Lacerations of the mouth or chin
- Bruises of the neck
  - Airway damage
  - Spine injury
- Fracture of the sternum (breastbone) with underlying problems to the heart.
- Rib fractures/flail chest, with underlying problems to the lungs.
- Shearing of the aorta (main artery).
- Shearing or compression of abdominal organs; liver, spleen, pancreas, duodenum.

It is clear from the above that steering wheel injuries are potentially lethal, so when there is damage to the steering assembly, always assume there is critical injury until proved otherwise.

### 6.3.3.3 Up-and-Over Injuries

The second route that an unrestrained front seat occupant can go is up and over the dashboard. Children, because of their size, are likely to take this route, almost always head-first so that the first impact is likely to be the head against the windscreen (laminated). The impact produces injuries to the head itself, concussion or compression, lacerations of the scalp and face plus fractures to the head area. Meanwhile, as the skull comes to an abrupt halt, the trunk is still moving forward and the kinetic energy may well be absorbed by the cervical spine. Therefore, the potential for spine damage is considerable. When the windscreen is cracked or broken, assume the casualty has suffered spinal injury until proved otherwise.

### 6.3.3.4 Restrained Passengers

Restrained passengers are less likely to suffer severe injury because they have some protection from the second collision. However, restraint devices are not perfect in design or always worn correctly. Additionally the head is still left to move forward so the neck is subject to enormous stresses such that damage to the low cervical and upper thoracic spine are not uncommon. Collarbone damage is also known to occur where the chest strap crosses the clavicle.

### 6.3.3.5 Front Quarter Oblique Impact

The same injuries are likely as in a front impact but because of the modern design of motor vehicles and the position of the longtitudinals in the car more energy is absorbed by the vehicle. This usually has the effect of pushing the front foot-well back by the vehicle's own suspension moving back and intruding in that area. If the car is rear wheel drive the transmission tunnel may act to sandwich the front seat occupants' legs. Therefore, it is more likely that there will be direct fractures to the lower limbs.

#### 6.3.3.6 Side Implosion (T-Bone)

In this case, as the name implies, the vehicle is hit in the side. The location on the vehicle where the exact implosion occurs will determine the severity of the injuries sustained. Collisions produce injury from secondary impact and from direct intrusion of the deformed part of the car into the passenger safety cell. Seat belts do not help a great deal in these circumstances and may, in fact, trap the passenger in the path of the incoming car door.

Usually the first impact is between the shoulder girdle and the 'B' pillar of the car, which may result to fractures to the collarbone, upper arm and possible multiple rib fractures, with underlying damage to the lungs.

If the car door is forced into the occupant's hip, then a fracture of the pelvis is likely and can cause underlying complications to the abdominal region.

When the shoulder and pelvis are brought to a halt, the head is still moving so the next impact will be of the head against the door post, leading to a variety of head injuries. The kinetic energy of the impact is usually absorbed by the neck and cervical spine injuries are likely to occur.

#### 6.3.3.7 Overturned Vehicle (Roll-Over)

The roll-over collision is usually a combination of accident types. Vehicles cannot roll over by themselves they must be acted upon by forces that create the momentum necessary.

A vehicle can roll in three different ways:
(1) Vehicles roll in time with their long axis, i.e. rolls onto its roof and side.
(2) Rotate about its central axis, such as when hit broadside at a point near the front or rear of the vehicle.
(3) Vehicles roll end over end. If a vehicle were to leave a road and plunge down an embankment, the vehicle could hit the ground (frontal collision), roll over as the rear hits the ground (rear end collision), until finally its deceleration is completed.

The extent of occupant injuries and entrapment is primarily influenced by the amount of force released during the roll-over, i.e. a gentle half roll is quite different from a series of complete high speed end-over-end rolls down an embankment. The destruction of both the vehicle and its occupants is directly related to the energy involved in the roll-over crash.

As a roll-over occurs, the occupants either move first towards the initial impacting force or are thrust towards the lower side of the vehicle. Any unrestrained occupants and loose objects inside the vehicle are tossed around and stand a chance of being ejected from the vehicle. Those who remain in the vehicle, are subject to multiple impacts in numerous directions as they collide with various surfaces within the car. Spinal injury is likely to be suffered together with almost any other kind of injury.

If the final resting place is upside down, occupants are likely to be found also inverted and held in by their seat belts. This can cause problems with casualty handling and can lead medical teams into a false sense of security because the blood pressure will be artificially maintained.



#### 6.3.3.8 Rear-End Collision

A typical rear-end collision can occur when a stationary vehicle is hit from behind by a moving vehicle. The impact produces a sudden acceleration in the struck vehicle, which in turn is transmitted to the occupants and pushes them forward. If they are properly restrained with correctly adjusted headrests then they should not suffer unduly. However, if not fitted or incorrectly adjusted, then the head will have more movement allowing hyper extension and a tearing of ligaments in the neck area referred to as "whiplash".

The other problem with rear end collisions is that they may lead on to a front end impact by the vehicle being projected forward possibly into the rear of another vehicle. This could lead to further injuries as already described in "Head-on Injuries".

### 6.3.4 Tell-Tale Signs

Certain indications in the vehicle are sure signs of injury to the occupant. These are:

(1) Cracked windscreen, "spider's web pattern" clear indication of head injury and/or cervical spine damage.
(2) Moved rear view mirror indicates possible head injury and may include fractured skull and again cervical spine damage. Also shows that occupant was not restrained.
(3) Deformed steering wheel/column. See steering wheel injuries.
(4) Deformed dash shows possible kneecap fracture or dislocation, dislocated hip and/or a fractured femur.
(5) Gear knob damage could again point to possible fractures to the legs or pelvis or a penetrating injury, depending on the type of accident collision and the forces involved.

### 6.3.5 Summary

This is very much an overview of the possible occurrences in an accident collision, but the development of personal experiences will lead to an ability to understand the forces involved and ability to 'read' the accident better.

To do this it is worth carrying out debriefs both with the crew and the medical team involved. To further learn and piece together the whole picture, it may be worth following up accidents by asking for details of injuries from the hospital staff. However, patient confidentiality must be remembered. Sometimes the police can be of assistance as well as ambulance crews in getting extra information on casualties' injuries.

Improving the skills of reading an accident will help in being able to decide the logic needed for release and the time scale available for the extrication. It will also provide knowledge of the medical team's possible requirements and the space they may need for stabilising the casualty.

### Additional help in diagnosis

Some fire and rescue services have conducted tests making use of mobile phone photographic technology at road traffic incident sites. Pictorial data can be added to other types of information sent to hospitals and other health service professionals.

Medical staff need the best possible information for the diagnosis of injuries and treatment of casualties. Time can be of the essence. The swift despatch of pictorial information direct from the scene of the incident can give valuable assistance to the medical staff so that they can see the circumstances in which the injuries have been sustained. The images can help hospitals to determine if specialist staff and equipment need to be despatched to the incident scene.

Information contained in the images can also help preparations for providing the most appropriate treatment when the casualty reaches the hospital.

The information flow can be two-way. Essential advice on immediate care of casualties at the incident can be relayed by health professionals to the incident site.

Developments in such technologies – including digital photography and video downloads – have the potential to achieve an important and positive effect on the treatment and subsequent recovery of road traffic incident casualties.

Consideration should be given to their use where appropriate.



## 6.4 Casualty Assessment & Management

### 6.4.1 Introduction

Pre-hospital preventable deaths are rarely due to the unavailability of advanced medical help/techniques but, more often, the failure of the rescuer to recognise and treat basic airway, breathing and circulation problems. This emphasises the importance of having good casualty assessment skills, which will focus the firefighter rescuer on life-threatening manifestations of the injury, and, therefore target vital immediate emergency care interventions.

**Preventable deaths can occur by failing to recognise basic ABC problems.**

On-scene assessment and a quick physical overview will give the firefighter rescuer a general impression of the casualty's condition. However, a focussed evaluation is designed to:

- Determine the casualty's airway, breathing, circulatory and mental status
- Recognise the most life-threatening conditions
- Prioritise treatment
- Identify the time critical vs. the non-time critical casualty
- Record changes in vital signs

Once scene safety has been established, a thorough assessment of the casualty should be carried out using the 'primary survey'. The primary survey is a universal system for assessing and managing the critically injured casualty. A more advanced version is used by doctors, nurses and paramedics. The use of similar systems promotes continuity of care and adheres to best practice.

### 6.4.2 Primary Survey Assessment

Primary survey assessment uses the following acronym:

**A** Airway
**B** Breathing
**C** Circulation
**D** Dysfunction
**E** Expose

Use your senses to **LOOK**, **LISTEN** and **FEEL**.

## 6.5 Airway – Assessment and Management

To have a normal and functioning respiratory system, the airway must remain patent (open and clear). Any airway compromise will lead to hypoxia (deficiency of oxygen at tissue level) which, if not recognised and treated promptly, will lead to permanent organ damage or even death.

### 6.5.1 Airway Assessment

After establishing an initial response level, immediately assess the airway for patency:

**Initially, LOOK, LISTEN and FEEL for:**

- **Apnoea (absence of breathing)**
  can be caused by complete airway blockage

**LOOK in the mouth for**

- **Foreign objects**
  such as loose teeth, bone fragments, food, broken glass or metal
- **Fluid**
  such as vomit, blood, mucus, excess saliva
- **Swelling**
  caused by burns, injury, inflammation

**LISTEN for**

- **Gurgling (throaty bubbling noises)**
  indicates partial obstruction of the pharynx (upper airway), caused by fluid
- **Snoring (snorting sound)**
  indicates partial obstruction of the pharynx, most commonly caused by the tongue
- **Stridor (high pitched grunting sound)**
  indicates partial obstruction of the larynx (lower part of the upper airway), commonly caused by swelling, foreign body, or crush injury. Stridor usually occurs on inspiration.
- **Wheezing (rasping or whistling sound)**
  indicates narrowing of the bronchioles (lower airways), commonly caused by swelling, inflammation or fluid. Wheezing usually occurs on expiration.

**Airway compromise that is not recognised and treated early will lead to permanent organ damage or death.**

### 6.5.2 Airway Management

The first priority when dealing with any unresponsive casualty is the establishment and maintenance of a clear airway.

When dealing with the airway of a casualty who has suffered significant trauma be aware of the potential for spinal injury, therefore the airway should be managed whilst **maintaining cervical spine (C-Spine) immobilisation**.

#### 6.5.2.1 Airway Management Manoeuvres

In the unconscious casualty the lower jaw drops and the tongue becomes flaccid and falls back partially or totally occluding the airway. The manual methods used to clear this type of obstruction are as follows.



**(a) Trauma Jaw Thrust**

This is the manual airway manoeuvre of choice when dealing with suspected cervical spine injuries.

- Use P.P.E.
- Stabilise the casualty's head and cervical spine
- Open the casualty's mouth, check for and remove any obstructions
- Grasp the angles of the lower jaw, with your index and or middle fingers, one hand on each side
- Pull the jaw gently forwards.
- Open the mouth slightly with the tips of your thumbs.

**(b) Trauma Chin lift**

The chin lift is an alternative manual airway manoeuvre in cases of severe facial injury in which jaw thrust is ineffective.

- Use P.P.E.
- Stabilise the casualty's head and cervical spine.
- Open the casualty's mouth, check for and remove any obstructions
- Grasp the tip of the jaw with thumb and index finger.
- Alternatively the thumb is placed inside the mouth behind the lower teeth/gums with the index finger grasping the chin.
- Pull the jaw gently forwards

### (c) Head Tilt/Chin Lift

This airway manoeuvre is NOT RECOMMENDED in cases of suspected cervical spine injury, it should only be used if recommended manual and mechanical methods have failed.

- Use P.P.E.
- Open the casualty's mouth, check for and remove any obstructions
- Use one hand to press backwards on the casualty's forehead
- Place the index finger and thumb of your other hand under the bony part of the chin
- Pull the chin forward so that the upper and lower teeth are nearly brought together

**Be careful when using these methods not to press on soft tissue in the neck area as this in itself can block the airway.**

### (d) Airway Adjuncts

Simple techniques such as chin lift or jaw thrust should be employed initially. However, it can be difficult in certain circumstances to maintain an open airway using manual manoeuvres only. In such cases it may be necessary to use mechanical adjuncts/devices to assist in controlling the airway.

## 6.5.3 Suction

In an unresponsive casualty fluid such as vomit, blood, mucus or excessive saliva can collect in the mouth and oropharynx. The risk is that the fluid may cause airway obstruction or may be inhaled into the lungs.

### 6.5.3.1 Types of Suction Devices

There are several types of aspirator (suction) devices available. They can be hand operated, battery or gas powered. There are generally three types of suction catheters (tubes); these are rigid, semi-rigid or soft. Only rigid or semi-rigid wide bore catheters should be used for adults in the pre-hospital setting.



### 6.5.3.2 Suctioning Techniques

- Use P. P. E.
- Open the casualty's mouth check for fluid
- Gently insert the catheter into the casualty's mouth. Do not insert the catheter beyond the base of the tongue (as far as you can see).

  **Note:** Inserting the catheter too far, or using vigorous techniques may cause gagging, laryngeal spasm or negatively affect the casualty's heart rate and blood pressure.

- Gently suction the back of the mouth, inside of both cheeks and under the tongue.

  **Note:** vigorous suctioning can damage soft tissue causing bleeding into the airway.

- Suction on the outward movement only.

  **Note:** if the catheter becomes blocked during insertion this prevents immediate removal of fluid from the back of the throat.

- If possible, try to limit suctioning to 15 seconds at any one time.

  **Note:** prolonged suctioning results in hypoxia as oxygen supplementation devices must be removed in order to access the mouth and throat.

  Suctioning will also remove oxygen as well as fluid from the oropharynx.

**Equipment for suctioning the oropharynx is essential for the maintenance of upper airway patency.**

## 6.5.4 Oropharyngeal (OP) Airway

To relieve obstruction caused by the tongue it may be necessary to use a mechanical device to assist in controlling the airway. One of the most commonly used adjuncts is the oropharyngeal (OP) airway. This is a rigid device designed to fit over the tongue keeping it forward and away from the back of the throat. Oropharyngeal airways are available in several sizes ranging from 00 (infant) to 5 (large adult).

**Oral devices are no substitute for simple airway management techniques and their use should never delay effective manual airway manoeuvres.**

### 6.5.4.1 Indications for OP airway use

The oropharyngeal airway can be used in the following situations:

- The unresponsive casualty in which the airway is difficult to manage using manual manoeuvres only.
- To help maintain an open airway during assisted ventilation.

### 6.5.4.2 Contraindications for OP airway use

The oropharyngeal airway should not be used in the following situations:

- The responsive casualty
- The unresponsive casualty with an intact gag reflex
- The casualty suffering trismus (clenched jaw/teeth) – do not force open the mouth

### 6.5.4.3 OP Insertion Techniques

Select the appropriate size by placing it against the casualty's face. It should extend from the corner of the mouth (flange at the level of the central incisors) to the angle of the jaw.

**Note:** an airway that is too small can push the tongue back or fall into the oral cavity, an airway that is too large can down fold the epiglottis (the flap over the opening of the trachea) causing complete airway obstruction.

Open the casualty's mouth and ensure it is clear of fluid and debris. Insert the tip of the airway in an upside down position into the mouth so that the convex curve of the airway is directed downwards..

**Note:** rough handling may tear the mucous membranes in the mouth causing bleeding and adding to airway problems.



Gently slide the airway along the roof of the mouth to the soft palate (until resistance is felt) and rotate 180 degrees, advancing it over the tongue until the oral flange is resting at the lips, if the casualty gags remove it immediately.

**Note:** poor insertion techniques may break teeth or dental fittings, which can drop into the upper and lower airways causing partial or total occlusion.

Check for correct placement by
(a) listening for improved airway and breath sounds
(b) observing and or feeling for chest wall movement and
(c) checking the lips and tongue are not caught between the teeth and the airway.

Once correct placement has been established, maintain good jaw position to assist airway control.

**Note:** If the casualty vomits or other fluid such as blood, mucus or saliva collects in the oral cavity, remove the airway, suction the oropharynx then check that the airway lumen is clear before reinsertion.

**This section does not cover devices such as nasopharyngeal or laryngeal mask airways employed by some fire, rescue and ambulance services, as their use is not widespread and they require strict individual medical directives.**

## 6.5.5 Paediatric Assessment/Management Considerations

Like adults, airway assessment and management is the first priority in the paediatric casualty. Children have specific anatomical and physiological differences that can affect assessment and management. The following are relevant differences:

**The classification for paediatrics age scale is: (An infant is a child under 1 year – A child is between 1 year and puberty)**

- Infants have a relatively large tongue in proportion to the oral cavity, making blockage easier.
- Infants have a large head and a short neck making the airway more likely to buckle when employing manual airway manoeuvres.
- Infants have a short narrow trachea making foreign body obstruction more likely.
- Stridor sounds like "crowing" (higher pitched grunting) noise in children.
- The mucous membranes in the mouth and throat are delicate; therefore, correctly sized paediatric airway adjuncts should be used in order to prevent damage.

- In infants and small children, inserting the OP airway in an upside down position can damage the delicate mucous membranes inside the mouth. The recommended insertion method for an infant or small child is to insert the airway the right way up using a tongue depressor to hold the tongue forward and against the floor of the mouth during insertion.

**It is important that the firefighter immediate emergency care provider must maintain competentence in airway assessment/ management skills.**

## 6.6 Breathing – Assessment and Management

All cells within the human body need a constant and adequate supply of oxygen in order to function properly. Any breathing/ventilation deficiencies will lead to a hypoxic state, resulting in major organ failure.

### 6.6.1 Breathing Assessment

Once the airway has been stabilised, the firefighter should make an accurate evaluation of the casualty's breathing status.

**Initially, LOOK, LISTEN and FEEL for:**

- **Apnoea**
  caused by complete airway blockage, respiratory or cardiorespiratory arrest. If not breathing or only taking the occasional gasp, implement basic life support procedures (see trauma related cardiorespiratory arrest).

**LOOK and LISTEN for:**

- **Skin Colour**
  pinkish skin (or mucous membranes in dark skinned individuals) generally indicates good blood oxygenation. Cyanosis (blueness) indicates poor blood oxygenation and is observed in the lips, mouth, neck, chest, extremities, and the mucous membranes.
- **Rate**
  the normal ventilation rate for an adult is between 12 and 20 breaths per minute.
- **Depth**
  refers to the amount of air that is exchanged with each breath and can be measured by watching movement of the chest
- **Regularity**
  respiratory rate can be regular or irregular and is determined by counting the number of breaths over a one-minute period
- **Symmetry**
  chest movement should be equal on both sides; it can be assessed by looking at the exposed chest.
- **Increased effort:** the following signs indicate an urgent/time critical casualty:
  - **nasal flaring** (nostrils opening wide during inspiration)
  - **use of accessory muscles** (using neck, shoulder and abdominal muscles)
  - **Tracheal deviation** (windpipe off-centre)



  - **intercostal muscle recession** (muscles between ribs, drawing in with inspiration
  - **seesaw movement** (distension of the abdomen when the chest falls)
  - **inability to speak** (a casualty who cannot complete a sentence in one breath).

**Ventilatory compromise must be recognised and treated early in order to prevent hypoxia.**

### 6.6.2 Breathing Management

After establishing a clear airway, it is the firefighter's next immediate care priority to ensure adequate oxygenation of the seriously injured/ill casualty.

#### 6.6.2.1 Supplemental Oxygen

Although oxygen is present in atmospheric air and is a naturally occurring gas, when used as a casualty treatment it is regarded as a drug. Therefore, it should only be used in accordance with agreed protocols set down in medical directives.

***Indications for Oxygen Administration***

Recognising the need for oxygen supplementation is an essential provider skill. The following are some of the conditions that require early oxygenation:

- Signs of airway, respiratory or circulatory compromise
- Hypoxia
- Altered/reduced level of consciousness
- Serious trauma and medical illness
- Toxic fume inhalation
- Respiratory and cardio respiratory arrest

***Contraindications for Oxygen Administration***

In casualties suffering from chronic lung disease such as chronic bronchitis or emphysema, high concentrations of oxygen administered over prolonged periods of time may be dangerous as it can affect their respiratory drive. However, in the pre-hospital setting, particularly when admission to hospital time is short, all trauma casualties showing signs of airway, respiratory or circulatory compromise should initially be given a high concentration of oxygen.

Oxygen must never be used in fire hazardous environments. Special care should also be taken when using near electrical equipment.

Side effects of oxygen supplementation include drying of the mucous membranes in the casualty's mouth, nose and respiratory tract.

**All trauma casualties showing signs of airway, respiratory or circulatory compromise should be given high concentrations of oxygen.**

***Oxygen Cylinders***
The most common form of portable medical oxygen used in the pre-hospital environment is pure oxygen gas. The compressed gas is stored in steel cylinders colour coded in the UK as black with a white neck and shoulder (the word oxygen or symbol O will also be printed on the cylinder). The cylinders range in size, which are designated by a letter. The cylinders generally used in the pre-hospital setting are:

- D size contains 340 litres charged at 2000 PSI
- F size contains 1360 litres charged at 2000 PSI (generally kept in ambulance vehicles)

Always follow manufacturer's recommendations and adhere to medical directives in relation to operation, storage and safe use. Some universal points to remember are:

- Oxygen cylinders must not be subjected to extreme (particularly high) temperatures
- Cylinders should be secured to prevent excessive movement
- Keep empty cylinders separate from full cylinders
- No smoking in the vicinity where oxygen is being used or stored
- Oil or grease must not come into contact with cylinder fittings, hoses and valves
- When in use, be sure that cylinder valves are facing away from you and anyone else
- Close valves when cylinder is not in use and purge any oxygen still left in the hose/tubing
- Try not to let cylinders run completely empty, replace if less than quarter full

***Regulators***
A regulator is fitted to the cylinder through a yoke/pin index system; this controls the pressure of oxygen. The pin index connector is unique to the oxygen gas cylinder this preventing incorrect attachment to other medical gas cylinders. There are two main regulator fixtures used.

(i) Pin Index (D size)
(ii) Bull nose (F size)

Both of the above regulators have an 'O' ring or bodok seal to help form an airtight seal between the regulator and the cylinder.

The flow rate is regulated by a 'flow meter', which can be adjusted to the desired setting, measured in litres per minute. Flow meters control the amount of oxygen delivered from the cylinder to the mask/device.

***Assembling the Equipment***
Always follow the same sequence when assembling oxygen equipment in accordance with the manufactures guidelines.

(1) Remove the manufacturer's seal.
(2) Check for damage to the cylinder outlet.
(3) Turn the cylinder away from yourself and others, open the outlet valve to release a small amount of gas to blow away any dust etc.



(4) Check that the regulator/therapy and cylinder outlet fittings are compatible.
(5) Screw on the regulator/therapy head, making sure that it is seated firmly against the bodok seal and there are no gas leaks. Do not over tighten.
(6) Ensure the flow meter is in the off position.
(7) Turn on the oxygen. Position yourself to the side of the cylinder, away from the cylinder valve. Check the contents gauge.
(8) Check the flow meter – then turn off.

**Always follow manufacturers' recommendations and medical directives when administering oxygen.**

***Oxygen Delivery***
When administering supplementary oxygen there are three key factors that will influence the percentage of oxygen the casualty will receive these are:

(1) Type of Mask
(2) Oxygen Flow Rate
(3) Mask to Face Seal

***Type of Mask Device***
There are several masks/devices used for oxygen delivery. Devices used in the pre-hospital environment include nasal cannulae, simple facemasks and partial or non re-breathing masks. The preferred method of choice for providing high concentration of oxygen to the spontaneously breathing casualty is the **non re-breather device**.

**Mask**
The non re-breather device consists of a clear plastic face mask, reservoir bag and a one-way flutter valve attached to the side of the mask which acts to minimise re-breathing of expired air. It comes in adult, child and infant sizes and can deliver up to 90% oxygen.

**Note:** the reservoir bag should be fully inflated before application.

**Flow Rate**
High oxygen concentrations can be achieved between 10–20L/min. Choice of flow rate to the casualty will be determined by oxygen reservoir bag filling.

**Note:** adjust the flow rate so that the reservoir bag does not deflate more than one third with each breath.

**Mask to Face Seal**
Choose the correct sized mask before application. The cone-end of the mask with the aluminium strip should fit over the bridge of the casualty's nose and the bottom of the mask fits below the lip or chin.

**Note:** make sure when fitting the mask, a good seal is achieved by tightening the elastic straps.

**The amount of oxygen a casualty receives is influenced by the type of mask, flow rate and mask to face seal.**

### 6.6.2.2 Assisted Ventilation

Artificial ventilation should be performed on any casualty who is not breathing or breathing is so inadequate (occasional gasps) it cannot sustain adequate oxygenation.

***Artificial Ventilation Techniques***

**Mouth-to-Mouth Expired Air Ventilation**
In the absence of ventilation devices, mouth-to-mouth resuscitation can be performed (see cardiorespiratory arrest in trauma section).



**Face Shield**
This is a plastic sheet, which is fitted with a one-way valve.

**Face Shield Ventilation Techniques**

- PPE
- Apply the sheet to the casualty's mouth and nose ensuring a tight seal
- Pinch the nose and commence mouth-to-mouth ventilation

**Ventilation Face Mask**
This is a single user mouth-to-mask ventilation device. It has a one-way valve ensuring that the casualty's expired air or any fluid is directed away from the rescuer. The mask is transparent allowing detection of vomit or blood. Some masks have an additional attachment allowing oxygen supplementation.

***Face Mask Ventilation Techniques***

- PPE
- Apply the mask to the casualty's face using the thumbs of both hands
- Lift the jaw up to the mask with the remaining fingers by exerting pressure behind the angles of the jaw (jaw thrust). At the same time, press the mask onto the face with the thumbs making a tight seal.
- Blow through the inspiratory valve and watch to ensure the chest rises and falls
- Any leaks between the face and mask can be reduced or abolished by adjusting the contact pressure or altering the airway manoeuvre
- If oxygen is available, add it via the nipple at above 10L/min.

**Bag Valve Mask Ventilation**
The bag valve mask device consists of a facemask, one-way valve, self-inflating bag and an oxygen reservoir bag. The self-inflating bag has to be manually squeezed to ventilate the casualty. Although high concentrations of oxygen can be delivered using this device, it is one of the most difficult skills to master, therefore the two-person technique is strongly recommended.

***Two-Person Bag Valve Mask Ventilation Technique***

- Firefighter 1 applies the mask to the casualty's face using the thumbs of both hands. Lift the jaw up to the mask with the remaining fingers by exerting pressure behind the angles of the jaw (jaw thrust), at the same time press the mask onto the face with the thumbs making a tight seal. If oxygen is available, add it via the nipple at between 10 and 20 litres per minute.

- Firefighter 2 holds the bag portion of the bag valve mask with both hands and squeezes the bag slowly and steadily to deliver the breath over one second (just enough to see the chest visibly rise). Any leaks between the face and mask can be reduced or stopped by adjusting the contact pressure or altering hand position.

**Note:** aggressive ventilation technique can causes gastric insufflation (air in the stomach) and subsequent gastric distension, this increases the risk of vomiting and aspiration of stomach contents into the lungs. To help minimise the risk of gastric distension, maintain a clear airway, deliver the ventilation slowly, do not over inflate the chest and allow adequate time for exhalation.

**Mechanical Ventilators**
These are oxygen or battery powered ventilation devices. They are usually automatically or manually triggered. Training in their use should be sourced from the manufacturers.

**Ventilation techniques should be practiced regularly to maintain a high skill level.**



### 6.6.2.3 Paediatric Assessment/Management Considerations

Like adults, breathing assessment and management is the next priority after airway stabilisation. Children have specific anatomical and physiological differences that can affect assessment and management. The following are some of relevant differences:

- Infants/Children have higher normal ventilation rates.
- An increase in ventilatory rate is one of the earliest signs of hypoxia in infants/children.
- "Head bobbing" with each breath is a sign of increased effort of breathing
- Mouth opening when breathing can be a time critical sign – children are primarily nose breathers.
- Specifically sized ventilation devices must be used for the paediatric casualty.

**It is important that the firefighter immediate care provider is competent in ventilation assessment/management skills.**

## 6.7 Circulation – Assessment and Management

The cardiovascular system is responsible for the circulation and delivery of oxygen and nutrients to the cells of the body and any failure in this system will result in a state of shock. If the shock becomes progressive, cells will start to dysfunction, and, without intervention organ damage or death can occur.

### 6.7.1 Circulation Assessment

Once the airway and breathing problems have been identified and stabilised, the casualty's circulatory status can be assessed.

**Initially, LOOK, LISTEN and FEEL for:**

**LOOK for:**

- **Haemorrhaging**
  Bleeding is the escape of blood from a ruptured blood vessel both externally, from an open wound, or internally from a ruptured vessel. Whilst damage to minor vessels may produce only a small amount of blood loss, rupture of a major blood vessel can lead to the loss of several litres of blood.

**LOOK and FEEL for:**

- **Skin Colour**
  Pale skin (or mucous membranes in dark skinned casualties) may indicate shock, flushed skin may indicate hyperthermia (high temperature) or hypertension (high blood pressure)
- **Temperature**
  Normal skin is warm and dry and can be assessed by touching the casualty; cold, clammy skin indicates diminished blood supply. Be aware that the environment will affect skin temperature

- **Pulse Rates**
  The normal pulse rate for an adult at rest is between 60–100 beats per minute. The rate may be fast or slow depending on the casualty's condition
- **Pulse Strength**
  This is the wave of blood, which is felt as it travels through the blood vessels. It may be strong or weak depending on the casualty's underlying problem. Central (carotid) and peripheral (radial) pulses should be checked in the casualty who is breathing. Peripheral pulses may disappear or become weaker as the state of shock progresses
- **Pulse Regularity**
  It may be regular or irregular depending on the casualty's underlying problem
- **Capillary Refill**
  This is the time taken for the capillary beds to fill after being blanched. To assess, press on the nail bed or peripheral skin (against a bony prominence) for up to five seconds and then release the pressure, count the time it takes for normal colour to return – less than two seconds is normal, greater than two seconds is abnormal. Results can be influenced by cold weather, poor circulation or underlying medical conditions. This test may not be reliable in adults, as some casualty's may display a normal capillary refill time even when there is underlying circulatory compromise.
- **Signs of Shock**
  Shock is a lack of circulation to the vital organs in the central body, which leads to a lack of circulation to the rest of the body. There are several types of shock that can affect the trauma casualty. This includes: hypovolaemia (loss of body fluid), neurogenic (relating to the nervous system) and cardiogenic (relating to the heart). Hypovolaemic shock is the most common type of shock in the trauma casualty. Signs of shock include:

  - Pale cold clammy skin (may be warm and dry in neurogenic)
  - Rapid weak pulse (may be slow in neurogenic)
  - Air hunger
  - Rapid shallow respirations
  - Extreme thirst
  - Increased capillary refill time
  - Weak or absent peripheral pulses
  - Altering level of consciousness

**Circulatory compromise must be recognised and treated early to minimise or prevent shock.**

**Circulatory Management**
After stabilisation of the airway and breathing it is the firefighter's next priority to treat circulatory compromise caused by external haemorrhage and or shock.

**Haemorrhage**
Bleeding must be controlled as soon as it is identified, as severe bleeding if left untreated can be fatal. Types of bleeding include:

- **Arterial**
  The blood, oxygenated and under pressure, is bright red and spurts with each heartbeat. Arterial bleeding is often hard to control and is the most severe form of bleeding.



- **Venous**
  The blood, de-oxygenated and under less pressure, is dark red and flows more steadily. It is generally easier to control than arterial bleeding but can be serious when it is a large vessel, e.g. Varicose vein bleeding.

- **Capillary**
  The blood oozes out and is bright red in colour: capillaries are minor vessels; therefore, damage is not usually life-threatening.

**Haemorrhage control**
- PPE
- Using a dressing pad, apply direct pressure to the bleeding site
- Elevate the injured part above the level of the casualty's heart (if possible)
- Secure pressure-dressing pad with a bandage. If the dressing becomes blood-soaked, add another dressing and bandage. If this does not control the haemorrhage, remove it and start again.
- If direct pressure is ineffective, apply indirect pressure, that is press on artery proximal (nearest to the body) to the wound, this will cut off the blood supply to the limb, and must not be applied for longer than ten-minute intervals.

**After stabilisation of the airway and breathing, haemorrhage control is the firefighter's next immediate care priority.**

**Casualty Positioning**
The injured casualty suffering shock should be placed supine (lying flat on back) on a spinal stretcher as soon as possible, ready for transport. The trendelenburg or shock position (head low with feet raised) is no longer recommended for the trauma casualty as it may further aggravate existing injuries particularly in the chest and abdomen.

**Positioning in pregnancy**
In the late stage of pregnancy, the prominent uterus can cause compression of major blood vessels, which may negatively affect circulation. During transport and resuscitation the casualty should be inclined (by placing a blanket or wedge under the spine board) 10–15 degrees to the left. Resuscitation of the mother is paramount to survival of the mother and fetus.

**Paediatric Assessment/Management Considerations**
As with adults, circulation assessment is the next priority after airway and breathing stabilisation. Children have specific anatomical and physiological differences that can affect assessment and management. The following are relevant differences:

- Infants/Children have higher normal pulse rates
- The brachial pulse is the easiest to palpate in infants.
- In small children capillary refill should be assessed by blanching the sole of the foot.
- Infants/Children have a smaller cardiovascular system therefore small amounts of blood loss can be devastating
- Sunken eyes, fontanel and dry mucous membranes can indicate circulatory compromise in the infant
- Children compensate very well in the early stages of shock therefore obvious signs may not be evident until the late stages of their condition.

**It is important the firefighter immediate care provider is competent in circulation assessment/management skills.**

## 6.8 Dysfunction – Assessment and Management

The state of a casualty's mental/cerebral function can be an indirect indication of brain oxygenation. Assessment of Dysfunction/Disability should be detailed with repeated recordings of observations, as it provides critical information to medical personnel.

### 6.8.1 Dysfunction Assessment

After establishing and managing the Airway, Breathing and Circulatory status, the casualty's mental/cerebral function should be assessed.

**LOOK, LISTEN and FEEL for:**

- **Conscious Level**
  Try to ascertain, on-scene, when and if the casualty lost consciousness and for how long. The level of consciousness can be assessed quickly and easily using the acronym **AVPU**.

  **A**lert – *casualty is awake*. Ask the casualty a direct question, such as *"do you hurt anywhere?"* to ascertain if they are coherent. If the casualty is aggressive, uncooperative or combative, this can be an early sign of hypoxia. Never assume this behaviour is caused by their injury or intoxication. If the casualty does not respond move onto verbal stimuli.

  **V**erbal – *casualty responds to verbal stimuli*. If the casualty has closed eyes, give them direct commands such as *"open your eyes"* or *"squeeze my fingers and release"*. If the casualty does not respond move onto painful stimuli.

  **P**ain – *casualty responds to painful stimuli only and does not respond to verbal stimuli*. Apply painful stimulus such as nail bed pressure, pinching the back of the upper arm or ear lobe (not if injury is present in these areas).
  A casualty's response to pain may include:
  - Trying to push away the pain source (localizing)
  - Pulling away from the pain source (withdrawal)
  - Bending of the limb towards the body (flexion)
  - Straightening of the limb away from the body (extension).

  **U**nresponsive – *casualty is unconscious and does not respond to painful or verbal stimuli*.
  If the casualty does not respond to painful stimulus, this signifies the lowest form of consciousness on the AVPU scale.

- **Pupils**
  Abnormal pupil size, reaction and equality may indicate altered brain function, drug intoxication/overdose or medical complications. Assessment of the pupils should include the following:

  - **Dilation** Pupils that are dilated (larger than normal) can indicate hypoxia, drug or alcohol intoxication, brain injury or eye medications.
  - **Constriction** Pupils that are constricted (smaller than normal) can indicate brain injury, disease or narcotic drug use.
  - **Inequality** Pupils that are unequal can be normal but may indicate brain insult/injury.
  - **Misshaped** Misshaped pupils that are abnormally shaped (not round) can indicate brain or eye injury.

**Note:** Assessing pupil reaction to light may prove difficult in the often poorly lit prehospital environment, particularly to the inexperienced.

**Changes in conscious level and pupils provide critical information for medical personnel.**

### 6.8.2 Dysfunction Management

Dysfunction/Disability management involves treating any problems identified during the assessment process that may indicate mental/cerebral impairment. For example, if the casualty shows any alteration in their conscious level such as combative behaviour (an early sign of hypoxia) or the pupils are dilated (a late sign of hypoxia), check:

(1) The airway is still patent.
(2) The casualty is receiving enough oxygen and ventilating adequately.
(3) There are no missed bleeding sites.

### 6.8.3 Paediatric Assessment/Management Considerations

As with, adults mental/cerebral function assessment and management is the next priority after establishing and managing the Airway, Breathing and Circulation. Children have specific anatomical and physiological differences that can affect assessment and management. The following are some of the relevant differences.

- Even a brief loss of consciousness in a child may indicate significant brain injury
- Although vomiting in a child following head injury is a less serious sign than in an adult, persistent vomiting must be viewed as significant
- The acronym AVPU for assessing conscious level must be adapted accordingly, due to the limited communication skills of children

**It is important that the firefighter immediate care provider is competent in dysfunction assessment/management skills.**

## 6.9 Expose – Assessment And Management

The purpose of Expose/Examine during the primary survey is to identify any injuries or conditions that may not have been immediately obvious during the initial part of the survey, i.e. wounds or bleeding that may be hidden by clothing.

### 6.9.1 Expose Assessment

Once the level of consciousness and pupils have been checked, a rapid head-to-toe examination should be performed. Before exposing parts of the body, take into account the environment and casualty dignity. Only expose what is necessary and re-cover immediately after examination.

**LOOK, LISTEN and FEEL for:**

- **Haemorrhage**
  With gloved hands, check under and over clothing to identify any bleeding sites that may have been missed during the initial visual assessment.
- **Immediately life threatening wounds**
  Expose the torso, look for serious/life threatening wounds such as:
  - **Open/sucking chest or upper abdominal wounds**
    An open and/or sucking wound occurs when there has been penetration of the chest/upper abdominal wall by an impaling object. The casualty may show signs of respiratory distress and complain of pain near or around the puncture site. Moist bubbling or sucking sounds may be heard coming from the wound. Large wounds may allow air to be sucked into the chest. A build up of air in the chest cavity will compress internal organs resulting in breathing and circulatory compromise.

**Re-cover after exposing the casualty to prevent hypothermia and preserve dignity.**

### 6.9.2 Expose Management

Expose/Examine management involves treating any immediate life threatening problems identified during the assessment process.

- **Haemorrhage**
  (For haemorrhage control see circulation management section)
- **Immediate life threatening Wound Management**
- **Open/Sucking Chest or upper abdominal wounds**
  Any sucking upper torso wounds should be sealed with an airtight dressing. Apply an occlusive dressing taping three sides only, this will act as a one-way valve sealing the chest cavity from further air entry but allowing air to escape out through the untapped fourth side.

### 6.9.3 Paediatric Assessment / Management Considerations

Like adults, Expose/Examine assessment and management is the next priority after establishing and managing the Airway, Breathing, Circulation and Dysfunction. Children have specific anatomical and physiological differences that can affect assessment and management. The following are some of the relevant differences.

- Special care should be taken when exposing areas of the body in a child, as they will often be frightened and anxious. Only expose what is necessary and cover immediately.
- Only expose small areas at a time, as children are more susceptible to developing hypothermia.



**It is important that the firefighter immediate care provider is competent in expose assessment/management skills.**

## 6.10 Secondary Survey

Once the primary survey has been completed and, if time permits, a secondary survey may be carried out.

The purpose of the secondary survey is to identify and manage any problems missed during the initial survey, and the recording of any relevant findings.

### 6.10.1 Secondary Survey Assessment

This secondary survey involves the repeating of ABCD and a more detailed Expose/Examination assessment including if possible obtaining an **AMPLE** history.

**LOOK, LISTEN and FEEL for:**

- **ABCD**
  Repeat ABCD with more detailed recording of observations, i.e. pulse and respiration rates over a one-minute period
- **Complete Head to toe examination**
  Carry out a thorough and methodical top-to-toe survey ensure protective gloves are worn before examining the casualty.
  **scalp** – bleeding, swelling, tenderness, deformities
  **face** – bruising, tenderness, colour, temperature
  **nose** – check for blood and/or fluid
  **ears** – check for blood and/or fluid
  **mouth** – bleeding, loose or broken teeth and smell the breath.
  **neck** – bruising, swelling, tracheal deviation, distended veins
  **chest** – symmetry, patterned bruising, tenderness, crepitus
  **abdomen** – patterned bruising, rigidity, tenderness, distension
  **pelvis** – bruising, tenderness, swelling, deformity
  **arms** – bruising, tenderness, swelling, deformity, needle marks
  **legs** – bruising, tenderness, swelling, deformity

  **Note:** check in the casualty's belongings for medilert cards/jewellery.

**AMPLE History**

It is important that the rescuer obtains a pertinent past medical history from the injured casualty. If the casualty is conscious, try to get direct information. If the casualty is unconscious or unable to verbalise, gather information from relatives or by-standers. If no one is able to provide information, seek clues from the casualty's belongings. The acronym AMPLE is a useful way of obtaining the information.

**A Allergies**
Is the casualty allergic to anything? e.g. medication, food, bites and stings or something that could be inhaled or absorbed through the skin.

**M Medication**
Is the casualty taking tablets or medicines for any medical conditions? Are they prescription or illegal drugs?

**P** **Past Medical History**
Is the casualty under the care of a doctor for any medical conditions?
Has the casualty been experiencing any medical problems, diagnosed or not?
Note names of hospitals or clinics that the casualty has attended and pass on any information to the ambulance personnel.

**L** **Last Meal**
When did the casualty last have anything to eat or drink, and what was it?
This information is important as:
- Food itself may be the problem, i.e. food allergy or diabetic emergency
- The casualty may require surgery on arrival at hospital; this information will be helpful to the receiving hospital

**E** **Events**
Events, preceding the illness, that may be relevant, e.g. alcohol/drug consumption.

### 6.10.2 Secondary Survey Management

Secondary survey management involves treating any problems identified during the assessment process such as:

**Wounds**
This is a break in the structure of an organ or tissue caused by an external agent. Bruises, abrasions (grazes), lacerations (tears), incisions (cuts), punctures and burns are all examples of wounds.

**Major Wounds**
Major wounds can be broadly classified as anything that cannot be treated by simple wound dressing application and therefore needs further specialist medical intervention such as:

**Abdominal Evisceration**
Evisceration occurs when an abdominal organ protrudes through an open wound in the abdominal skin wall.

The exposed organ is at risk of drying out which can lead to cellular death. To treat cover the organ with an airtight dressing (e.g. Clingfilm) or keep it moist by using sterile pads moistened with saline (sterile eye wash).

**Do not try to replace the organ.**

**Open Fracture**
This occurs when bone ends perforate or are visible through the skin, which can result in complications such as internal/external haemorrhage, damage to muscles and nerves and bone infection. To treat, remove any constriction from around the wound, build up padding on either side of the bone ends and cover with a sterile dressing.

**Loss of Tissue**
This occurs when muscle, skin, bone or limbs are separated from the body, which can result in external and internal haemorrhage. To treat amputated tissue, place in a sterile sealed bag/container, then place it into a separate bag/container filled with ice and water (do not soak or place directly onto ice).

**Burns**
Burn injuries vary in depth and degree and this will be dependant on duration of exposure to the heat within the vehicle. To treat, stop the burning process (neutralise the cause), Remove non-adhering clothing and jewellery from around the injured area cool with clean cold (but not ice cold) water, do not cool more than 10% of the burnt surface area for longer than 10–15 minutes intervals as this risks causing hypothermia in the casualty. Cover with a burn dressing (i.e. Clingfilm or water based gel products).

**Minor Wounds**
Minor wounds are very common and as they are not usually life-threatening treatment should only be given if time permits. To treat, remove any constrictions, clean the wound (using first aid wound cleaning fluids or clean water). Cover the wound with a sterile or clean dressing.

**Fractures and Dislocations**
Suspected fractures or dislocations should be immobilised in the position found. If available, and if time permits, splints/immobilisation devices should be used prior to movement/extrication.

**Crush Injury**
Sustained compression of a limb (usually longer than 10 minutes) will lead to internal physiological complications including toxins build up. The immediate problem in the pre-hospital environment is that the sudden release of the offending object may cause severe bleeding and/or a sudden drop in blood pressure; therefore, do not remove it until medical help arrives.

**Secondary Survey involves detailed examination and recording of casualty findings.**

### 6.10.3 Paediatric Assessment/Management Considerations

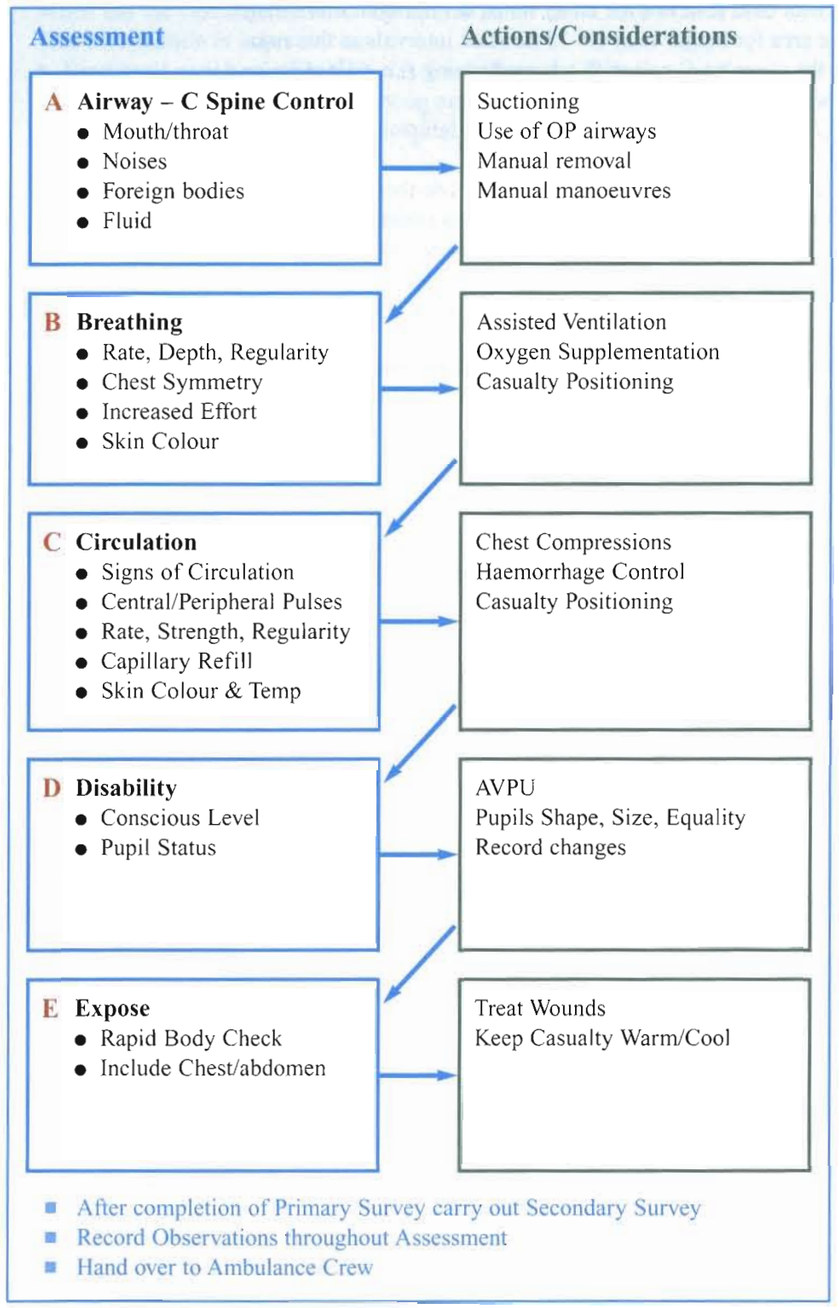
As with adults, a secondary survey follows completion of the primary survey. Children have specific anatomical and physiological differences that can affect assessment and management. The following are some of the relevant differences.

- The child skeleton is more pliable than in an adult therefore: Internal organ damage may be present without any obvious visible skeletal deformity, e.g. significant chest injury without rib fracture.
- The diaphragm in a child is more horizontal and the abdominal organs are more anterior (forward) making them more susceptible to injury.
- If skeletal deformity is present this is an indicator that severe force/damage energy has occurred.

**Note:** Using the acronym **MIST** may be helpful when giving a casualty findings handover to the receiving medical professional:

**M** Mechanism of injury
**I** Injuries found or suspected
**S** Signs & Symptoms
**T** Treatment given

**Assessment & Management Algorithm**






## 6.11 Trauma Related Cardiorespiratory Arrest

### 6.11.1 Introduction

Cardiorespiratory arrest resulting from trauma (particularly blunt trauma) has a poor prognosis and is virtually impossible to successfully manage in the pre-hospital setting. The trauma casualty often requires specialist intervention/s (surgery, blood transfusion and intensive therapy) that generally cannot be performed in the field. The aim therefore is to maintain adequate ventilation and circulation until means can be obtained to transport the casualty to hospital as soon as possible.

**Maintain adequate ABC until medical help arrives.**

### 6.11.2 Cardiopulmonary resuscitation – Sequence of Actions

[The following has been adapted from Resuscitation Council (UK) Guidelines 2005]

**Danger**
Ensure continued safety

**Response**
Check the casualty and see if they respond:
- Whilst maintaining in-line spinal immobilisation, gently pinch the ear and ask loudly "can you hear me?"

***If he/she does not respond***
- Shout for assistance

**Airway**
Open/clear the airway:
- Use jaw thrust or chin lift

**Breathing**
Look, listen and feel for breathing
- Look for chest movement, listen for breath sounds and feel for air on your cheek
- Take no more than 10 seconds to determine if the casualty is breathing normally

***If the casualty is breathing***
- Complete a primary survey assessment

***If he/she is not breathing or is only making occasional gasps or weak attempts at breathing:***
- Send someone to ensure paramedics on route are informed
- Rapidly extricate the casualty onto a spine board or hard flat surface
- Place the heel of one hand in the centre of the victim's chest
- Place the heel of the other hand on top of the first
- Extend or interlock the fingers of both hands and lift them to ensure that pressure is not applied over the victim's ribs. Do not apply any pressure over the upper abdomen or bottom tip of the sternum

- Position yourself vertically above the victim's chest and, with your arms straight, press down on the sternum to depress it between 4–5cms
- Release all the pressure without losing contact between the hand and sternum, then repeat at a rate of about 100 times a minute (a little less than 2 compressions a second); it may be helpful to count aloud. Compression and release should take an equal amount of time

- Combine ventilations and chest compression:
  - After 30 compressions give 2 effective breaths
    (1) Pinch the soft part of the casualty's nose closed, using the index finger and thumb
    (2) Allow the mouth to open but maintain chin lift
    (3) Take a normal breath and place your lips around the mouth, making sure that you have a good seal
    (4) Blow steadily into the mouth whilst watching for the chest to rise; take about one second to make the chest rise as in normal breathing and then observe for the chest to fall with expiration
    (5) Repeat to give 2 effective breaths then resume chest compressions
  - Return your hands without delay to the correct position on the sternum and give 30 further compressions, continuing compressions and breaths in a ratio of 30:2
  - Only stop to recheck the casualty if they start breathing normally; otherwise resuscitation should not be interrupted

***Continue resuscitation until:***

- Medical help arrives and takes over
- The victim shows signs of life
- You become exhausted

**Note:** Care must be taken during handling and resuscitation to maintain the head, neck, and chest in neutral alignment. A spinal board and/or cervical collar should be used if available. However, resuscitation takes priority; remember that successful resuscitation that results in paralysis is a tragedy, but failure to carry out adequate ventilation in cases of respiratory arrest will result in death.

### 6.11.3 Paediatric Resuscitation Considerations

Like adults, the paediatric casualty requires maintenance of adequate ventilation and circulation until transportation to hospital. Children have specific anatomical and physiological differences that can affect assessment and management. The following are some of the relevant differences.

- For Airway manoeuvres see airway section
- When checking for breathing in the infant/child look for abdominal as well as chest movement
- Ventilation rate for a child/infant is approx. 1–1.5 seconds sufficient to make chest visibly rise
- When performing chest compressions on children locate and place the heel of one hand over the lower half of the sternum (breastbone) ensuring that you do not compress on or below the xiphisternum (bottom of the breast bone)
- Compressions and breaths should be performed at a ratio 30:2, beginning with 5 breaths.



**It is important that the firefighter immediate care provider is competent in resuscitation skills.**

### 6.11.4 Automated External Defibrillation

**Introduction**

The most common cause of death in cardiac arrest is ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), which can only be treated effectively with prompt defibrillation. The chances of successful defibrillation decline at a rate of 7–10% with each minute.

**Chances of survival decline at a rate of 7-10% with every minute defibrillation is delayed.**

**Cardiac Arrest**

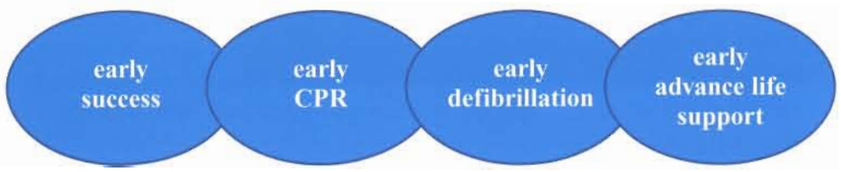
In the normal heart, the electrical impulses that result in synchronised co-ordinated muscle contraction are initiated in the sinotrial (SA) node. The impulses are then transmitted to the rest of the heart, stimulating each portion of the heart in proper sequence to produce a synchronised contraction of the heart muscle that will effectively propel the blood. If this arrangement is disturbed it results in disorganisation of the electrical signal and subsequent disruption of the heart's ability to pump blood. As long as the heart is in this disrupted state, there can be no co-ordinated muscle contraction and therefore no circulation of blood, the blood pressure falls to zero, there is no pulse and the victim ceases to breathe. Clinical death has occurred and biological death will follow in a matter of minutes if the situation is not returned to normal.

**Defibrillation**

Ventricular fibrillation is the most common cardiac arrest arrhythmia, it occurs when there is uncoordinated depolarisation occurring throughout the myocardium (the heart is quivering inside the chest), although there is electrical activity it does not cause the mechanical pumping of the heart to produce output. Pulseless ventricular tachycardia (fast heart rhythm) is another common cardiac arrest arrhythmia. Both can respond to electrical defibrillatory counter shocks. Defibrillation is the passing of an electrical current, which depolarises most, or all, of the cardiac muscle simultaneously allowing the natural pace making tissues to resume control of the heart.

**Defibrillation stuns cardiac muscle allowing pace-making tissue to resume control of the heart.**

Although defibrillation is the primary intervention that makes the greatest difference in the survival of cardiac arrest victims, it will only succeed when implemented as part of the chain of survival.



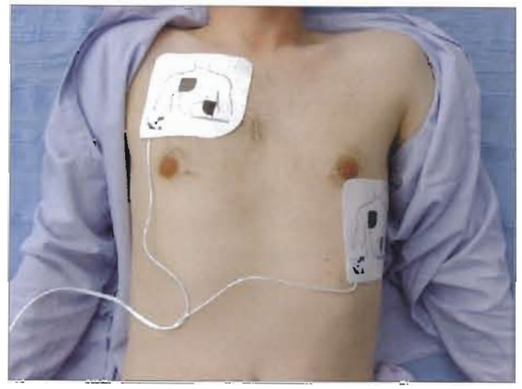

**Automated External Defibrillator ("AED")**
Developed in the early eighties it has several advantages, the main advantages being easy accessibility as early defibrillation is the most important single factor in survival outcome. Another advantage is that basic level providers can use it as the tasks to recognise cardiac arrhythmias and preparing for defibrillation are automated. All that is required of the operator is to recognise that cardiac arrest has occurred and attach two large, adhesive electrodes to the victim's chest. The machine will recognise the cardiac arrhythmia and decide if a defibrillatory counter shock is indicated, charge itself to a pre-determined level and instruct the operator, through a synthesised voice. This takes away much of the human decision-making and therefore reduces the possibility for error.

**AEDs take away, from the user, the difficulty of diagnosing complex heart arrhythmias.**

**Successful Defibrillation**
The success of defibrillation depends on a sufficient current being delivered to the myocardium (heart muscle). This is influenced by reducing transthoracic impedance (the blocking of electrical current flow through the internal chest cavity). In automated external defibrillation, carrying out defibrillation during the expiratory phase of ventilation and correct electrode pad placement can reduce transthoracic impedance.



**Electrode Pad Placement**
Correct pad placement should allow maximum current flow through the heart. Place one pad a finger space below the clavicle (collar bone) to the right of the sternum (breast bone).
Place the other pad in the mid-axillary line with its long axis vertical. If the victim has a cardiac pacemaker unit fitted, the pad should be placed at least 12.5 centimetres (a pad length) from the pacemaker site. This is to minimise the risk of damage to the pacemaker or causing burns to the heart. It is essential to achieve good contact between the electrode pads and the skin.



**Correct pad placement and good skin contact are essential for successful defibrillation.**

**Defibrillation Safety**
Great care is needed when performing defibrillation. It is essential that the following safety procedures are carried out prior to delivering a shock:

- Do not use the defibrillator in wet conditions, take the victim to a dry area, remove wet clothing and dry off the victim's chest.
- Remove transdermal (skin) medication patches and any jewellery that may come into contact with the pads, as they may block delivery of current to the heart; also, if it has metal backing (rare), skin burns or sparks can occur.
- Ensure that oxygen is not flowing across the chest as oxygen supports combustion and, if arcing occurs, a fire may result.
- There is no direct or indirect contact with any part of the victim.
- Shout "stand clear" and check that everybody has done so before delivering the shock.

**Post Resuscitation Care**
The aim of the initial responder using an Automated External Defibrillator is to successfully resuscitate the victim. The victim may recover immediately or may remain in a state of reduced consciousness. However, the return of spontaneous circulation is not the end of resuscitation and does not mean that the victim is out of danger. The post resuscitation aim is to monitor and stabilise the victim's ABCs. If possible, information should be obtained about the pre-arrest circumstances, i.e. possible causes of the arrest, is there a past medical history and current drug therapy. All events before, during and after resuscitation must be documented and should be passed on to the emergency medical services.

**Post Resuscitation Management**

- Establish and maintain a clear airway
- Administer high concentration oxygen
- If unconscious, place in the recovery position
- Monitor vital signs including airway, breathing, circulatory and conscious level status
- Obtain past medical history if possible
- Hand over to the emergency medical services

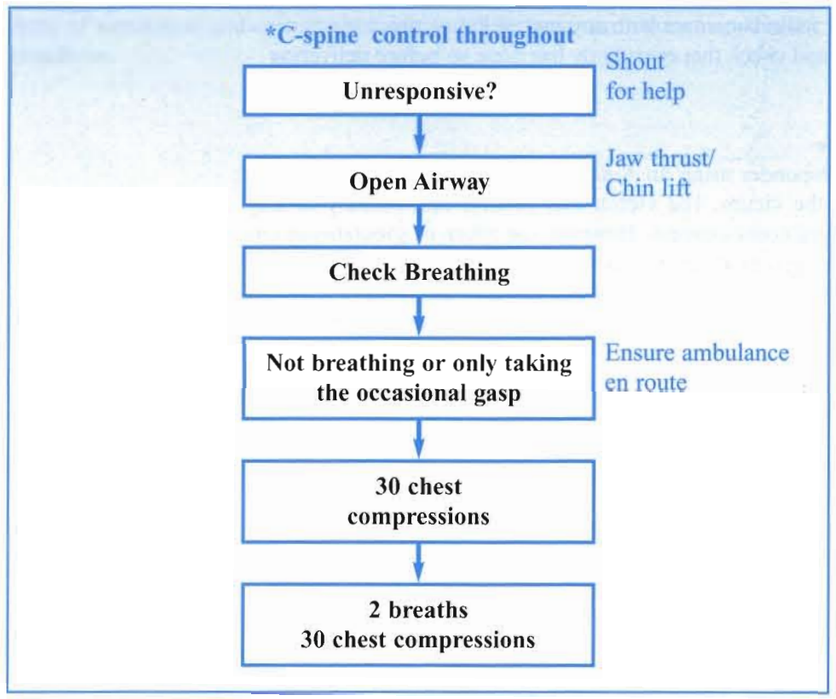
**Resuscitation Council (UK) 2005 Recommendations for AED use by non-medical personnel**

AEDs must be deployed within a medically controlled system under the direction of a suitably experienced medical practitioner. This individual should be a consultant in Accident and Emergency Medicine, Cardiology or Anaesthesia or a doctor from another discipline who has clinical expertise in resuscitation. This "medical director" is responsible for setting and maintaining standards of training and assessment, and ensuring that the competence of AED users is maintained through periodic refresher training. Training and assessment must be provided by appropriately trained individuals, for example doctors, resuscitation training officers, nursing staff, ambulance service trainers and other individuals such as first aid trainers accredited in AED training.

Mechanisms should be in place to audit the use of AEDs. The Utstein style of uniform reporting of resuscitation attempts is recommended. Where AEDs are deployed for use by non-medical personnel, such individuals should report within 48 hours the use of the AED to the medical director (or designated deputy). Each event should be documented using a standardised proforma and the memory module from the AED should be returned for analysis. The medical director should also ensure that appropriate support is available for AED users to receive 'critical incident debriefing' following a resuscitation attempt.

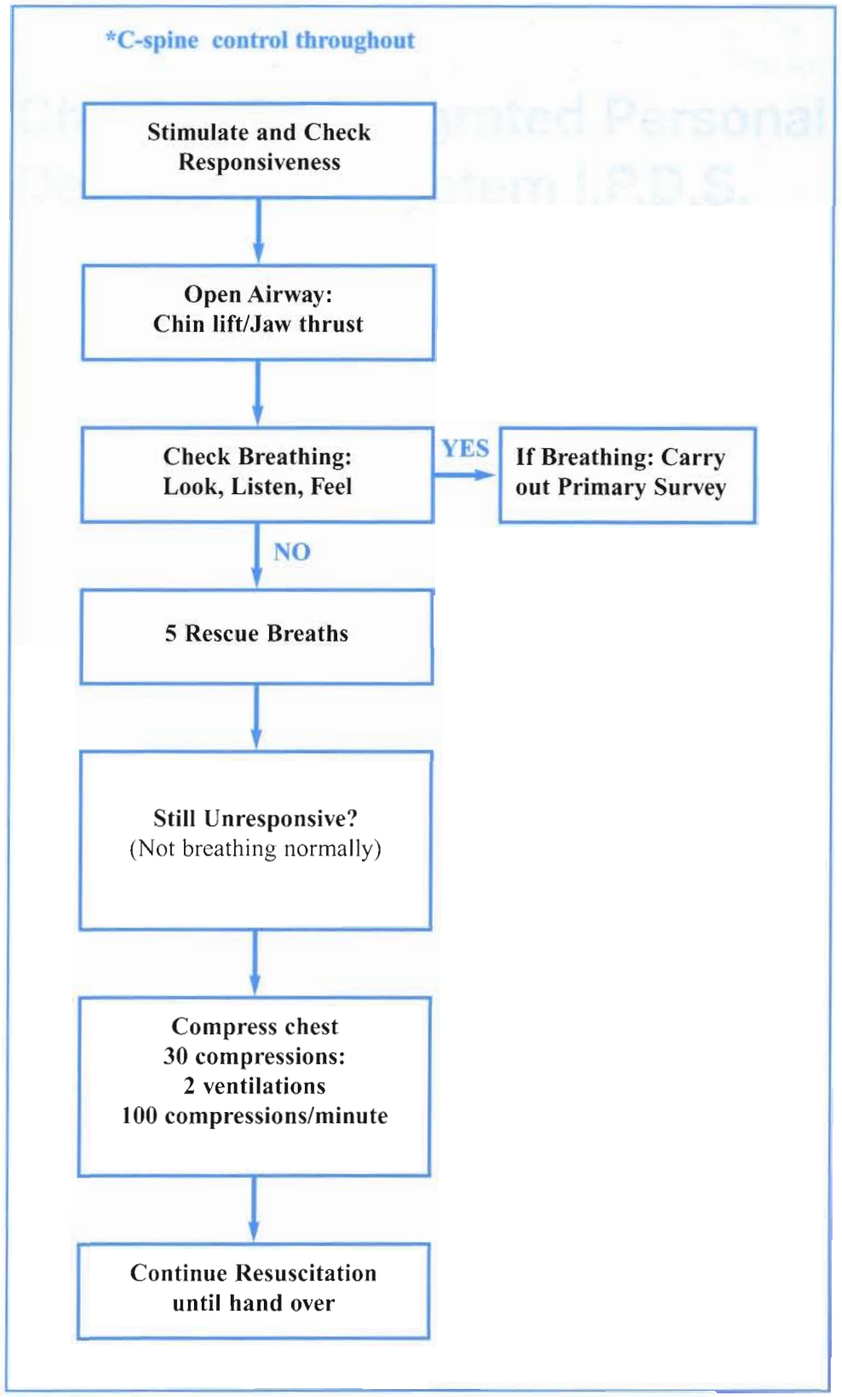
**Defibrillation is the gold standard treatment for VF/VT cardiac arrest.**

### 16.11a Trauma-related CPR Adult Algorithm






### 16.11b Trauma-related CPR Paediatric Algorithm



# Chapter 7 – Integrated Personal Development System I.P.D.S.

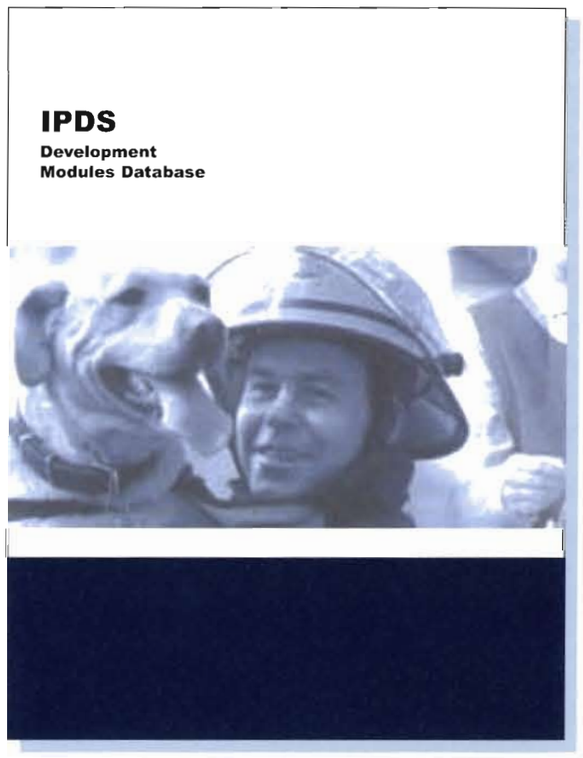
## Integrated Personal Development System

**The recent emphasis on I.P.D.S incorporating individual role-maps, requires personnel to identify specific competencies to prove competency in their present role and for future progression within the service.**

**In order to simplify this cross referencing procedure, the relevant development modules database, in relation to vehicle rescue incidents, have been listed in this chapter.**

**This will allow quick referencing of relevant main grade role maps, national standards and other related modules.**

**Note: due to the established framework for these national guide lines and role maps, they have been left in single column format to assist in easy recognition.**



## 7.1 Module 057 Dealing with transport incidents

| Number | Title |
|---|---|
| 057 | **Dealing with transport incidents** |

**Relevant Main Grade Role Map**

| | |
|---|---|
| Firefighter | ✓ |
| Control Supervisor | ✗ |
| Crew Manager | ✓ |
| Control Operations | ✗ |
| Watch Manager | ✓ |
| Control Watch Manager | ✗ |
| Group Manager | ✗ |
| Station Manager | ✗ |
| Brigade Manager | ✗ |
| Area Manager | ✗ |
| Control Operations Manager | ✗ |
| **Relevant Specialist Roles** | |
| Trainer | ✓ |
| Fire Safety / Investigation | ✗ |
| Technical Support | ✗ |
| Incident Command Support | ✗ |

**Scope:**

This module is about developing the relevant level of skills, knowledge and understanding to enable effective response to a wide range of incidents involving transport. It is suggested that this module includes a number of "sessions", each capable of being accessed/delivered as a stand alone section. These will include:

- Common hazards and risks within incidents involving transport
- The common range of equipment and resources used at incidents involving transport
- Specific hazards and risks within rail transport incidents
- Specific hazards and risks within aircraft/airport transport incidents
- Specific hazards and risks within motor transport incidents
- Specialist equipment/resources that is most often used at each of the transport incident types above
- Operational considerations and methods and techniques of resolving transport incidents
- PPE at transport incidents



**Skill Objectives:**

**Managing specific hazards and risks involved in transport incidents:**

- Identify potential and actual hazards and risks associated with:
  (a) rail incidents
  (b) aircraft/airport
  (c) motor
  (d) waterways
- Demonstrate a range of methods of controlling and minimising risk to self and others in respect of specific transport incidents
- Demonstrate use and obtaining access to types of equipment and resources appropriate to specific transport incidents

**Knowledge Objectives:**

- Types of hazards and risks associated with transport incidents – rail, air, waterway, motor vehicle
- Action and control measures associated with management of risk in transport incidents
- Capabilities and limitations of types of equipment used at transport-related incidents
- Capabilities and limitations of equipment specific to use at rail, air, waterway or motor vehicle
- How to access additional resources to support response to incidents involving transport – limits of authority
- Lines and methods of communication at the incident ground

**Relevant National Standards:**

| Ref | Unit Title |
|---|---|
| FF4 | Resolve operational incidents |
| FF5 | Protect the environment from the effects of hazardous materials |
| FF9 | Drive, manoeuvre, and redeploy FRS vehicles |
| CO3 | Co-ordinate response to assist with resolution of event |
| CO5 | Manage information to support the needs of your community |
| WM1 | Lead the work of teams and individuals to achieve their objectives |
| WM2 | Maintain activities to meet requirements |
| WM3 | Manage information for action |
| WM7 | Lead and support people to resolve operational incidents |
| WM8 | Lead and support control operations to resolve operational incidents |

**Other Related Modules:**

| Number | Module Title |
|---|---|
| 004 | Equality and fairness – Equal Opps and anti discrimination |
| 006 | Health, safety and risk management |
| 008 | Incident Command 1 – initial response and mgt |
| 027 | Incident Command 2 |
| 048 | Environmental risks and control |
| 058 | Dealing with fire incidents |
| 059 | Dealing with HAZMAT incidents |
| 060 | Save and rescue endangered life |
| 061 | Treat casualties and support people at incidents |
| 062 | Managing yourself |

**Relevant Personal Skills:**

**Acting Assertively**

- takes personal responsibility for making things happen
- maintains beliefs, commitments and effort in spite of set backs or opposition

**Building teams**

- shows respect for the views and actions of others
- uses power and authority in a fair and equitable manner

**Communicating**

- listens actively, asks questions, clarifies points and rephrases others' statements to check mutual understanding
- adopts communication styles appropriate to listeners and situations, including selecting an appropriate time and place
- confirm listeners understanding through questioning and interpretation of non-verbal signals

**Influencing others**

- presents oneself positively to others

**Managing Self**

- remains calm in difficult or uncertain situations

**Managing personal learning and development**

- seeks feedback on performance to identify strengths and weaknesses
- learns from own mistakes and those of others

**Conceptualising**

- uses own experience and evidence from others to identify problems and understand situation

**Taking Decisions**

- reconciles and makes use of a variety of perspectives when making sense of a situation focuses on facts, problems and solutions.



## 7.2 Module 061 Treat casualties and support people at incidents

| Number | Title |
|---|---|
| **057** | **Dealing with transport incidents** |

**Relevant Main Grade Role Map**

| | |
|---|---|
| Firefighter | ✓ |
| Control Supervisor | ✗ |
| Crew Manager | ✓ |
| Control Operations | ✗ |
| Watch Manager | ✓ |
| Control Watch Manager | ✗ |
| Group Manager | ✗ |
| Station Manager | ✗ |
| Brigade Manager | ✗ |
| Area Manager | ✗ |
| Control Operations Manager | ✗ |
| **Relevant Specialist Roles** | |
| Trainer | ✓ |
| Fire Safety / Investigation | ✗ |
| Technical Support | ✗ |
| Incident Command Support | ✗ |

**Scope:**

This module is about developing the relevant level of skills, knowledge and understanding to enable effective response to immediate treatment of casualties and support of people involved in incidents. This module will include:

- Range, type and appropriate use of immediate casualty treatment techniques
- Roles, responsibilities and limits of authority and action in relation to treatment of casualties at incidents
- Range, type and access to specialist support for casualties at incidents
- Methods and techniques for supporting people involved in incidents
- Range of PPE used when treating casualties

**Skill Objectives:**

**Immediate casualty care**

- Assess urgency of response to located casualty.
- Provide appropriate immediate treatment to minimise risk and preserve life.
- Obtain relevant specialist assistance. Inform, advise, support and calm a range of people involved in incidents including those under stress and other members of the public.
- Provide immediate casualty care with due regard for hazards and risks present at the incident.
- Provide support to team, colleagues, other agencies and people involved in incidents with due regard for prevalent hazards and risks.

**Knowledge Objectives:**

- Action and control measures associated with treatment of casualties, including PPE
- Capabilities and limitations of types of equipment and materials used for casualty treatment
- How to access additional resources to support treatment of casualties – limits of authority
- Lines and methods of communication at the incident ground
- How to recognise injuries and casualty situations which require additional or specialist support
- The type and range of situations which would require specialist support and advice in respect of treatment of casualties
- Limits of personal authority in respect of contact with press and media at incidents
- Methods and techniques for supporting distressed people

**Relevant National Standards:**

| Ref | Unit Title |
|---|---|
| FF3 | Save and Preserve endangered life |
| FF4 | Resolve operational incidents |
| CO3 | Co-ordinate response to assist with resolution of event |

**Other Related Modules:**

| Number | Module Title |
|---|---|
| 004 | Equality and fairness – Equal Opps and anti discrimination |
| 006 | Health, safety and risk management |
| 008 | Incident command 1 – initial response and mgt |
| 027 | Incident Command 2 |
| 048 | Environmental risks and control |
| 057 | Dealing with transport incidents |
| 058 | Dealing with fire incidents |
| 059 | Dealing with HAZMAT incidents |
| 060 | Save and rescue endangered life |
| 062 | Managing yourself |

**Relevant Personal Skills:**

- Behaving ethically complies with legislation, industry regulation, professional and organisational codes shows integrity and fairness in decision making
- Building teams makes time available to support others encourages and stimulates others to make the best use of their abilities
- Communicating listens actively, asks questions, clarifies points and rephrases others' statements to check mutual understanding
- Adopts communication styles appropriate to listeners and situations, including selecting an appropriate time and place



- Confirm listeners' understanding through questioning and interpretation of non-verbal signals
- Striving for excellence actively seeks to do things better
- Influencing others presents oneself positively to others
- Managing Self remains calm in difficult or uncertain situations
- Handles others' emotions without becoming personally involved
- Managing personal learning and development takes responsibility for meeting own learning and development needs
- Conceptualising uses own experience and evidence from others to identify problems and understand situation
- Taking Decisions produces a variety of solutions before taking a decision.

## 7.3 Unit FF3

| Unit FF3 | Save and preserve endangered life |
|---|---|
| **Elements** | |
| **FF3.1** | **Conduct a search to locate life involved in incidents** |
| **FF3.2** | **Rescue life involved in incidents** |
| **FF3.3** | **Provide treatment to casualties** |
| **FF3.4** | **Support people involved in rescue operations** |

| | |
|---|---|
| **Scope of this unit** | You will be expected to demonstrate competence in contexts specified at element level.<br>The following guidelines apply at element level: |
| **Element FF3.1** | **Conduct a search to locate life involved in incidents**<br>This element concerns your ability to search for people who are in some form of difficulty or danger through involvement in an incident. This may include searches in a range of locations and hazardous environments usually as a team member. |
| **Element FF3.2** | **Rescue life involved in incidents**<br>This element concerns your ability to move endangered people to a place of safety. This may include extrication using relevant equipment, releasing a trapped person, moving conscious and unconscious people to a place of safety. You may also be involved in the rescue trapped animals. |
| **Element FF3.3** | **Provide treatment to casualties**<br>This element concerns your ability to administer immediate treatment to casualties to assist with stabilisation of the casualty's condition and preservation of life. The level of treatment you provide will be within the limits of the training you have received, in line with your organisational policies and will aim to prepare casualties for handover to appropriate agencies. This will include basic life support and casualty handling. |
| **Element FF3.4** | **Support people involved in rescue operations**<br>This element concerns your ability to provide both physical and emotional support to people directly and indirectly involved in a rescue incident. This will include reassuring and comforting people, protecting their privacy and dignity, maintaining security at the scene of an incident and liaison with other agencies. This element includes dealing with deceased. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Relevant people | May include team members, line managers, colleagues, specialists and people outside of your organisation |
| Search | Action to locate life which is known or thought to be missing, to establish that all life is accounted for, to include: search within known parameters and within unspecified parameters, with one team and with multiple teams, both simple search and search requiring guidelines |
| Treatment | Within the limits of the training you have received and in line with your organisational policy |
| Signs and symptoms | Consciousness, pulse, breathing, injury |
| Records | Written and computerised, relevant to your work activity |
| Rescue operation | • Unaided removal, such as leading or guiding people to safety,<br>• Aided removal such as carrying, stretchering, raising and lowering<br>• Extricating including cutting, jacking, spreading to preserve endangered life |
| Other agencies | Other emergency services, direct and indirect support services |
| Evidence | Observation, physical items, including their condition and location, comments made by people at the incident which may have relevance to subsequent investigations |



| Unit FF3 | Save and preserve endangered life |
|---|---|
| **Element** | **FF3.1 Conduct a search to locate life involved in incidents** |

Simulation is acceptable for this element, in the absence of opportunity for demonstration of competence through actual work performance. This may include three of the four contexts listed below. Actual work performance must be provided for use of BA equipment on at least one occasion. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards and coverage of the following contexts.

(a) search for people reported/known missing
(b) search to establish all life accounted for
(c) search with significant difficulties or barriers to progress to be overcome
(d) search where the incident is protracted, involving more than one team

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) you confirm your objectives with relevant people<br>(b) you use equipment within its limitations and capabilities, to meet the needs of the search objectives and the known and anticipated risks<br>(c) you report the outcome of the search to the relevant person at the earliest opportunity<br>(d) you conduct your search across your specified search area applying principles of risk assessment<br>(e) you conduct your search taking account of all factors which influence the end results | **Health and Safety**<br>• Hazards and risks of the workplace affecting people and the environment.<br>• How to make and apply decisions based on the assessment of risk<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>**Organisational**<br>• Applicable FRS or other legislation<br>• Sources and availability of information<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting diversity<br>• Lines and methods of communication and reporting in the workplace<br>• Roles, responsibilities and limits of authority of yourself, others and other agencies<br>**Technical**<br>• Capabilities and limitations of personal and operational equipment<br>• How to select and use personal and operational equipment<br>• Roles and responsibilities within the incident command system<br>• How to identify and preserve evidence<br>• Types of evidence and its importance<br>• Relevant search procedures |

| Unit FF3 | Save and preserve endangered life |
|---|---|
| **Element** | **FF3.2 Rescue life involved in incidents** |

Simulation is acceptable for this element, in the absence of opportunity for demonstration of competence through actual work performance. This may include two of the three contexts listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards and coverage of the following contexts;

(a) unaided removal, such as leading or guiding people to safety
(b) aided removal such as carrying, stretchering, raising and lowering
(c) extricating, including cutting, jacking, spreading to preserve endangered life

**You must ensure that:**

(a) you administer treatment to minimise further injury and suffering during rescue
(b) your liaison with others involved in the rescue is constructive, supportive and promotes co-operation
(c) you provide timely reports to confirm your progress and outcomes against objectives with relevant people
(d) you use equipment within its limitations and capabilities to meet the needs of the rescue
(e) you assist with rescue of casualties to a place of safety
(f) you operate within agreed levels of your responsibility and authority
(g) you support and reassure casualties in a calm, considerate manner
(h) you progress the rescue applying principles of risk assessment

**You must know and understand:**

**Health and Safety**
- Hazards and risks of the workplace affecting people and the environment.
- How to make and apply decisions based on the assessment of risk
- How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace

**Organisational**
- Applicable FRS or other legislation
- Sources and availability of information

**Personal and Interpersonal**
- How to communicate clearly and effectively with the range of people involved
- How to treat colleagues and members of the public with respect and consideration, taking account of and accepting diversity
- Lines and methods of communication/reporting in the workplace
- Roles, responsibilities and limits of authority of yourself, others and other agencies
- How to recognise and support distressed people

**Technical**
- Capabilities and limitations of personal and operational equipment
- How to select and use personal and operational equipment
- Roles and responsibilities within the incident command system
- How to identify and preserve evidence
- Types of evidence and its importance
- How to prioritise casualties and how and when to apply immediate medical care
- Appropriate casualty handling techniques
- Relevant rescue procedures



| Unit FF3 | Save and preserve endangered life |
|---|---|
| **Element** | **FF3.3 Provide treatment to casualties** |

Simulation is acceptable for this element, in the absence of opportunity for demonstration of competence through actual work performance. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

**You must ensure that:**

(a) you check for signs and symptoms to prioritise your response to casualties
(b) you administer treatment to support the stabilisation of casualties' condition
(c) you progress your treatment using risk assessment to minimise risks to yourself and others
(d) you reassure casualties in a calm and considerate manner
(e) you meet the needs of casualties by using your equipment within its limitations and capabilities and minimising the risks to life
(f) your liaison with any other agencies involved in the incident is constructive and supportive to meet the needs of the incident
(g) you influence further treatment by confirming the details of your action and treatment of casualties with relevant people
(h) you operate within your agreed level of authority and responsibility
(i) your records are in the agreed format, accurate, complete, legible and accessible to all authorised people

**You must know and understand:**

**Health and Safety**
- Hazards and risks of the workplace affecting people and the environment
- How to make and apply decisions based on the assessment of risk
- How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace

**Organisational**
- Record systems and their use
- Sources and availability of information

**Personal and Interpersonal**
- How to communicate clearly and effectively with the range of people involved
- How to treat colleagues and members of the public with respect and consideration, taking account of and accepting diversity
- How to recognise and support distressed people
- Lines and methods of communication/reporting in the workplace
- Roles, responsibilities and limits of authority of yourself, others and other agencies

**Technical**
- Capabilities and limitations of personal and operational equipment
- How to select and use personal and operational equipment
- Roles and responsibilities within the incident command system
- How to identify and preserve evidence
- Types of evidence and its importance
- Relevant casualty treatment procedures
- How to prioritise the treatment of casualties
- Protocols determining the status and removal of the deceased

| Unit FF3 | Save and preserve endangered life |
|---|---|
| **Element** | **FF3.4 Support people involved in rescue operations** |

Simulation is acceptable for this element in the absence of opportunity for demonstration of competence through actual work performance. This may include one of the three contexts listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

(a) liaison with other agencies to obtain support for people involved in rescue operations
(b) the preservation of three different types of evidence at events
(c) comforting and supporting distressed people

**You must ensure that:**

(a) you use risk assessment to minimise risks to yourself and others and to progress your objectives
(b) you maintain a controlled, considerate and compassionate manner when supporting people
(c) you avoid the unnecessary distress of people and aid rescue activities by restricting the view and access to the rescue operation
(d) you safeguard the ownership of any belongings and items of value and inform the relevant people
(e) your liaison with other agencies involved is constructive and supportive to meet the needs of the rescue operation
(f) you return and secure resources to their correct location and report any defects and deficiencies
(g) you preserve evidence to meet the needs of an investigation
(h) you operate within your agreed levels of authority and responsibility
(i) your records are in agreed format, accurate, complete, legible and accessible to authorised users
(j) you inform relevant people on factors affecting the safety of people
(k) you treat any deceased with respect and due regard to your objectives and the nature of risk

**You must know and understand:**

**Health and Safety**
- Hazards and risks of the workplace affecting people and the environment.
- How to make and apply decisions based on the assessment of risk
- How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace

**Organisational**
- Applicable FRS or other legislation
- Sources and availability of information
- Record systems and their use

**Personal and Interpersonal**
- How to communicate clearly and effectively with the range of people involved
- How to treat colleagues and members of the public with respect and consideration, taking account of and accepting diversity
- Lines and methods of communication/reporting in the workplace
- Roles, responsibilities and limits of authority of yourself, others and other agencies
- How to recognise and support distressed people

**Technical**
- Capabilities and limitations of personal and operational equipment
- How to select and use personal and operational equipment
- Roles and responsibilities within the incident command system
- How to identify and preserve evidence
- Types of evidence and its importance
- Protocols determining the status and removal of the deceased



## 7.4 Unit FF4

| Unit FF4 | Resolve operational incidents |
|---|---|
| **Elements** | |
| **FF4.1** | **Control and extinguish fires** |
| **FF4.2** | **Resolve incidents other than those involving a fire or hazardous materials** |
| **FF4.3** | **Support people involved in an operational incident** |

| | |
|---|---|
| **Scope of this unit** | You will be expected to demonstrate competence across contexts specified in each element. The following guidelines apply at element level: |
| **Element FF4.1** | **Control and extinguish fires**<br>This element refers to your ability to work as a team member to respond to emergencies involving fires. You will be required to apply your skills and use appropriate equipment to contain and extinguish fires. |
| **Element FF4.2** | **Resolve incidents other than those involving a fire or hazardous materials**<br>This element refers to your ability to work as a team member to respond to emergency, non-emergency or special services such as lock-ins, lock-outs, pump-outs, emergency provision of water, support to other agencies for potential incidents, stand-by for potential life-risk . |
| **Element FF4.3** | **Support people involved in an operational incident**<br>This element concerns your ability to provide both physical and emotional support to people directly and indirectly involved in an operational incident. This will include reassuring and comforting people, protecting their privacy and dignity, maintaining security at the scene of an incident and liaison with other agencies. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Fires | Classes A, B C D fire types,<br>Fires involving one crew and involving multiple crews<br>Fires involving use of BA |
| Incidents other than those involving fire or hazardous materials | supply or removal of water<br>support for groups or other agencies |
| Risk assessment | Continuous assessment of any hazards and identification of risks as you progress your work |
| Resources | Operational appliances and equipment, extinguishing media |
| Evidence | Observation, physical items, including their condition and location, comments made by people at the incident which may have relevance to subsequent investigations |
| Relevant people | May include team members, line managers, colleagues, specialists and people outside of your organisation |
| Records | May include written, computerised, relating to your work activities |
| Other agencies | Other emergency services, direct and indirect support services |

| Unit FF4 | Resolve operational incidents |
|---|---|
| **Element** | **FF4.1 Control and extinguish fires** |

Simulation is acceptable for this element in the absence of opportunity for demonstration of competence through actual work performance. This may include two of the contexts listed below. Actual work performance must be provided for use of BA equipment on at least one occasion. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards.

- incidents in the open air
- incidents which are enclosed or underground
- incidents which are above the ground
- incidents involving cooling/protecting surrounding risks

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you confirm your objectives with the relevant person and provide them with timely reports<br>(b) you use your equipment and extinguishing media within its limitations and capabilities, to meet the needs of the incident and the known and anticipated risks<br>(c) you progress your objectives using risk assessment to minimise risk to yourself and others<br>(d) you identify the extent, nature and location of the fire, and report this to the relevant people at the earliest opportunity<br>(e) you operate within your agreed level of authority and responsibility<br>(f) you return and secure resources to their correct location and report any defects or deficiencies<br>(g) you preserve evidence to meet the needs of an investigation<br>(h) your contact with people is supportive, constructive, positive and timely | **Health and Safety**<br>• Hazards and risks of the workplace affecting people and the environment<br>• How to make and apply decisions based on the assessment of risk<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>• **Organisational**<br>• Applicable FRS or other legislation<br>• Record systems and their use<br>• Sources and availability of information<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to treat colleagues and members of the public with respect and consideration, taking account of and accepting diversity<br>• Lines and methods of communication/reporting in the workplace<br>• Roles, responsibilities and limits of authority of yourself, others and other agencies<br>**Technical**<br>• Capabilities and limitations of personal and operational equipment<br>• How to select and use personal and operational equipment<br>• Roles and responsibilities within the incident command system<br>• How to identify and preserve evidence<br>• Types of evidence and its importance<br>• Methods of controlling and extinguishing fires<br>• Causes, effects and behaviour of fire<br>• The methods employed to gain access, effect entry and maintain egress |



| Unit FF4 | Resolve operational incidents |
|---|---|
| **Element** | **FF4.2 Resolve incidents other than those involving a fire or hazardous materials** |

Simulation is acceptable for this element in the absence of opportunity for demonstration of competence through actual work performance. This may include one of the two contexts listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards.

supply and/or removal of water

support for groups and other agencies

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you confirm your objectives with the relevant person and provide them with timely reports<br>(b) you use equipment within its limitations and capabilities, to meet the needs of the incident and the known and anticipated risks<br>(c) you progress your objectives using risk assessment to minimise risk to yourself and others<br>(d) you identify the nature of the incident and report this to the relevant people at the earliest opportunity<br>(e) you operate within your agreed level of authority and responsibility<br>(f) you return and secure resources to their correct location and report any defects or deficiencies.<br>(g) your contact with people is supportive, constructive, positive and timely | **Health and Safety**<br>• Hazards and risks of the workplace affecting people and the environment<br>• How to make and apply decisions based on the assessment of risk<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>**Organisational**<br>• Applicable FRS or other legislation<br>• Record systems and their use<br>• Sources and availability of information<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to treat colleagues and members of the public with respect and consideration, taking account of and accepting diversity<br>• Lines and methods of communication/reporting in the workplace<br>• Roles, responsibilities and limits of authority of yourself, others and other agencies<br>**Technical**<br>• Capabilities and limitations of personal and operational equipment<br>• How to select and use personal and operational equipment<br>• Roles and responsibilities within the incident command system<br>• How to identify and preserve evidence<br>• Types of evidence and its importance<br>• How to limit damage to property and the environment<br>• Importance of limiting damage to property and the environment<br>• The methods employed to gain access, effect entry and maintain egress |

| Unit FF4 | Resolve operational incidents |
|---|---|
| **Element** | **FF4.3 Support people involved in an operational incident** |

Simulation is acceptable for this element in the absence of opportunity for demonstration of competence through actual work performance. This may include one of the three contexts listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards.

preservation of 2 types of evidence

liaison with other agencies to obtain support for people involved in operational incidents

comforting and supporting distressed people

**You must ensure that:**

(a) you use risk assessment to minimise risks to yourself and others and to progress your objectives

(b) you maintain a controlled, considerate and compassionate manner when supporting people

(c) you avoid the unnecessary distress of people and aid operational activities by restricting the view and access to the incident

(d) you safeguard the ownership of any belongings and items of value and inform the relevant people

(e) your liaison with other agencies involved is constructive and supportive to meet the needs of the operational incident

(f) you return and secure resources to their correct location and report any defects and deficiencies

(g) you preserve evidence to meet the needs of an investigation

(h) you operate within your agreed levels of authority and responsibility

(i) your records are in agreed format, accurate, complete, legible and accessible to authorised users

(j) you inform relevant people on factors influencing the safety of people

**You must know and understand:**

**Health and Safety**

- Hazards and risks of the workplace affecting people and the environment
- How to make and apply decisions based on the assessment of risk
- How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace

**Organisational**

- Applicable FRS or other legislation
- Sources and availability of information
- Record systems and their use

**Personal and Interpersonal**

- How to communicate clearly and effectively with the range of people involved
- How to treat colleagues and members of the public with respect and consideration, taking account of and accepting diversity
- Lines and methods of communication/reporting in the workplace
- Roles, responsibilities and limits of authority of yourself, others and other agencies
- How to recognise and support distressed people

**Technical**

- Capabilities and limitations of personal and operational equipment
- How to select and use personal and operational equipment
- Roles and responsibilities within the incident command system
- How to identify and preserve evidence
- Types of evidence and its importance



## 7.5 Unit FF7

| Unit FF7 | Support the development of colleagues in the workplace |
|---|---|
| **Elements** | |
| **FF7.1** | **Communicate your own skills and knowledge to colleagues** |
| **FF7.2** | **Support development of colleagues** |

| | |
|---|---|
| **Scope of this unit** | As this unit applies across a range of working contexts, the following guidelines apply at element level: |
| **Element FF7.1** | **Communicate your own skills and knowledge to colleagues**<br>This element concerns your ability to pass on your skills and knowledge at key opportunities, in order to assist colleagues to improve their understanding and performance. This will include opportunities that arise from normal work activities and during debriefs and performance reviews. |
| **Element FF7.2** | **Support development of colleagues**<br>This element concerns your ability to actively and proactively provide support to your colleagues, taking opportunities to assist with the development of skills and competence through demonstration and instruction. This may apply to new colleagues and to existing colleagues who are in a new working situation or demand. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Learning resources | Work place equipment and supporting information |
| Information and support | From own experience and level of competence and workplace practice |
| Records | May include written, computerised, video, audio and audio visual |
| Relevant people | May include team members, line managers, colleagues, specialists and people outside of your organisation |
| Authorised users | People who have the authorisation of your organisation to access information |
| Diversity | Relating to differences in age, gender, sexual orientation, social background, race, religion, status, ethnicity, appearance, work style, physical and mental ability |
| Relevant opportunities | During a training event, debrief, review or at work |
| Level of risk | As low as reasonably practicable |

| Unit FF7 | Support the development of colleagues in the workplace |
|---|---|
| **Element** | **FF7.1 Communicate your own skills and knowledge to colleagues** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards.

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you confirm with the appropriate people, the knowledge and skills to be acquired<br>(b) you make available the necessary learning resources<br>(c) you base your information and support on current systems of operation<br>(d) your information and support is within your own level of competence and you confirm colleagues understanding<br>(e) you support colleagues actions to ensure that the acceptable level of risk is not exceeded<br>(f) you actively seek feedback to improve your performance<br>(g) you replace all resources in their specified location after use<br>(h) you confirm the results of any activities with relevant people at the earliest opportunity<br>(i) your records are in the agreed format, accurate, complete, legible and available to all authorised users | **Health and Safety**<br>• Hazards and risks of the workplace affecting people and the environment<br>• How to make and apply decisions based on the assessment or risk<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>**Organisational**<br>• How to access, interpret and provide relevant information, including feedback<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting, diversity<br>• Lines and methods of communication/reporting in the workplace<br>• Roles, responsibilities and limits of authority of self, others and other agencies in the workplace<br>• How to select and use feedback techniques<br>• How to involve and motivate people<br>• The impact of providing incorrect or inappropriate information<br>• Methods of providing support and development to others<br>• How to present information to individuals and groups<br>**Training and Development**<br>• How to identify and analyse training and development needs<br>• How to facilitate learning |



| Unit FF7 | Support the development of colleagues in the workplace |
|---|---|
| **Element** | **FF7.2 Support development of colleagues** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards.

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you make contributions at relevant opportunities to provide feedback and support colleagues<br>(b) you encourage colleagues to ask for help and support on work-related activities<br>(c) you support colleagues action to ensure that the acceptable level of risk is not exceeded<br>(d) you actively support and promote your organisation's values, ethics and codes of practice<br>(e) you seek advice from relevant people where difficulties are outside of your sphere of competence or authority<br>(f) you provide support in a manner which promotes effective working relationships<br>(g) your support is given in a manner, level and pace appropriate to your colleague's needs<br>(h) you encourage self-development and independent decision making<br>(i) your behaviour demonstrates that you accept and respect diversity of people with whom you work | **Health and Safety**<br>• Hazards and risks of the workplace affecting people and the environment<br>• How to make and apply decisions based on the assessment or risk<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>**Organisational**<br>• How to access, interpret and provide relevant information, including feedback<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting diversity<br>• Lines and methods of communication/reporting in the workplace<br>• Roles, responsibilities and limits of authority self, others and other agencies in the workplace<br>• How to select and use feedback techniques<br>• How to involve and motivate people<br>• The impact of providing incorrect or inappropriate information<br>• Methods of providing support and development to others<br>• How to present information to individuals and groups<br>• How to recognise achievements and acknowledge success<br>**Training and Development**<br>• How to identify and analyse training and development needs<br>• How to facilitate learning |

## 7.6 Unit WM1

| Unit WM1 | Lead the work of teams and individuals to achieve their objectives (MCI Unit C12) |
|---|---|
| **Elements** | |
| **WM1.1** | **Plan the work of teams and individuals** |
| **WM1.2** | **Assess the work of teams and individuals** |
| **WM 1.3** | **Provide feedback to teams and individuals on their work** |

| | |
|---|---|
| **Scope of this unit** | As this unit applies across a range of working contexts, the following guidelines apply at element level: |
| **Element WM1.1** | **Plan the work of teams and individuals**<br>This element concerns your ability to plan work for your watch on a daily and weekly basis, allocating tasks and duties and setting objectives. |
| **Element WM1.2** | **Assess the work of teams and individuals**<br>This element concerns your ability to assess individuals and teams against their prescribed standards of performance in their completion of the tasks you have allocated. |
| **Element WM 1.3** | **Provide feedback to teams and individuals on their work**<br>This element concerns your ability to give feedback proactively and on request to your team and to individuals. It includes your taking opportunities during normal work activity, during debriefs and during performance reviews to provide constructive feedback to improve performance. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Allocating work | Giving teams and individuals responsibility for tasks which should achieve agreed work objectives |
| Confidentiality | Only providing information to those who are authorised to have it |
| Feedback on performance | Information you give to team members on how well they are performing against the objectives which have been agreed |
| Objectives | Clearly defined results which you need to achieve which are specific, measurable, agreed with others, realistic and time-bound |
| Organisational constraints | Your organisation's policies, objectives and level of resources, which limit your freedom to take decisions and action |
| Plans | Documents or spoken agreements, which describe the work to be carried out, when, by whom, to what standard and with what resources, in order that requirements and objectives can be met |
| Schedules | Documents showing the work to be done, when and, sometimes, by whom |
| Team members | People who work with you as part of a functional or project team; team members may report to you either as their line manager or as the manager in charge of a specific project or activity on which they are working |



| Unit WM1 | Lead the work of teams and individuals to achieve their objectives (MCI Unit C12) |
|---|---|
| **Element** | **WM1.1 Plan the work of teams and individuals** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

**You must ensure that:**

(a) you give opportunities to your team members to contribute to the planning and organisation of their work

(b) your plans are consistent with your team's objectives

(c) your plans cover all those personnel whose work you are responsible for

(d) your plans and schedules are realistic and achievable within organisational constraints

(e) your plans the way you allocate work take full account of team members' abilities and development needs

(f) you explain your plans and their work activities to your team members in sufficient detail and at a level and pace appropriate to them

(g) you confirm your team members' understanding of your plans and their work activities at appropriate times

(h) you update your plans at regular intervals and take account of individual, team and organisational changes

**You must know and understand:**

**Communication**

- The importance of effective communication when explaining work plans and allocations
- How to present work plans in a way that gains the support and commitment of those involved

**Continuous improvement**

- The importance of regularly reviewing work

**Involvement and motivation**

- The importance of providing your team members with the opportunity to contribute to the planning and organisation of their work

**Organisational context**

- The types of organisational constraints which influence your planning
- Legal implications

**Planning**

- The importance of planning work activities to organisational effectiveness and your role and responsibilities in relation to this
- How to develop realistic and achievable work plans for teams and individuals both in the short and medium term
- The team's objectives and how your plans succeed in meeting these

**Working relationships**

- The difference between someone who is within your line management control and someone for whom you have functional responsibility, and the implications this difference may have for planning work

| Unit WM1 | Lead the work of teams and individuals to achieve their objectives (MCI Unit C12) |
|---|---|
| **Element** | **WM1.2 Assess the work of teams and individuals** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) you explain the purpose of assessment clearly to all involved<br>(b) you give opportunities to team members to assess their own work<br>(c) your assessment of work takes place at times most likely to maintain and improve effective performance<br>(d) your assessments are based on sufficient, valid and reliable information<br>(e) you make your assessments objectively against clear and agreed criteria | **Communication**<br>• The importance of being clear yourself about the purpose of assessment and communicating this effectively to those involved.<br>**Continuous improvement**<br>• The importance of assessing the ongoing work of teams and individuals and your role and responsibilities in relation to this.<br>**Information handling**<br>• How to gather and evaluate the information you need to assess the work of teams and individuals.<br>**Involvement and motivation**<br>• The importance of providing opportunities to your team members to assess their own work and how you can encourage and enable this involvement.<br>**Monitoring and evaluation**<br>• The range of purposes of work assessment, why work assessment may play a role in an organisation and how they apply to your own situation<br>• How to assess the work of teams and individuals, and processes in the workplace which can support such assessment<br>• The principles of fair and objective assessment of work and how to ensure this is achieved |



| Unit WM1 | Lead the work of teams and individuals to achieve their objectives (MCI Unit C12) |
|---|---|
| **Element** | **WM 1.3 Provide feedback to teams and individuals on their work** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) you provide feedback to your team members in a situation and in a form and manner most likely to maintain and improve their performance<br>(b) the feedback you give is clear and is based on an objective assessment of your team members work<br>(c) your feedback recognises team members' achievements and provides constructive suggestions and encouragement for improving their work<br>(d) the way you give feedback shows respect for the individuals involved<br>(e) you treat all feedback to individuals and teams confidentially<br>(f) you give opportunities to team members to respond to feedback and recommend how they could improve their work | **Communication**<br>• The importance of good communication skills when providing feedback<br>• How to provide both positive and negative feedback to team members on their performance<br>• How to choose an appropriate time and a place to give feedback to teams and individuals<br>• How to provide feedback in a way which encourages your team members to feel that you respect them.<br>**Continuous improvement**<br>• The importance of providing clear and accurate feedback to your team members on their performance and your role and responsibilities in relation to this.<br>**Information handling**<br>• The principles of confidentiality when providing feedback – which people should receive which pieces of information.<br>**Involvement and motivation**<br>• How to motivate team members and gain their commitment by providing feedback<br>• The importance of being encouraging when providing feedback to team members and showing respect for those involved<br>• Why it is important to provide constructive suggestions on how performance can be improved<br>• The importance of giving those involved the opportunity to provide suggestions on how to improve their work |

## 7.7 Unit WM5

| Unit WM5 | Support the development of teams and individuals (MCI Unit C9) |
|---|---|
| **Elements** | |
| **WM5.1** | **Contribute to the identification of development needs** |
| **WM5.2** | **Contribute to planning the development of teams and individuals** |
| **WM5.3** | **Contribute to development activities** |
| **WM5.4** | **Contribute to the assessment of people against development objectives** |

| | |
|---|---|
| **Scope of this unit** | As this unit applies across a range of working contexts, the following guidelines apply at element level: |
| **Element WM5.1** | **Contribute to the identification of development needs**<br>This element concerns your ability to take part in the active identification of training and development needs for individuals on your watch and for the watch as a whole. It includes your ability to accurately assess gaps in workplace performance. |
| **Element WM5.2** | **Contribute to planning the development of teams and individuals**<br>This element concerns your ability to prepare effective and efficient plans to meet identified gaps in performance for individuals and teams. This will include the individuals on your watch and your watch as a whole. |
| **Element WM5.3** | **Contribute to development activities**<br>This element concerns your ability to take part in the development of individuals and of your watch as a whole, including suggestions for ideas and means to meet identified needs. It includes coaching and on job development as well as one to one feedback and support. |
| **Element WM5.4** | **Contribute to the assessment of people against development objectives**<br>This element concerns your ability to take part in the accurate assessment of improvements in performance resulting from development activities. This will include providing feedback on your evaluation of the effectiveness of training and development activities. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Assessment against development objectives | Using various techniques such as tests, observations of performance and discussions to measure team members' current skills, knowledge and performance against the agreed objectives for development |
| Authorised people | Team members, colleagues working at the same level as yourself, higher-level managers or sponsors, personnel specialists and members of selection teams or boards |
| Confidentiality | Only providing information to those who are authorised to have it |
| Development activities | Any activities undertaken by team members to develop knowledge and skills, such as carrying out work-based projects or assignments, observing expert colleagues at work, reading books and specialist journals, undertaking open learning or computer-based training, attending training courses or conferences |
| Equal access | Giving every member of your team the same opportunity to be involved in activities or to use resources |
| Identification of development needs | Identification of the gap between the demands of team members' jobs (both now and in the foreseeable future) and their current level of performance, knowledge and skills |
| Individual aspirations | The personal wishes of individual team members to improve their performance at work, their career prospects or their personal circumstances |
| Objectives | Clearly defined results which you need to achieve which are specific, measurable, agreed with others, realistic and time-bound |
| Organisational constraints | Your organisation's policies, objectives and level of resources, which limit your freedom to take decisions and action |
| Personnel | All people working for your organisation; these may be internal or external workers, permanent or temporary, full-time or part-time, paid or voluntary |
| Team members | People who work with you as part of a functional or project team; team members may report to you either as their line manager or as the manager in charge of a specific project or activity on which they are working |
| Values | The values of your organisation which may be reflected in your organisation's mission, standards of work, relationships between individuals at work, relationships with suppliers, customers and other stakeholders, personnel management and reward systems, training, equal opportunities, health and safety and environmental policies |

| Unit WM5 | Support the development of teams and individuals (MCI Unit C9) |
|---|---|
| **Element** | **WM5.1 Contribute to the identification of development needs** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) you give opportunities to team members to help identify their own development needs<br>(b) you identify their development needs accurately and use sufficient, reliable and valid information<br>(c) the development needs you identify are consistent with team objectives and organisational values<br>(d) you present information on development needs to authorised people only, in the required format and to agreed deadlines | **Communication**<br>• How to present development needs to people in a way which is likely to influence their decision-making positively<br>**Continuous improvement**<br>• The importance of team development to the continuing effectiveness of your organisation and your role and responsibilities in contributing to this<br>**Information handling**<br>• How to collect and validate the information needed to identify development needs<br>**Involvement and motivation**<br>• The importance of providing team members with opportunities to help identify their own development needs<br>• How to encourage and enable team members to identify their development needs<br>**Organisational context**<br>• Team objectives and organisational values which have a bearing on development needs<br>• How to decide whether development needs are consistent with organisational objectives and values<br>**Training and development**<br>• How to identify development needs in the team<br>• What information is needed to identify development needs |



| Unit WM5 | Support the development of teams and individuals (MCI Unit C9) |
|---|---|
| **Element** | **WM5.2 Contribute to planning the development of teams and individuals** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) your contributions to the planning process reflect the identified development needs of all those you are responsible for<br>(b) your contributions are clear, relevant, realistic and take account of team and organisational constraints<br>(c) you agree your ideas with individual team members, taking account of their work activities, learning abilities and personal circumstances<br>(d) you present your contributions to authorised people only, in the required format and to agreed deadlines. | **Involvement and motivation**<br>• The importance of agreeing development plans with those involved and how to reach such agreements<br>**Organisational context**<br>• The team and organisational constraints which influence the planning of development activities<br>**Training and development**<br>• How to contribute to planning the development of teams and individuals<br>• The training needs you have identified and how your contributions to the planning process will help meet these needs<br>• How to take account of team and organisational constraints in the planning process<br>• The importance of taking account of team members' work activities, their learning abilities and personal circumstances and how to build these factors into development activities<br>• The correct procedures for presenting your contributions to planning development activities |

| Unit WM5 | Support the development of teams and individuals (MCI Unit C9) |
|---|---|
| **Element** | **WM5.3 Contribute to development activities** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| You must ensure that: | You must know and understand: |
|---|---|
| (a) your contributions to development activities support your team objectives and plans<br>(b) your contributions meet the agreed objectives of the development activity<br>(c) your contributions take into account the work activities, learning abilities and personal circumstances of your individual team members<br>(d) you encourage and use feedback from those taking part in the activities to improve your future contributions to development activities | **Continuous improvement**<br>• The importance of monitoring and reviewing development activities and taking note of feedback from those who are taking part<br>• How to encourage and gather useful feedback from team members on the development activities they are involved in<br>**Training and development**<br>• The types of contributions which you could make to development activities for your team members<br>• How to choose contributions which are appropriate to your team members, the type of development activity which is planned and your own abilities and objectives<br>• How to ensure your own contribution is meeting agreed objectives and plans for the activities<br>• Why development activities should take account of team members' work activities, their learning abilities and personal circumstances |



| Unit WM5 | Support the development of teams and individuals (MCI Unit C9) |
|---|---|
| **Element** | **WM5.4 Contribute to the assessment of people against development objectives** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you agree the purpose of the assessment and your role in it with relevant people<br>(b) you give opportunities to team members to contribute to their own assessments<br>(c) you give equal access to all team members to be assessed against development objectives<br>(d) you carry out your role in the assessments objectively against clear, agreed criteria<br>(e) you base your assessments on sufficient, valid and reliable information<br>(f) you provide information about assessments to authorised people only, in the required format and to agreed deadlines | **Information handling**<br>• The information needed to assess team members' progress<br>• How to collect and check the validity of information<br>• The importance of confidentiality when carrying out and reporting assessments – what types of information should be provided to which people<br>**Involvement and motivation**<br>• The importance of team members contributing to the assessment of their own progress<br>• How to encourage and enable them to do so<br>**Organisational context**<br>• The organisational procedures for reporting the results of assessment<br>**Training and development**<br>• The importance of assessing team members' development<br>• The range of purposes which the assessment may have<br>• The importance of agreeing the purpose of the assessment with team members, line managers, colleagues and specialists<br>• The importance of fair and objective assessment<br>• How to assess team members' progress against development objectives<br>• Methods which may be used to assess the progress of team members objectively and fairly |

## 7.8 Unit WM7

| Unit WM7 | Lead and support people to resolve operational incidents |
|---|---|
| **Elements** | |
| **WM7.1** | **Plan action to meet the needs of the incident** |
| **WM7.2** | **Implement action to meet planned objectives** |
| **WM7.3** | **Close down the operational phase of incidents** |
| **WM7.4** | **Debrief people following incidents** |

| | |
|---|---|
| **Scope of this unit** | As this unit applies across a range of working contexts, the following guidelines apply at element level: |
| **Element WM7.1** | **Plan action to meet the needs of the incident**<br>This element concerns your ability to prepare clear, realistic and appropriate plans for initial response to operational incidents. It includes your plans for anticipated resource demands and the ability to allow sufficient flexibility and contingency planning for potential changes during the progress of the incident. |
| **Element WM7.2** | **Implement action to meet planned objectives**<br>This element concerns your ability to implement plans you prepare to meet objectives for operational incidents. You must demonstrate that you confirm objectives and deploy appropriate resources to meet both initial and changing demands of operational incidents. You must demonstrate that you consistently operate within your own level of competence and authority. It includes your ability to communicate clearly, concisely and with relevant degree of priority to a range of people. |
| **Element WM7.3** | **Close down the operational phase of incidents**<br>This element concerns your ability to ensure that operational incidents are closed and all action is taken to ensure that the incident is resolved or brought to a point at which handover to another agency can take place. It includes your ability to ensure that effective handover takes place and all relevant information is communicated. |
| **Element WM7.4** | **Debrief people following incidents**<br>This element concerns your ability to conduct a debrief of both individuals and groups, including measurement and feedback of performance against specified standards relevant to work roles. It includes your ability to ensure that risk-critical issues are addressed, that you recognise and support successful actions and that you communicate clearly, concisely and constructively with a range of people. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Information | Relating to the event, received from control, from incident command and people involved in the event |
| Resources | Operational appliances, equipment, people, external agencies and support services |
| Incidents | Emergency and non-emergency |
| Assessment of risk | Identification of hazards with potential to cause harm |
| Authorised users | People who have the authorisation of your organisation to access information |
| Relevant people | May include team members, line managers, colleagues, specialists and people outside of your organisation |
| Records | Written and computerised, including your own Personal Development Record (PDR/PDP) |



| Unit WM7 | Lead and support people to resolve operational incidents |
|---|---|
| **Element** | **WM7.1 Plan action to meet the needs of the incident** |

Simulation is acceptable for this element, in the absence of opportunity for demonstration of competence through actual work performance. This may include simulation for one item from each of the categories listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| | |
|---|---|
| Category 1 – teams | single and multiple |
| Category 2 – incidents | initial deployment and redeployment |
| Category 3 – location | enclosed or underground, above the ground, involving cooling/protecting surrounding risks |

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) you collect and confirm information relevant to the known and anticipated risks to people, property and the environment<br>(b) you plan action to lead and support your crew's response to the incident<br>(c) you develop your objectives through risk assessment<br>(d) you determine initial action against available resources, using a realistic assessment of their suitability for operational use<br>(e) your action plan provides sufficient flexibility to meet the known and anticipated needs of the incident | **Health and Safety**<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>• How to make and apply decisions based on the assessment of risk<br>• Hazards and risks of the workplace affecting people and the environment<br>**Organisational**<br>• How to access, interpret and provide relevant information, including feedback<br>• Organisational policies, aims and objectives<br>• Sources and availability of information<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to solve problems, make decisions and plan for contingencies<br>• How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting, diversity<br>• Lines and methods of communication/reporting in the workplace<br>• Roles, responsibilities and limits of authority of self, others and other agencies in the workplace<br>**Technical**<br>• Capabilities and limitations of personal and operational equipment<br>• How to match and use resources to meet objectives<br>• Roles and responsibilities within the incident command systems |

| Unit WM7 | Lead and support people to resolve operational incidents |
|---|---|
| **Element** | **WM7.2 Implement action to meet planned objectives** |

Simulation is acceptable for this element, in the absence of opportunity for demonstration of competence through actual work performance. This may include simulation for one item from each of the categories listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| | |
|---|---|
| Category 1 – teams | single and multiple |
| Category 2 – incidents | initial deployment and redeployment |
| Category 3 – location | enclosed or underground, above the ground, involving cooling/protecting surrounding risks |

**You must ensure that:**

(a) you make appropriate adjustments to your plan based on an initial assessment of the incident
(b) you confirm your objectives and deploy your resources to meet priority needs
(c) your decisions continue to minimise risk and maximise progress towards your objectives
(d) you re-deploy your resources to meet the changing priorities of the incident
(e) you actively seek information to update your plan and progress action to meet your objectives
(f) you operate within the agreed level of your responsibility and authority
(g) your role and responsibilities at the incident are known and understood by those under your leadership and support
(h) your records are accurate, complete, in the agreed format, legible and available to authorised users
(i) your contact with people is supportive, constructive and timely

**You must know and understand:**

**Health and Safety**
- Risks and hazards of the workplace affecting people and the environment
- How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace
- How to make and apply decisions based on the assessment of risk

**Organisational**
- Applicable FRS or other legislation
- How to plan and prioritise work, including time management
- The range of external regulations and requirements that impact on your work
- How to plan the use of physical resources
- How to access, interpret and provide relevant information, including feedback
- Organisational policies, aims and objectives
- Sources and availability of information

**Personal and Interpersonal**
- How to communicate clearly and effectively with the range of people involved
- How to make positive contributions to effective teamwork
- How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting, diversity
- Lines and methods of communication/reporting in the workplace
- Roles, responsibilities and limits of authority of self, others and other agencies in the workplace
- How to plan and prioritise work in response to work demands
- How to involve and motivate people
- How to set objectives
- How to solve problems, make decisions and plan for contingencies
- Role requirements and expected standards of performance

**Technical**
- Capabilities and limitations of personal and operational equipment
- How to match and use resources to meet objectives
- Roles and responsibilities within the incident command systems
- The availability and access to internal and external resources and support



| Unit WM7 | Lead and support people to resolve operational incidents |
|---|---|
| **Element** | **WM7.3 Close down the operational phase of incidents** |

Simulation is acceptable for this element, in the absence of opportunity for demonstration of competence through actual work performance. This may include simulation for one item from each of the categories listed below. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| | |
|---|---|
| Category 1 – teams | single and multiple |
| Category 2 – incidents | initial deployment and redeployment |
| Category 3 – location | enclosed or underground, above the ground, involving cooling/protecting surrounding risks |

**You must ensure that:**

(a) you confirm your achievements against the planned objectives with relevant people
(b) you confirm the final status of the incident and agree any further action with relevant people
(c) you identify any unresolved risks and hazards and take action to minimise these within operational constraints
(d) you collate and provide accurate and complete information and advice to relevant people and confirm mutual understanding
(e) your contact with people is supportive, sensitive to context and presents a positive image of the organisation
(f) you make your resources available for redeployment at the earliest opportunity
(g) you accurately confirm with relevant people your resource status and availability
(h) you operate within agreed levels of your authority and responsibility
(i) your records are complete, accurate, legible, in the agreed format and available to authorised users

**You must know and understand:**

**Health and Safety**
- Hazards and risks of the workplace affecting people and the environment
- How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace
- How to make and apply decisions based on the assessment of risk

**Organisational**
- Applicable FRS or other legislation
- How to access, interpret and provide relevant information, including feedback
- Organisational policies, aims and objectives
- Sources and availability of information
- Record systems and their use
- How to monitor and evaluate the effectiveness of plans and objectives

**Personal and Interpersonal**
- How to communicate clearly and effectively with the range of people involved
- How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting, diversity
- Lines and methods of communication/reporting in the workplace
- Roles, responsibilities and limits of authority of self, others and other agencies in the workplace
- How to plan and prioritise work in response to work demands
- How to involve and motivate people
- How to set objectives
- How to solve problems, make decisions and plan for contingencies
- Role requirements and expected standards of performance

**Technical**
- Capabilities and limitations of personal and operational equipment
- Matching and using resources to meet objectives
- Roles and responsibilities within the incident command systems
- How to identify and preserve evidence
- Types of evidence and its importance
- The requirements for availability, operational readiness and response of human and physical resources
- How to support the investigation of an event

| Unit WM7 | Lead and support people to resolve operational incidents |
|---|---|
| **Element** | **WM7.4 Debrief people following incidents** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| **You must ensure that:** | **You must know and understand:** |
|---|---|
| (a) you measure performance against specified standards relevant to defined roles<br>(b) you identify opportunities and action to improve future performance<br>(c) you conduct the debrief in a manner which promotes constructive, open and supportive review of the incident<br>(d) you recognise successful actions, acknowledge effective performance and report meritorious actions to the relevant people<br>(e) you immediately address risk critical issues identified through performance of people, equipment, working practices and systems<br>(f) you identify and record all significant learning points and agree action to address these<br>(g) your records are in the agreed format, accurate, complete, legible and available to authorised users | **Health and Safety**<br>• How to apply practices that maximise the health, safety and welfare of yourself and others in the workplace<br>**Organisational**<br>• Organisational policies, aims and objectives<br>• Record systems and their use<br>• How to provide information to influence change or improve service delivery<br>**Personal and Interpersonal**<br>• How to communicate clearly and effectively with the range of people involved<br>• How to treat colleagues and members of the public with respect and consideration, taking account of, and accepting, diversity<br>• How to recognise problems that affect performance and action appropriate and timely solutions<br>• How to select and use feedback techniques<br>• Lines and methods of communication/reporting in the workplace<br>• Methods of active and proactive monitoring of achievements of objectives<br>• Role requirements and expected standards of performance<br>• Roles, responsibilities and limits of authority of self, others and other agencies in the workplace<br>• The importance of challenging unacceptable behaviour<br>**Training and Development**<br>• How to organise and conduct debriefs and review of performance |



## 7.9 Unit WM9

| Unit WM9 | Support the efficient use of resources (MCI Unit B1) |
|---|---|
| **Elements** | |
| **WM9.1** | **Make recommendations for the use of resources** |
| **WM9.2** | **Contribute to the control of resources** |

| | |
|---|---|
| **Scope of this unit** | As this unit applies across a range of working contexts, the following guidelines apply at element level: |
| **Element WM9.1** | **Make recommendations for the use of resources**<br>This element concerns your ability to make positive and constructive recommendations for the use of equipment, materials, services, supplies, finance, energy and time within your own sphere of responsibility. |
| **Element WM9.2** | **Contribute to the control of resources**<br>This element concerns your ability to monitor and control resources to ensure the most effective and productive use of those available to you and your team. |

| **Key words and concepts** | These definitions are provided to explain how key words and concepts are used in this unit |
|---|---|
| Benefits | Positive results from the use of resources, for example: improved effectiveness and efficiency, better results for the customer |
| Corrective action | Action taken to match actual expenditure to budget, such as altering activities, modifying the use of resources, or re-negotiating the allocation of resources |
| Ensuring consistency in product & service delivery | Making sure that the products and services for which you are responsible continuously meet the standards agreed in your organisation and with your customers |
| Impact on the environment | Positive or negative effects on the environment which may result from the use of resources |
| Monitoring | Keeping a close eye on how resources are used and comparing this with plans or budgets |
| Policies | Rules which govern the use of resources, for example: planning policies, policies governing the supply of equipment and materials, health and safety policies, environmental policies |
| Recommendations | Requesting budget allocations or proposing the supply of resources your team needs to achieve its objectives; suggesting new methods of using available resources to improve your team's effectiveness and efficiency |
| Relevant people | Team members, colleagues working at the same level as yourself, higher level managers or sponsors, specialists |
| Resources | The equipment, materials, services, supplies, finance, energy and time your team needs to achieve its objectives |
| Team members | People who work with you as part of a functional or project team; team members may report to you as either their line manager or as the manager in charge of a specific project or activity on which they are working |
| Team objectives | Clearly specified results which your team needs to achieve |
| Trends and developments | Changes in your team, organisation and market; for example, new skills and working methods, efficiency drives, new products and services, changes in customer requirements |

| Unit WM9 | Support the efficient use of resources (MCI Unit B1) |
|---|---|
| **Element** | **WM9.1 Make recommendations for the use of resources** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you give relevant people the opportunity to provide information on the resources your team needs<br>(b) your recommendations for the use of resources take account of relevant past experience<br>(c) your recommendations take account of trends and developments which are likely to affect the use of resources<br>(d) your recommendations are consistent with team objectives and organisational policies<br>(e) your recommendations clearly indicate the potential benefits you expect from the planned use of resources<br>(f) your recommendations are presented to relevant people in an appropriate and timely manner | **Analytical techniques**<br>• How to analyse the use of resources in the past, and utilise the results to make recommendations on more effective use of resources in the future<br>**Communication**<br>• How to communicate effectively with team members, colleagues and line managers<br>• How to develop and argue an effective case for changes in the management of resources<br>**Involvement and motivation**<br>• How to enable people to identify and communicate the resources they need<br>**Organisational context**<br>• Team objectives and organisational policies regarding the use of resources<br>• Organisational procedures for making recommendations on the use of resources<br>• The trends and developments which may influence the future use of resources and how to plan for these<br>**Resource management**<br>• The importance of effective management of resources to organisational performance<br>• The principles underpinning the effective and efficient management of resources<br>• The importance of keeping accurate records on the use of resources |



| Unit WM9 | Support the efficient use of resources (MCI Unit B1) |
|---|---|
| **Element** | **WM9.2 Contribute to the control of resources** |

Simulation is not acceptable for this element. Assessment should be conducted on several occasions, over time, to ensure demonstration of consistency of competence against the specified standards

| You must ensure that: | You must know and understand: |
|---|---|
| (a) you give relevant people opportunities to take individual responsibility for the efficient use of resources<br>(b) you monitor the use of resources under your control at appropriate intervals<br>(c) the use of resources by your team is efficient and takes into account the potential impact on the environment<br>(d) you monitor the quality of resources continuously and ensure consistency in produce and service delivery<br>(e) you identify problems with resources promptly, and make recommendations for corrective action to the relevant people as soon as possible<br>(f) you make recommendations for improving the use of resources to relevant people in an appropriate and timely manner<br>(g) your records relating to the use of resources are complete, accurate and available to authorised people only | **Communication**<br>• How to communicate effectively with team members, colleagues and line managers<br>**Involvement and motivation**<br>• How to encourage others to take responsibility for the control of resources in their own area of work<br>**Organisational context**<br>• Team objectives and organisational policies regarding the use of resources<br>• The potential environmental impact of the resources being used<br>• The problems which may occur with resources and how you can deal with these<br>• Organisational procedures for making recommendations on the use of resources<br>**Resource management**<br>• The principles underpinning the effective and efficient management of resources<br>• How to monitor and control the use of resources to maximise efficiency, whilst maintaining the quality of products and services<br>• The importance of keeping accurate records on the use of resources |

# Appendix 1
# Highways Agency/Fire and Rescue Service Memorandum of Understanding (MOU)

**Table of Contents**

# Memorandum of Understanding between the Highways Agency and the Chief Fire Officers Association (CFOA)

## 1. Introduction

1.1 The FRS and Highways Agency (HA) have a joint interest in ensuring they deliver the best possible service to members of the public involved in fires, accidents or other incidents on the motorway and trunk road network. Both organisations acknowledge the need to develop the partnership to maximise synergy and benefit the management of incidents on the road network.

## 2. Background

2.1 **The Highways Agency (HA)**. The HA is an executive agency of the Department of Transport and its function is to carry out, on behalf of the Secretary of State (SoS) for Transport, his duties and functions as highway and traffic authority for motorways and trunk roads in England.

2.2 The HA has been charged by the SoS with developing its role as a "Network Operator" to achieve greater efficiency in traffic and congestion management to help the existing trunk road system work better. As part of this initiative it is introducing a "Traffic Officer Service".

2.3 Highways Agency Traffic Officers are uniformed officials that patrol the SoS's motorways and selected trunk roads in England. They will undertake a range of traffic management functions such as dealing with breakdowns, obstructions, debris and supporting the Police at major accidents. They have the power to set variable message signs and stop or direct traffic in order to manage traffic and help keep it moving.

2.4 **Fire and Rescue Service**. The FRS deals with fires and other emergencies. They also carry out other various emergency planning activities and are governed by the Fire and Rescue Services Act, which requires Fire Authorities to make provision for Firefighting, Road Traffic Accidents, Fire Safety and other emergencies.

2.5 The latest Fire and Rescue Services Act 2004 places a legal requirement on the Fire and Rescue Services to make provision for: -

a) Rescuing people in the event of a Road Traffic Accident,
b) Protecting people from serious harm to the extent that it considers it reasonable to do so in the event of a Road Traffic Accident.

**Note:** The Act also highlights the importance of environmental issues.



## 3. Purpose and Scope

3.1 This document seeks to provide a framework for the FRS and the HA to work in partnership.

3.2 It is recognised by both parties that nothing in this MoU shall affect the statutory duties or responsibilities of either party.

3.3 This MoU does not commit either party to the allocation of funds or other resources although both parties will use their reasonable endeavours to deliver against the agreed work areas covered by Annex 1 and 2 subject to their other duties and the financial framework within which they operate.

## 4. Aims of Joint Working between the Fire and Rescue Service and the HA

4.1 To develop a structured working relationship in order for each organisation to understand, in more depth, the issues, which face the other and provide a framework to manage and resolve them.

4.2 To develop areas of mutual interest and opportunities for joint working.

4.3 This MoU is not intended by either party to be legally binding and some or all of the arrangements or procedures referred to herein may be terminated in writing by either party though they will use their best endeavours to give reasonable notice to the other party of such termination and the reason.

4.4 The MoU will be reviewed at least annually.

## 5. Partnership Working between the Fire and Rescue Service and the HA

5.1 The MOU has been produced to enable the FRS and HA to develop joint working practices for the management of incidents on the motorway and trunk road network and to establish efficient communication channels.

5.2 It will provide a focus to establish a regular meeting cycle regime between the two organisations, with a provision for more 'ad-hoc', unscheduled meetings should any serious issues arise requiring quick resolution.

5.3 The MOU will provide a framework for information sharing to be encouraged throughout both organisations to facilitate the working relationship.

5.4 The FRS and HA will provide contact details of staff who can act as focal points for operational and planning issues that both organisations agree need to be addressed.

5.5 Both parties will endeavour to develop relationships at local level as well as maintaining a good relationship at policy/national level.

5.6 The MOU seeks to facilitate the development of protocols for managing issues of joint concern.

## 6. Confidentiality Provisions

6.1 Subject to any statutory requirements to release information and in exceptional circumstances, either party may request that commercially confidential information provided in connection with this MoU should not be disclosed. Any information regarded by either party as commercially confidential should be provided separately, so as not to inhibit the disclosure of other information.

6.2 Any information regarded as commercially confidential should remain confidential only as long as necessary, so that after an agreed period it can also be released.

## 7. Termination

7.1 This MoU can be terminated by either party by notice in writing to the other, specifying the reason(s) why they are requesting termination but every endeavour will be made to meet its obligations and to discuss termination should this be desired by either party. Each party should provide a three-month notice period to meet/agree actions on any outstanding issues.

**Signed by:**

| | |
|---|---|
| **Janet Butler** | **Tom Carroll** |
| FOR THE HIGHWAYS AGENCY | FOR THE CHIEF FIRE OFFICERS ASSOCIATION (CFOA) |
| _____ | _____ |
| Date _____ | Date _____ |



# Annex 1 HA Responsibilities

## Major Incidents

The Police Service has responsibility for major incidents (where there are casualties or issues of a criminal nature) that require co-ordination of the emergency services, the NHS or local authority. Highways Agency Traffic Officers (TO's) will support the Police Service by liasing with the Senior Police Officer at the site to coordinate overall scene management. This will include an integrated assessment of the incident and the required response.

The Police Service has responsibility for the coordination of the Emergency Services at a major incident. The TO's will assess, plan and implement the restoration to normality of the carriageway and infrastructure at the scene and undertake traffic management, including the approach to the incident scene, the tactical, regional and the wider strategic network. TO's will support the implementation and management by police of a "safe working environment" for the emergency services.

## Minor Incidents

For minor incidents (embankment fires, single vehicle fires, etc.) it will not always be appropriate for the Police to attend. For these incidents the TO's will implement and manage the creation of a "safe working environment" for the emergency services. If appropriate they will arrange for Incident Support Units (ISU's) to provide additional support by removing debris or implementing a full Chapter 8[1] closure.

## Closing Sections of the Motorway

In the event of a serious incident or obstruction, it may be necessary to close one or both carriageways of a motorway between junctions. The decision to close a carriageway will have serious implications for traffic off the motorway and local roads are likely to become heavily congested whatever the time of the closure.

For major incidents the TO's will liaise with the Senior Police Officer/Senior Fire Officer to decide if a closure is appropriate; if appropriate they will then implement the closure. They will arrange for this to be replaced by full chapter 8[1] signing if the closure is going to be prolonged. If required TO's will arrange for traffic to be diverted onto signed diversion routes around the closure. For minor incidents or obstructions the TO's will decide if a road closure or diversion is appropriate.

[1] Chapter 8 closures are carriageway closures (cone layouts and signing) implement by the Highways Agency's contractors and are specified in Chapter 8 of the Highways Agency Traffic Signs manual.

## Reporting Incidents

Response to Incidents – When reporting incidents to the FRS the RCC/TO's will provide sufficient information for the FRS to decide what level of response is required.

Hazchem – TO's will inform the FRS of all suspected Hazchem incidents. Providing as much information as possible about the nature of the incident and if appropriate any spillage details.

## Other Services

The Agency will consider if additional services can be added to this agreement.

It is important that the Fires and Rescue Services procedures and the Traffic Officer Service procedures developed by the Agency are consistent. The Agency will seek to formally respond within 28 working days to any request by the FRS to review their existing or new procedures.



# Annex 2 FRS Responsibilities

## Regional Collaboration

The FRS will ensure all senior managers are aware of the Agency's new role. They will support the Agency's regional communication strategy, which is being designed to raise the profile of the Traffic Officer Service within regions. Also, they will work with communication managers within the Agency to identify opportunities for joint working and information sharing on improved joint communication strategies.

## Regional Communication

The FRS will encourage local Fire and Rescue Services to provide each RCC with appropriate planning and operational contacts.

## Support for Operational De-briefings

The Agency's Regional Control Centres (RCCs) will establish formal mechanisms to review how incidents are managed. This is particularly important for complex incidents where many Agencies are involved and/or when one party believes improvements could be made to the process or procedures followed. Local fire brigades will be encouraged to support this procedure for improved incident management.

The FRS will support any de-briefing sessions arranged by the teams that managed the incident (Police and the Highways Agency Traffic Officer Service) such debriefs will seek to:

- Identify areas for improvement
- Determine best practice
- Capture intelligence of suspected criminality
- Supply updated situation reports
- Provide feedback to staff on performance

## Other Services

It is important that the FRS procedures and the Traffic Officer Service procedures developed by the Agency are consistent. The FRS will seek to formally respond within 28 working days to any request by the Agency to review their existing or new procedures.

## Annex 3 National Contact Details

### Highways Agency

John Walford

National Stakeholder Engagement Team
Room 208
Jefferson House
27 Park Place
Leeds

Tel – 07710958437
E-mail John.Walford@Highways.gsi.gov.uk

### Fire and Rescue Service

Peter Hazeldine

Assistant Chief Officer
Hertfordshire FRS
Old London Road
Hertford

Tel – 01992 507507
E-mail Peter.Hazeldine@hertscc.gov.uk





# Appendix 2 – Training and General Information

### AIM

**In order to develop and maintain vehicle crash rescue skills each FRS needs to take ownership of their own training and development. This is best achieved by having dedicated personnel who will instigate and monitor a programme of improvement in conjunction with Watch/crew managers for the training and development of the watch or crew in vehicle rescue.**

The pre-plotting of collision rescue training into the yearly Watch Planner is critical. If you do not plan it, it will not happen!

### Planning training to develop the Watch/section

Start at the beginning! Then progress. Use visits to manufacturers, main dealers, windscreen replacement firms to enhance vehicle knowledge. Scrap yard vehicles are old vehicles, new vehicles are very different!

Acquisition and using scrap vehicles can be extremely difficult and onerous taking into account all environmental issues. However, local agreements and charging/funding will dictate, but liaison with the other emergency services, environment agency staff, local scrap yard owners, new vehicle manufacturers and other stations trainers will maximize the benefits for all parties.

Pre-stage the vehicle to assimilate differing scenarios and situations, time spent preparing is time well spent. Include the other emergency services.

As with any other FRS subject vehicle rescue instruction has suffered from varying levels of skills within the service. This is also true in relation to the ambulance and police services.

Joint training will highlight any areas of weakness and through partnership these can be successfully ironed out

### Evaluation of the team performance

As at fires, personnel have differing roles, few take direct action but many support. Therefore, in order for the maximum benefit to be gained by all, a structured and informative debrief is required. This can be achieved in many ways; the use of an 'assessment techniques' sheet by an incident commander is one such method.

### Information Sharing

Technical manuals such as this need to be maintained and updated as information relating to certain areas of vehicle rescue are for ever changing. (i.e. new vehicle technology) Although the responsibility for up dating this manual is with "The Department for Communities and Local Government." it is vitally important that feed back is provided about unusual incidents attended or on equipment issues or on vehicle technologies that have hindered the rescue.

'Bigger picture' information may be gleaned from specialist magazines.

### Request information about patient care, Rescue technique and vehicles

An enquiring mind is an improving mind! Use your vehicle rescue trainers, medical trainers, specialist dealers, training department or specialist magazines/publications. Share any lessons learnt.

**National Network for sharing information**

Put forward suggestions for improvements in equipment. Advise about vehicle technology that has caused problems with the extrication or has not operated in a manner that was expected.

Feedback all of these issues to the Crash Hazards Rescue Group and this will allow progress on a National level. All items can be posted on the following web site, www.crashrescue.org

## EVALUATION TECHNIQUES

Consider utilising the following criteria in order to evaluate the performance of those personnel undertaking vehicle rescue training:

**Coordination And Control**
Assessment and evaluation.
Mobilisation.
Communication.
Task Delegation.
Team Coordination.

**Safety**
Scene Stabilisation.
Exterior Hazards.
Vehicle Hazards.
Personal Protection.
Clothing.
Warnings.
Positioning.
Debris Control.

**Casualty Protection**
Communication.
Protection.
Debris Control.

**Area Safety**
Working area.
Debris control.

**Extrication Techniques**
Vehicle Stabilisation.
Casualty Accessing.
Tool Knowledge.
Metal Relocation.
Vehicle Knowledge.
Path of Egress.

**Medical Aspects**
Initial survey.
'C' spine.
Secondary survey.
Comfort.
Extrication device application.
Removal.
Completion of task.

## LEGISLATION

Although previous legislation allows The British FRS to perform various rescue functions, other than firefighting, new legislation gives the Fire & Rescue Services legal responsibilities at the scene of a vehicle crash. A background knowledge of existing legislation is desirable, as "Dear Chief Fire Officer Letters" tend to deal with specific aspects of vehicle extrication.

## CONTENTS

F & RSA 2004

FSA 1947: Section 3.1(e) – Special Services

FSA 1947: Section 30 –
Authority at Fires to Position Appliances and Stopping Traffic

FSC 39/66: Attendance at Road Accidents (Warning Signs)

FSC 22/67: Attendance at Road Accidents (Equipment and Training)

DCOL 35/7: Hydro-Pneumatic Suspension Units

DCOL 24/81: Pressurised Vehicle Suspension Units
FSC 11/83: Motorway Incidents

FSC 13/83: Roles of Police and Fire Services at Road Traffic Accidents

DCOL 13/83: Hazards from Vehicle Fires

DCOL 9/94: Attendance at Road Accidents



## END OF LIFE VEHICLE REGULATIONS

In November 2003 the End of Life Vehicle (ELV) Regulations were enacted. The aim of the regulations is to reduce or eliminate the environmental impact caused by polluting materials contained within scrapped road vehicles. The Regulations are enforced by the Environment Agency in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and Environment and Heritage Department in Northern Ireland.

The ELV Regulations effectively control the disposal of vehicles that have been declared as waste (scrap) and their polluting contents as well as ensuring that they are de-polluted in an environmentally effective way. Other regulations such as the Hazardous Waste Regulations 2004 (formally the Special Waste Regulation) also apply. A vehicle will become waste when "it has been discarded, or is intended or required to be discarded" for example by its owner. Vehicles recovered by local authorities will normally become waste after the statutory period for retaining them expires.

The ELV Regulations require all facilities (i.e. scrap yards) wishing to store, dismantle and de-pollute vehicles to obtain a licence. Licensed vehicle dismantlers are known as Authorised Treatment Facilities or 'ATFs'. The licences specify the conditions under which the storage and de-pollution may be undertaken in order to minimise the risk of pollution to the environment or harm to human health (including from fire) Additionally, transportation of such vehicles must be by a registered waste carrier. Enforcement action by Environment Agencies began in early 2005.

**Impact of ELV Regs on FRS Road Traffic Collision Training.**
The ELV Regulations effectively make it illegal for FRS's to store or dismantle scraped vehicles unless they have first been de-polluted. This provides two options for FRS's who wish to use scraped vehicles for training.

Either;
- de-polluted vehicles can be obtained from licensed Authorised Treatment Facility and delivered to fire stations and collected after use
- crews might visit licensed Authorised Treatment Facilities to undertake training on de-polluted vehicles.

FRS vehicle workshops are not permitted by the Regulations to de-pollute scrapped vehicles unless they themselves become licensed waste sites, which will not normally be economically viable.

FRS's may wish to obtain vehicles, which have not been scrapped and are not therefore subject to the ELV Regulations. However, during RTC training, it is inevitable some fluids contained within the vehicle such as engine oil, coolant, brake or clutch fluid, suspension fluid, etc will become spilt. If such fluids enter drainage systems it is possible that pollutant will enter the main sewer and or eventually a watercourse or groundwater. This can occur even if separators (also known as interceptors) are installed on site because separators only retain floating materials such as oils, while other materials such as coolants pass through the system. Consequently, FRS's should be aware that offences under the Water Resources Act or the Water Industries Act may be committed in these circumstances.

It is recommended that FRS's using vehicles that are not regulated by the ELV Regulations employ only 'fully contained' training areas and arrange for the legal disposal of any contained run off through a registered waste contractor. After use, FRS's need to ensure that they pass on the vehicle only to an appropriately licensed Authorised Treatment Facility and complete the necessary DVLA paperwork.

Further advice on the management and disposal of ELVs or containment facilities that may be required should be directed in the first instance to local Environment Agency offices (Tel: 08708 506506).

## FIRE AND RESCUE SERVICE ACT 2004

**PART 2 – FUNCTIONS OF FIRE & RESCUE AUTHORITIES**
**SECTION 8 ROAD TRAFFIC ACCIDENTS or FIRE (SCOTLAND) ACT 2005 SECTION 10**

**(1)** A Fire and rescue authority must make provision for the purpose of –
**(a)** rescuing people in the event of road traffic accidents in its area;
**(b)** protecting people from serious harm, to the extent it considers it reasonable to do so, in the event of road traffics in its area.

**(2)** In making provision under subsection (1) a fire & rescue authority must in particular-
**(a)** secure the provision of the personnel, services and equipment necessary efficiently to meet all normal requirements;
**(b)** secure the provision of training for personnel;
**(c)** make arrangements for dealing with calls for help and for summoning personnel;
**(d)** make arrangements for obtaining information needed for the purpose mentioned in subsection (1).
**(e)** Make arrangements for ensuring that reasonable steps are taken to prevent or limit damage to property resulting from action taken for the purpose mentioned in subsection (1).

**PART 6 SUPPLEMENTARY**
**Section 44**
**Powers of Firefighters etc in an emergency etc.**

**(2)** In Particular, an employee of a fire and rescue authority who is authorized in writing by the authority for the purposes of this section, may under that subsection:–
**(a)** enter premises or a place, by force if necessary, without the consent of the owner or occupier of the premises or place;
**(b) move or break into a vehicle without the consent of its owner.**
**(c) close a highway;**
**(d) regulate traffic;**
**(e)** restrict the access of persons to premises or a place.

## FIRE SERVICES ACT 1947
**SECTION 3.1(E)**

The powers of a fire authority shall include power –
to employ the Fire Brigade maintained by them or use any equipment so maintained, for purposes other than fire-fighting purposes, for which it appears to the authority to be suitable and, if they think fit to make such charge as they may determine for any services rendered in the course of such employment or use.

## FIRE SERVICES ACT 1947
**SECTION 30 – CLOSURE OF ROADS**

At any fire, Senior Fire Officers shall have **sole charge of fire-fighting operations** including **positioning of appliances and apparatus**.

The Senior Police Officer or, **in absence of any Police Officer**, the Senior Fire Officer may stop or regulate traffic in any street if it is necessary for **fire-fighting purposes**.

## FIRE SERVICE CIRCULAR 39/1966
**ATTENDANCE AT ROAD ACCIDENTS**

**1** I am directed by the Secretary of State to say that he has considered the recommendations of his Central Fire Brigades Advisory Council for England and Wales regarding the use by fire authorities of police road warning signs at the scene of accidents.

**2** Whilst the police are usually present at accidents to place these signs in position there are times when the fire service is the first to arrive, and the use of warning signs on these occasions would afford firemen some protection from possible injury by other road users.

The Secretary of State therefore recommends that on these occasions, and subject to the agreement of Chief Officers of Police locally, fire authorities should use police accident warning signs.

**3** The signs which may be used on highways and motorways are prescribed in the Traffic Signs Regulations and General Directions 1964 and signs not so prescribed constitute an unlawful obstruction. The 'Police Accident' sign (No 635 in the regulations) has been found to be the most effective in causing motorists to slow down; this may be used with a blue flashing beacon, which increases its effectiveness both by day and by night.

**4** Chief Officers of Police are aware of these recommendations.

## FIRE SERVICE CIRCULAR 22/1967
**ATTENDANCE AT ROAD ACCIDENTS**

**1** I am directed by the Secretary of State to refer to Fire Service Circular 39/1966 and to say that, after consultation with the Central Fire Brigades Advisory Council for England and Wales he wishes to bring to the notice of fire authorities the following further recommendations regarding the use of special equipment by fire brigades at road accidents.

**2** An emergency tender may have a longer distance to travel than pumping appliances, and may be delayed or even prevented from reaching the scene of the accident by the build-up of traffic behind the accident or by bad climatic conditions. It is accordingly recommended that in the predetermined first attendance to the scene of a road accident fire authorities should ensure that at least one appliance is specially equipped to render help to persons who might be injured or trapped.

**3** The special equipment recommended in addition to the normal gear carried on pumping appliances is:-

**(a)** A set of portable hydraulic lifting and spreading gear with a minimum capacity of four tons.
**(b)** A metal cutting tool. The choice of the various types available is one for the fire authority. There may be a preference for a light portable power pack which will drive a combination of tools and lighting. Alternatively, a compressed air operated reciprocating saw has the advantage of not generating sparks, which might create a hazard if petrol is spilt, and can be operated from compressed air cylinders supplied for breathing apparatus.
**(c)** Heavy duty gloves to provide protection against sharp metal edges, broken glass, etc.

**4** For illuminating the scene of an accident at night the lighting equipment normally carried on fire-fighting appliances, should be sufficient. In exceptional circumstances it may be possible to provide additional lighting from an emergency tender.

**5** Training in the use of the specialised equipment and in rescue techniques is essential, and it is proposed to make arrangements centrally for the training of instructors who could subsequently undertake the training of firemen at Brigade level.

**6** In the interests of safety, the Secretary of State recommends that members of the fire service in attendance at road accidents, particularly on motorways and trunk roads, should be provided with conspicuous clothing, as is already the practice of a number of fire authorities.

Tests have shown that a man is most clearly visible, even when bending down, if he is wearing a conspicuous surcoat together with yellow overtrousers. Two types of material can be recommended for use in the surcoat.

The first material is fluorescent orange in colour and is a pvc-coated, rayon staple cloth, meeting the performance requirements of British Standard 3546: 1962 (MR grade of material), with the additional requirement that it should be flameproof to British Standard 3120: 1959.

The second material is that used in the yellow overtrousers. Both materials are conspicuous by day but, for effective use at night, strips of silver reflective material should be affixed to the front, back and hem. The reflective material will not be conspicuous by day and a proper balance must therefore be maintained between the areas of the reflective material and the exposed parts of the surcoat.

The over-trousers could also be made more conspicuous by night by the addition of strips of reflective material. A surcoat in the yellow overtrousers material, if provided with sleeves, could be used as a waterproof in place of the black,

inconspicuous one at present provided for use in damping down and other operations.

## DEAR CHIEF OFFICER LETTER 35/79

### HAZARDS FROM EXPLOSIONS IN VEHICLES

### CITROEN CARS – HYDRO-PNEUMATIC SUSPENSION UNITS

**1** I am writing to inform you of an incident in Bedfordshire in March 1978, where a Citroen car was severely damaged by a fire following an electrical fault. The 2 rear suspension units of the hydro-pneumatic suspension disintegrated during the course of the fire and the hemispherical upper halves of both rear suspension units were propelled from the car with considerable force, causing damage to property though fortunately without causing personal injury. The suspension units concerned operate with nitrogen at working pressures of up to 1,044 psi (72 bar).

**2** Subsequent investigations of the occurrence by the Home Office and Citroen Cars Limited have so far been inconclusive. The top halves and one bottom half of the pressurised spheres were retrieved but, although these have been examined by the French parent company and the history of the car is well documented, no definite cause of the forced ejection of parts of the suspension units has been established. In the absence of a full explanation of the event, the possibility of a re-occurrence cannot be dismissed entirely.

**3** It is understood that the Department of Transport have no record of similar hazards with respect to pressurised systems incorporated in vehicles. The systems which are commonly in use are air brake systems, hydro-pneumatic and hydro-gas suspension systems, air suspension systems and power hydraulic suspension systems.

**4** Pending any further information which may arise from continuing investigation into this incident, you will no doubt wish to alert personnel to the need to regard those hydro-pneumatic suspension units of Citroen cars which utilise two-piece spheres as a potential projectile hazard when severely involved in a fire. The models concerned are:

DS Saloons (up to and including 1972 models)
DS Estates (discontinued 1974/75)
CX Estates (introduced 1974)

If a similar incident comes to your knowledge, I should of course be glad if you would let me have details.

## DEAR CHIEF OFFICER LETTER 24/1981

### HAZARDS FROM EXPLOSIONS IN VEHICLES

**1** Further to my predecessor's letter of 18 May 1979 (No 35/1979), I have been informed of three further incidents involving explosions of pressurised vehicle suspension systems. In each case there was a severe fire which resulted in the explosion of Hydra-gas suspension units. All four metal caps of the suspension units on two Allegro cars, which had been set on fire, and the two front caps on units fitted to a Mini Metro were blown off with considerable force, although they were contained within the car bodies and nobody was injured.

**2** Hydra-gas and hydro-pneumatic front suspension units are normally mounted vertically but rear units are mounted horizontally in many vehicles. The caps of vertically mounted units will normally travel upwards if ejected explosively from the vehicle unless they are deflected by the bonnet or boot lid. They may remain contained within the vehicle if the bonnet and boot are closed. Components of horizontally mounted units are likely to present the greatest projectile hazards, even with the boot closed, with the area behind the vehicle being the position of greatest danger.

**3** Although fire service personnel are generally aware of the danger presented by severe vehicle fires, particularly as regards the possible involvement of the fuel system, you may think it appropriate that due warning should also be given of the hazards associated with any pressurised systems which are, or may in future be, fitted to vehicles. These systems were mentioned in my predecessor's letter and include air brake systems, air suspension systems, hydro-pneumatic and hydra-gas suspension systems any of which may, exceptionally, result in a projectile hazard if involved in a serious fire.



## FIRE SERVICE CIRCULAR 11/83

### MOTORWAY INCIDENTS

The attention of fire authorities is drawn to some changes in the guidance on procedures for incidents on motorways which was previously issued to the fire service in a booklet made available with FSC 4/81. The procedures have now been incorporated in Book 12 of the Manual of Firemanship, but some amendments have had to be made which reflect current advice and practice and about which the organisations represented on the Joint Committee on Fire Brigade Operations have been consulted. In addition, the following summary of changes made includes some clarification of the regulations relating to beacons and lamps on advice received since Book 12 was completed, although it must be recognised that authoritative interpretation of the statutes is a matter for the courts:–

**(a)** The text on page 60 of Book 12 indicates that a lamp other than a blue flashing light may be used with a 'Police Accident' sign. This is now recognised not to be correct, as Regulation 28(2) of the Traffic Signs Regulations and General Directions 1981 does not permit other than a blue flashing beacon to be displayed with this sign.

## DEAR CHIEF OFFICER LETTER 9/1994

### ATTENDANCE AT ROAD ACCIDENTS

**1.** In 1993, the Joint Committee on Fire Brigade Operations (JCFBO) set up a small Working Group to review Fire Service Circular 22/1967 which is concerned with specialized equipment recommended to be in attendance at road traffic accidents. The Working Group has completed its review and this item contains guidance for Chief Fire Officers. Fire Service Circular 22/1967 is now superseded by this item.

**2.** Fire Service Circular 22/1967 contains guidance and recommendations regarding the use of special equipment by fire brigades at road accidents. In 1993, the CFBAC Joint Committee on Fire Brigade Operations agreed to set up a Working Group to review and update FSC 22/1967. The Working Group has now concluded its review, and the following recommendations are made as a result of the work carried out by that Group.

**3.** It is generally accepted that a rescue/emergency tender may have a longer distance to travel than a pumping appliance, and may be delayed or even prevented from reaching the scene of the incident by the build up of traffic behind the accident or by adverse weather conditions. It is accordingly recommended that as part of the predetermined attendance to the scene of a road accident fire authorities should ensure that at least one pumping appliance is specially equipped to render help to persons who might be trapped or injured.

**4.** In order to facilitate the above it is recommended that equipment additional to that which is normally carried on designated pumping appliances is made available, within the following categories:

**a)** Lifting, Spreading and Cutting Equipment;
**b)** Personal Protection of Crew Members;
**c)** Medical Equipment;
**d)** Communications;
**e)** Miscellaneous Equipment.

### ROAD TRAFFIC COLLISION INSTRUCTORS COURSE

It is appreciated that there are a considerable number of variations and different types of equipment available to brigades. Accordingly, this guidance is not prescriptive in its recommendations and it is for individual fire authorities to assess their needs in light of what is required to meet that specific need in provision of equipment.

#### (a) LIFTING, SPREADING & CUTTING EQUIPMENT

A set of portable powered lifting spreading and cutting equipment, with a minimum capacity of four tons.

#### (b) PERSONAL PROTECTION OF CREW MEMBERS

A range of equipment which could include high visibility jackets (one per crew member), chemical protection suits (minimum of two per appliance), protective gloves (various types, i.e., heavy duty),

eye protection, i.e., goggles or visors (grade 1 impact resistant) in accordance with the relevant current standard, bump hat or suitable head protection (for use where the fire helmet is inappropriate) and ear defenders (minimum provision for two persons per appliance). Whilst the above list is intended to give guidance in protection of crew members, consideration should
also be given to the provision of equipment to protect casualties when appropriate.

**(c) MEDICAL EQUIPMENT**
Medical equipment may include, resuscitation equipment, neck splints and spinal boards etc, blankets (woollen or foil exposure type), stretcher, enhanced first aid box containing large dressings and various solutions for first aid use.

**(d) COMMUNICATIONS**
Hand held portable radios and loud hailer. Brigades should refer to previous guidance about the use of radios in close proximity to vehicles fitted with airbags; see ITEM F of DCOL 8/1994.

**(e) MISCELLANEOUS EQUIPMENT**
Lighting (powered and portable), lighting tripods, selection of blocks, road cones, accident warning signs, stationary to include tags for body tagging, road marking equipment, warning beacons, hand cleaning solution, i.e., Dettol or equivalent.

**5. TRAINING**
Training in the use of specialist rescue equipment together with rescue techniques is essential. It is therefore recommended that training with the additional and enhanced equipment should be carried out at regular intervals and where possible exercises involving other emergency services (police and ambulance) should be carried out.

**6. THIS ITEM SUPERSEDES FIRE SERVICE CIRCULAR 22/1967.**
**(a)** Fig 3.3 on page 58 depicts the use of blue beacons with police warning signs and traffic cones. The use of blue beacons at incidents rests on their being used in combination with police warning signs in accordance with the provisions of Regulation 28(2). There is no provision covering the use of blue beacons with cones other than in combination with police warning signs. Amber road danger lamps may be used with cones under the provisions of Regulation 40; it should be noted that these lamps are not beacons as provided for in Regulation 28(1).
**(b)** It should also be noted that the recommended police procedure is to use police warning signs in the sequence Accident – Accident – Slow as shown in Book 12, rather than Accident – Slow – Slow, as depicted in the previous guidance.
**(c)** When an appliance is placed in a fend-off position to protect personnel at an incident, it may be necessary to park it at an angle of less than the 30°–35° previously recommended. Because of the size of appliances and the width of motorway lanes, care is needed to avoid obstructing adjoining lanes unnecessarily.
**(d)** To give extra protection to personnel working at a motorway incident and to ensure that the way through for traffic is clearly understood it is recommended that the whole of any lane affected by an incident should be 'coned' off.
**(e)** Police officers at the scene of an incident when an appliance arrives will be in control of traffic movements, and it is suggested that the officer-in-charge of the appliance should take account of police views in positioning his appliance. This advice is not intended to detract from the responsibility of the officer-in-charge to do what is operationally necessary.

## FIRE SERVICE CIRCULAR 13/1983
## RESPECTIVE ROLES OF THE POLICE AND FIRE SERVICES AT ROAD TRAFFIC ACCIDENTS

From time to time there has been discussion within the police and fire services about the respective roles which the two services fulfil at road traffic accidents. It is evident that there is a wide measure of agreement between the two services as to what these roles are, and that in practice working relationships between them at incidents are normally very effective. Nevertheless questions continue to be asked about these roles and about equipping both services for rescuing people from accidents.

The day to day operations of each service are for the respective chief officers, and provision of resources for the two services is a matter for police and fire authorities; nothing in this letter is intended to detract in any way from these responsibilities.

It is acknowledged that the fire service is better trained and equipped to deal with most major incidents on the roads, and that it is the principal rescue service. Its resources are particularly important at incidents requiring rescue equipment, involving dangerous substances and where breathing apparatus is needed. The police role at such incidents is to identify the problem, protect the area, control traffic, summon the fire service and other specialist assistance required and to investigate the circumstances surrounding the incident itself.

It is recognised that where police patrols are first on the scene and essential action cannot await the arrival of the fire brigade, the use of police equipment can save life or reduce the risk of danger. It is clear that at all times the safety and protection of the public will be the overriding consideration, and that speed of action by whichever service is first present will often be crucial in saving lives and mitigating injury.

When both police and fire services are present, it would be normal for the police to undertake overall co-ordination of the incident, protecting the area and controlling traffic, and to leave the fire service to undertake rescue, prevent fire and deal with dangerous substances. The investigation of offences which may have been or are suspected to have been committed, including the need to preserve evidence, the protection of property and clearance of the scene are the responsibility of the police. These arrangements do not detract from the statutory responsibility of the senior fire brigade officer present to have sole charge and control of all operations for the extinction of any fire.

## DEAR CHIEF OFFICER LETTER 13/83
## HAZARDS FROM VEHICLE FIRES

**1.** In my letter of 13 November 1981 (No 24/1981) I referred to hazards from explosions in severe vehicle fires. Recent incidents have shown further specific hazards which may arise from gas strut dampers, which are now commonly fitted to the boot lid/tailgate of many cars, and spring brake actuators of commercial vehicles.

**2.** Gas struts may explode when subjected to high temperature. Provided that the end fixings remain intact the casing is likely to split, but no projectile or other significant hazard should arise. One case is recorded, however, where the end anchorages of the strut failed first in the heat of the fire and thereafter the strut separated explosively into two parts, one of which punched a hole through the car body and emerged as a projectile.

**3.** In the case of spring brake actuators, many are manufactured from cast aluminium alloys and the heat of a severe fire may melt the spring retaining cap or permit sufficient distortion to release the retaining clip which secures the cap. In either event the springs, which store considerable energy, will be released violently and on occasions have travelled some considerable distance. They represent a serious projectile hazard. The units concerned are only fitted to rear axles and axles of trailers as part of the secondary (parking) brake. Most of these units have their axis in a near horizontal plane but some are directed in a slightly upward direction. They are therefore a particular hazard to anyone approaching from the rear of the vehicle or trailer.

**4.** Although attention has been drawn by previous letters to the general hazards arising from explosions of motor vehicle components in severe vehicle fires, you may think it appropriate that warning should also be given of the particular hazards which may arise from gas struts and spring brake actuators when involved in fire.

**5.** Providing feedback information about incidents attended by the watch if any learning points are evident.

**6.** Requesting information about patient care, rescue technique and vehicles etc.

**7.** Putting forward any possible improvements in equipment, approach and liaison with other services or any other relevant areas.

## Special Order for use of Reflective Material and red Flashing Lights

The FRS has been provided with Special Order VSE 23/9/16/59 under Section 44 of the Road Traffic Act by the Department for Transport. This replaces Special Order 4/11/16/13 and extends the exemption to permit vehicles covered to use red

flashing lights when stationary at the scene of an emergency. It also permits the use of reflective material.

The full order details the exemption details and also lists all FRS's that are part of the same. The order came into force on the 28th July 2006 and shall continue in force until 31st July 2009.





# Appendix 3 – Emergency Services Personnel (ESP) Aide Mémoire

## THE FOLLOWING WILL PRESENT HAZARDS IF UNDEPLOYED

- Airbags
- Supplementary Restraint Systems SRS
- Seat Belt Pre-tensioner Systems SBPT
- Roll Over Protection Systems ROPS

## THE DANGERS POSED TO THE RESCUER CANNOT BE OVER EMPHASISED.

Airbags deploy at very high speeds and with very high forces that can cause serious injury. They also become very hot, reaching temperatures of up to 300ºC. The deployment is completed in 80 milliseconds. By comparison it takes 200 milliseconds to blink an eye!

## WHERE ARE THEY FOUND?

- Steering Wheel (Drivers airbag)
- Dashboard (Passenger airbag)
- Side of seat (Thorax/side impact)
- Roof lining (Curtain side impact)
- Lower Dashboard (Knee airbags)
- Back of front seat (Passenger airbag)
- Font & rear seat trim (Side impact)

Due to the fact that technology will continue to develop this list cannot be exhaustive

## WHAT SIGNIFIES THAT AIR BAGS ARE FITTED?

- Airbag
- SRS Supplementary Restraint Systems
- ITS Inflatable Tubular Systems
- SIPS Side Impact Protection Systems
- HPS Head Protection Systems
- IC Inflatable Curtains

## NOT ALL SYSTEMS WILL BE READILY IDENTIFIABLE.

## ASSUME THAT AIRBAGS ARE PRESENT AT ALL RTCs.

**DEPLOYED AIRBAGS DO NOT INDICATE THAT ALL DANGERS HAVE BEEN ERADICATED.**

**INDIVIDUAL RESTRAINT SYSTEMS ARE ONLY SAFE IF THEY HAVE BEEN DEPLOYED BUT MAY STILL BE HOT.**

## ON SCENE

- Survey the vehicle internally and externally for hazards.
- Do not enter the passenger cell until all hazards have been assessed (do not delay medical attention un-necessarily).
- However medical attention is administered it is essential to remain outside the deployment range of any un-deployed airbags.
- Avoid using radio transmitters inside crashed vehicles.

**Remember the 5, 10, 15 and 20 rule. (See Figure A3.1)**

Avoid placing solid objects between casualties and un-deployed airbags.

## SEAT BELT PRE-TENSIONERS

- Normally deploy in tandem with airbags
- They reduce the slack in the seat belt by up to 6 inches (15cm).

These devices, when un-deployed, present a finger/hand trap hazard to ESP and could potentially cause further injury to casualties.

## ROLL OVER PROTECTION SYSTEMS (ROPS)

Active rollover devices are generally only found in certain convertible vehicles. They can operate with explosive force away from the bodywork of the vehicle.

These devices, when un-deployed, present the serious risk of injury to ESP if in close proximity.

**THE DANGERS POSED TO THE RESCUER CANNOT BE OVER EMPHASISED.**

ROPS deploy at very high speeds and with very high forces that can cause serious injury. The direction of deployment is not always apparent from outside the vehicle.

There are two main types in production:

## ROTATING BAR

These devices protect all the occupants and are generally stored behind and around the rear of the seats. The bar may be mistaken for part of the "soft top" mechanism. An example of this is the Mercedes SL.




*Figure A.3.1 The 5, 10, 15 and 20 Rule.*

## POP-UP ROLL HOOPS

These devices are mounted behind each seat and protect the head of each occupant. They normally deploy at the same time as each other. Some devices are electric, some spring loaded and some are pyrotechnic. Sometimes the devices are visible as "head restraint" loops, sometimes not. The BMW 3 Series convertible is an example of the visible type.

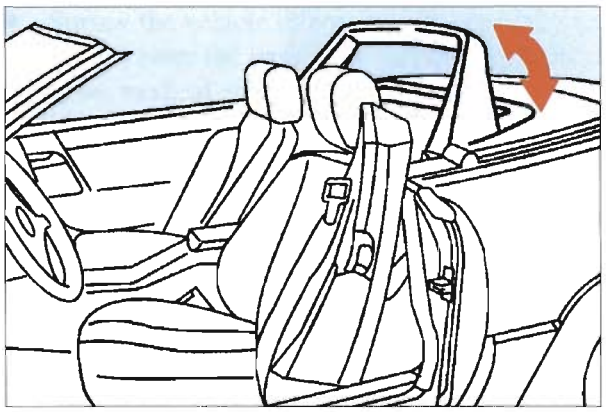


*Figure A.3.2 Single roll hoop.*

## SPECIFIC DANGER TO RESCUERS

The specific danger of these devices is to rescuers who may be supporting the head and neck of the casualty from behind, or when removing a casualty on a spine board etc.

This is particularly hazardous when the vehicle is on a slope, especially a lateral slope and the vehicle is close to rolling over. Under such circumstances it is vital that the vehicle is made stable.

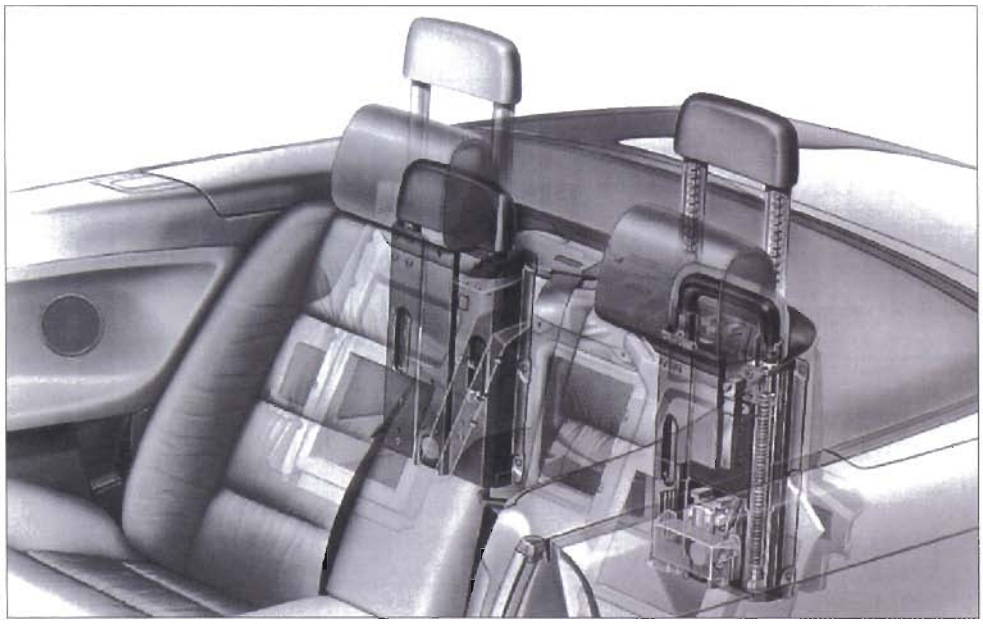


*Figure A.3.3 Individual roll hoops.*

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