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SKILLS FOR EMERGENCY SERVICES PERSONNEL

Road Rescue

Third Edition

2009

AUSTRALIAN EMERGENCY
MANUAL SERIES

SKILLS FOR EMERGENCY SERVICES PERSONNEL

ROAD RESCUE

Third Edition 2009

MANUAL NUMBER 34

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The AEM Series has been developed to assist in the management and delivery of support services in a disaster context. It comprises principles, strategies and actions compiled by practitioners with management and service delivery experience in a range of disaster events.

The series has been developed by a national consultative committee representing a range of State and Territory agencies involved in the delivery of support services and is sponsored by EMA.

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Preface

With an increasing use of transportation networks, there is a greater risk of road-related emergencies and the potential for physical trauma. This third edition of the manual Road Rescue (previously titled Road Accident Rescue) in the Skills for Emergency Services Personnel section of the Australian Emergency Manual (AEM) series provides a basic reference for road rescue operations. Road rescue operations are inherently hazardous and should only be undertaken by trained personnel. This manual is intended for use in the planning, training and operations of emergency service personnel and organisations. State and Territory legislation and emergency service road rescue protocols must be adhered to when undertaking road rescue activities.

The use of trade names in this manual is not intended to be restrictive, preferential or promotional; rather, trade names are used where descriptive clarity is required. Where trade names are utilised it should be understood that these products are neither officially endorsed nor recommended by The Federal Attorney-General's Department or individual emergency service organisations.

I would like to thank the State Emergency Service National Education and Training Committee (SES NETC) for coordinating this review and for ensuring current national best practice in road rescue skills. I would also like to thank the numerous organisations both national and international that have contributed to the content of this manual.

As situations change and improved techniques are developed, the Road Rescue manual will be updated and amended under the auspices of the SES NETC.

Martin Studdert, AM

First Assistant Secretary

National Security Capability Division

Attorney-General's Department

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CHAPTER 1
ROAD RESCUE ORGANISATION

1.1 Aim

To provide, a reference for Road Rescue (RR) operations in Australian states and territories.

NOTE

This manual should not be regarded as a self-teaching medium and is provided as a reference only. Any training on, or practical adaptation of the methods or techniques covered in this publication, should be conducted by a qualified Trainer/Assessor.

1.2 Functions

To effectively perform the Road Rescue role of providing lifesaving support to trapped and injured persons and subsequently their extrication, personnel should possess knowledge of:

- the systems approach to Road Rescue
- first aid
- other agency roles and resources
- the importance of scene integrity
- the construction of motor vehicles
- vehicle safety systems
- rescue equipment
- the techniques employed to effect disentanglement and extrication
- critical incident stress and the importance of effective operational and emotional debriefing, and
- occupational health and safety.

NOTE

Rescue personnel need to be aware that legislation varies throughout the Commonwealth. They should make themselves aware of the legislative or policy requirements in their state/territory for the provision of Road Rescue activities.

1.3 Systems approach

A systems approach to Road Rescue can be described as a sequence of inter-related events that will enable achievement of a safe, effective and efficient rescue.

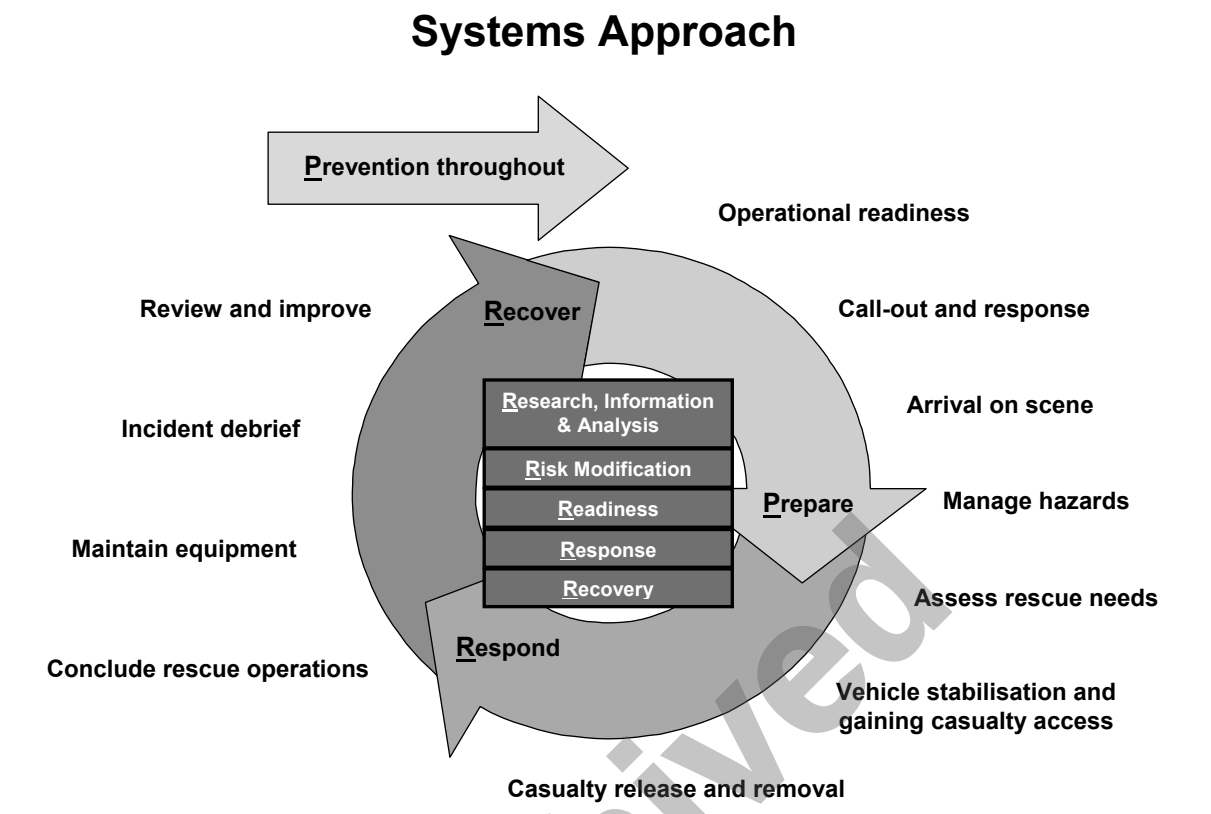

Figure 1:1
Systems Approach

1.4 First aid

ALL RESCUERS SHOULD BE TRAINED IN LIFE-SUSTAINING FIRST AID TO RECOGNISED STATE OR TERRITORY STANDARDS (Refer to Emergency Care - Chapter 9).

1.5 Team composition

Team composition must be determined by the various organisations within each state and territory on the basis of the safe accomplishment of set tasks. Regardless of the team composition, a team leader must be appointed.

1.6 The psychology of rescue

People tend to react differently to danger, but the most general responses are anxiety and fear, perhaps the most powerful of all emotions. It must be remembered that it is not just the casualty who faces the danger. Even if the main danger has struck and passed, additional dangers are still often present. The biggest difference between the casualty and the rescuer is that the rescuer is better able to cope with, or handle the

situation. This is because the rescuer has the knowledge, skills, experience and the resources to minimise risk and to remedy the situation.

It is normal to be anxious and feel fear in the face of danger. These are emotional reactions common to both casualty and rescuer. Many other emotional responses may develop during a rescue situation—pity, disgust, contempt, pride, concern and many more. These are often exaggerated beyond all reason by the urgency and pressures of the situation, thus lowering the efficiency of the overall operation.

The rescuer must be aware of the psychological needs of casualties, not just their physical needs, and be prepared to meet those psychological needs.

1.7 Rescuers

An event requiring rescue operations will usually create three categories of people.

1.7.1 Group 1—survivors

The immediate reaction of survivors of road incidents, once they have discovered they are not seriously injured is to help others. They usually do not know what to do, but they feel they should do something to assist. The situation where untrained survivors, possibly in some state of shock, attempt to render assistance is a concern.

These good intentions could aggravate the conditions of those being 'helped' to the point where loss of life may be greater than it should be. These same individuals could also be a hindrance, in the way of, and interrupting the functioning of trained rescuers. Nevertheless, uninjured and slightly injured survivors could well be the only hope of survival for many casualties e.g. if toxic gases, dangerous chemicals, fire or danger of fire exists at the site of the incident. The first group to commence rescue work at an incident usually consists of those survivors still physically capable of doing so. The potential for good is enormous but the danger inherent in utilising untrained personnel is equally serious.

1.7.2 Group 2—untrained personnel

The second category of people is drawn from those either witnessing the event or from the vicinity of the event, drawn to the site by curiosity and, for many, a desire to assist the casualties. Although not quite as emotionally involved as the survivors, the danger inherent in utilising untrained personnel is still a factor which must be considered. On the positive side, they often bring necessary resources with them and can be very effective if they can be brought under control and properly supervised.

Unfortunately, a large number of the 'curious', are just that. They have no desire to help, but just look. They get in the way, shout advice and generally add to the excitement at the site, the very thing that is least needed.

1.7.3 Group 3—trained rescuers

The last group to arrive at the scene are the trained rescuers e.g. Ambulance, Police, Fire, SES etc. It takes some time for various emergency services to mobilise and arrive at the scene. The quicker they can arrive the less time there will have been for the first two groups to aggravate the situation and create more dangers to surviving casualties and to themselves. Well trained rescuers will effectively utilise the resources available, to efficiently carry out the necessary tasks.

1.8 Personal traits of the rescuer

Rescue work is not an easy task, nor is it glamorous. Certainly not all people are suited to such work. Physical fitness, personality, emotional stability and availability are all factors involved in determining one's suitability.

The following traits are desirable:

- Interest—Rescuers must have a genuine interest in rescue work.
- Motivation—Rescuers must be prepared to continually undergo training to maintain a professional standard.
- Dependability—Lives of casualties and rescuers rely upon dependability.
- Initiative—The nature of rescue operations is such that it is often impossible to closely supervise each rescuer. Each rescuer must be able to see what needs doing, and complete the tasks at hand.
- Versatility—Each situation is unique, therefore the rescuer must interpret each situation and apply a wide range of knowledge, skills, experience and resources.
- Cooperation—Rescue work is a team effort.
- Physical Fitness—Rescue work is physically demanding and often continues for long periods. Physical limitations must be recognised by the rescuer and taken into consideration.
- Leadership Qualities—Required by all rescuers at various times and to varying degrees. Through capable leadership by trained rescuers, many more untrained personnel may be utilised.
- Control over Fears (Phobias)—It is important that rescuers are aware of their limitations. Part of this knowledge consists of being aware of phobias. It is vital that the leader of a rescue team is aware of any phobias among team members.

NOTE

Some phobias which could seriously affect a rescuer, and which may be identified in training are:

- haemophobia (fear of the sight of blood)
- acrophobia (fear of heights)
- claustrophobia (fear of confined spaces); and
- hydrophobia (fear of water)
- Conduct and appearance—Rescuers conduct and appearance should instil confidence in others at all times.

1.9 Personal behaviour

The conduct of rescuers provides an indication as to their psychological make-up and personality. The nature of rescue work is such that it is particularly important that personal conduct does not aggravate an already stressful situation. Whilst maintaining a safe environment, it should assist in creating an atmosphere of the rescue being in competent hands and everything possible being done to rescue and care for the casualties.

Some of the important general areas of conduct or behaviour are:

- **Attitude**—A serious, professional attitude must be maintained to gain confidence and support.

NOTE

Arrogance and superiority create instant antagonism, while loud talking, joking and horseplay reduce credibility. They create a feeling of resentment and add to the confusion, thus hindering the work. Rescuers who display this type of irresponsible, unprofessional attitude add to the state of anxiety of the casualties.

- **Emotion**—At an incident the control of emotions is a very difficult task. However, every effort must be made to prevent adverse emotions from influencing good judgement and competence. Regardless of the excitement and the severity of the incident, the rescuer must be able to remain calm and be sympathetic without becoming emotionally involved.
- **Courtesy**—Courtesy, tact and good judgement are vital. If the rescue task is to be completed quickly and effectively, courtesy to all concerned is essential.
- **Safety** – Promoting a safe environment for casualties, other rescuers, general public and property.

1.10 The operational sequence

The operational sequence refers to the decision making process. Personnel involved in Road Rescue will be continually assessing, evaluating and re-evaluating the operation from the time of first call through to completion.

1.10.1 Decision making

To carry out any task successfully, all rescuers must have an understanding of the decision making process. The following method is one means of ensuring this is done:

a. **Assessment**—The gathering of information.

b. **Appreciation**—The method by which the information is processed to the stage of a decision being made. It includes defining the problem, aim, factors, courses open, best course and outline plan. (Refer to section 1.10 of the General and Disaster Rescue – Fifth Edition AEM for further detail on the appreciation process)

c. **Plan**—The outline plan moulded into a formal plan of action, and includes resources deployment.

d. **Orders**—The delivery of the plan to subordinates and is usually based on the SMEAC mnemonic.

Situation—Description of the actual situation.

Mission—A positive statement of what is to be done.

Execution—The method of the rescue.

Admin & Log—Administrative and logistic requirements.

Command & Communications—A positive statement of command and communication details.

1.11 Safety in training and operations

The task of Road Rescue is potentially dangerous to the casualty, bystanders and the rescuers. Therefore considerable training is necessary. Personnel must strictly observe safety measures at all times.

Wherever possible, rescuers should adhere to standard techniques and practices in the field.

In any rescue technique, safety limitations and margins have been built in for casualty, bystander and rescuer protection. These must be adhered to at all times.

CHAPTER 2
PREPARATION

2.1 Introduction

This chapter forms step one in the systems approach to Road Rescue. It is important that rescuers understand the relationship between each step and its relevance to the overall task.

The following subjects are covered:

- Selection of the rescue vehicle
- Types of rescue vehicles
- Selection of Road Rescue equipment
- Readiness of the rescue vehicle and equipment
- Road rescue training
- Rescue team composition
- Personal safety
- Manual handling techniques

2.2 Selection of the rescue vehicle

Before obtaining a vehicle/trailer, factors which should be considered are:

- present and potential needs of the community
- financial situation relative to obtaining and maintaining the vehicle
- type and amount of equipment to be carried on vehicle/trailer and compliance with state regulations and standards and occupational health and safety (OHS) requirements
- number of personnel to be carried; and
- topography of the land and road conditions (specific to operational area).

2.3 Types of rescue vehicles

2.3.1 Design considerations

Consideration of vehicle design should include:

- heavy tools stored in a position that requires minimum reaching and lifting
- equal weight distribution throughout the vehicle to maintain low centre of gravity
- location of plant and equipment exhausts should be directed to a position that will not infringe on the working of the rescue team or creating further hazards
- equipment to be readily accessible, preferably from the outside
- Gross Vehicle Mass (GVM) not to exceed the manufacturer's specifications
- stowage configurations designed in a way to keep equipment secure, visually displayed and easily accessible (where possible)

- compartment doors designed to permit complete access to the equipment but not endanger or create further hazard at the incident scene when open
- sufficient external and internal lighting to illuminate equipment lockers and the incident scene, and
- vehicle emergency lighting should be fitted in compliance with state and territory regulations and standards. All devices should be clearly identifiable to all approaching vehicles.

2.3.2 Standard model vehicles

Various manufacturers produce stock models which are designed for carriage of tools and equipment which can readily be adapted with partitions and flood light systems. These are usually van type bodies with limited personnel facilities. Access to the rescue equipment is limited to the existing openings on the body configuration.

2.3.3 Custom-built vehicles and modules

Custom-built vehicles are designed from the chassis up whilst the modules are designed to fit the cab chassis configuration. Both are specifically designed to locate the rescue tools as recommended. Many effective custom-built vehicles/modules are already in use. Contact with existing rescue organisations may provide plans to assist with a local design. The advantage of custom-built modules is that they allow for a change over of the drive unit with the retention of the rescue module for a greater service life. Modules can also be made to suit dual cab vehicles and vehicles to allow for additional personnel carrying capacity.

2.3.4 Road rescue trailers

There are circumstances where local terrain or cost factors indicate that a trailer unit would best serve the community needs. The same basic principles apply in respect to weight loading and configuration of the trailer module. An advantage of the trailer type rescue module is that in rural areas they can be transferred from a road type vehicle to a suitable four-wheel-drive or tractor type vehicle for access over more difficult terrain.

2.4 Selection of Road Rescue equipment

Rescue equipment varies from hand tools to powered hydraulic sets. A suggested list is attached at Annex A (Recommended Tool List). This list is designed only as a guide and may be added to or subtracted from as local operational requirements dictate.

NOTE

Rescue personnel should refer to manufacturers' instructions for details of care, use, maintenance and safety requirements of rescue equipment.

2.5 Readiness of the rescue vehicle and equipment

Due to the high demand for reliability for emergency vehicles all emergency vehicles should be regularly maintained to ensure the vehicle is in its most appropriate state of readiness.

2.6 Road rescue training

Road rescue at an incident is a demanding, labour intensive activity covering a wide variety of incidents. Thus, a high level of training is necessary to achieve a rapid, efficient operation. In addition to training, an effective call out system needs to be developed and exercised.

NOTE

Where applicable, State/Territory policy and standards relating to qualifications and accreditation apply.

There can be no doubt that in a local community there exists much expertise that may be utilised for the purpose of Road Rescue. Relevant people within the motor vehicle industry can be an invaluable resource and may assist with information and or training for rescuers.

Most members of other organisations involved in emergency work can provide expertise and specialist training in first aid, casualty handling and firefighting as well as information on procedures for hazardous materials. It would be remiss of any rescuer not to take advantage of sources of expertise. One of the most successful ways in establishing a good rapport with other agencies is to invite them to assist with training and perform roles as umpires on exercises designed to test rescue procedures.

There is no substitute for regular hands-on training for the team. Sources for appropriate vehicles may be wrecking companies, vehicle manufacturers, or Local Authorities that may remove abandoned vehicles. Follow your agency's protocols regarding clearance and ownership of these vehicles.

Wherever possible, the vehicle obtained should be complete, have all fuels and oils removed to reduce potential hazards. For some training scenarios simulated vehicle damage may be necessary to replicate realistic collision damage. Simulating vehicle damage must be undertaken under supervised conditions with appropriate and approved resources.

2.7 Rescue team composition

Considerations for Road Rescue team composition are:

- A Road Rescue Team Leader
- A qualified driver, and
- Trained Road Rescuers.

2.7.1 Leadership

Whilst there should be a recognised team leader at incidents, all rescuers operating at a Road Rescue must understand the qualities of leadership. In the event of a larger incident, teams may be fragmented, necessitating a leadership role by individual rescuers.

2.8 Personal safety

All rescue organisations supply their members with protective clothing and equipment. Rescuers may be confronted with a variety of hazards, such as:

- fire
- hazardous materials
- unsafe or unstable locations
- internal vehicle hazards
- live electrical wires
- the threat of communicable diseases, and
- on scene grieving parties.

2.8.1 Protective equipment

Safety is the responsibility of every member. Protective equipment should be worn during all training and operational incidents. The recommended minimum issue of equipment is:

- helmet
- overalls/coat
- work gloves
- boots
- respiratory protection
- eye protection
- facial protection
- ear protection, and
- disposable gloves.

2.9 Manual handling techniques

Adoption of correct manual handling techniques is essential. Rescuers will be required to lift, haul or push loads, and must be trained to handle these tasks properly and safely.

2.9.1 Avoiding injury

There is a serious risk of spinal or abdominal muscle injury due to incorrect lifting, and the following points detail correct manual handling techniques:

a. As the leg and thigh muscles are stronger than those of the arms, back or abdomen, it follows that these are the muscles which should be used for safe lifting.

b. During a lifting operation, the rescuer should crouch down with knees bent, back straight and feet properly placed to bear the load. See Figure 2:1 – Correct lifting technique.

c. Gripping the load securely, the rescuer should start the lift by the thrust of the legs, and continue this thrust until the legs are straight, keeping the load close to the body and keeping the back straight. In this way, the strain involved is placed on the leg muscles, and the possibility of back or abdominal injury is greatly reduced.

d. Loads should be lowered in a reversal of the manual handling techniques.

Heavy loads should be lifted with assistance from other people or a mechanical lifting device.

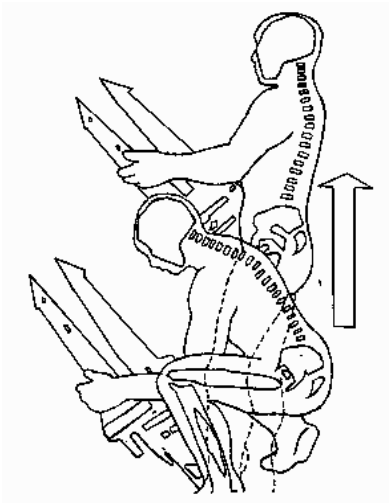

Figure 2:1
Correct lifting technique

Annex ‘A’ To Chapter 2

Recommended Equipment

Quantity:	Tools & Types:	Application:
20 each	Blocks, timber approx. 100 x 25 x 500mm, 100 x 50 x 500mm, 100 x 100 x 500mm	Used as cribbing to pack under the vehicle in increments of 25mm, 50 and 100mm.
4	Blocks, timber, step	Used as packing under a vehicle in a series of steps.
12 each	Wedges, timber 100 x 100 x 500mm and 100 x 50 x 500mm	Used in conjunction with blocks to take up the gaps.
12	Wedges, timber assorted sizes (e.g. wheel chocks and shims)	Used to place in front of and behind the wheels to prevent horizontal movement.
4	Wedges, step/blocks 500mm x 200mm	Used in conjunction with step blocks to take up the gaps.
1	Tension buttress kit for side stabilisation (e.g. Acrow prop, shackles and straps; or Stabfast or Holton Foot or Side Stabiliser)	Used for side stabilisation or supporting the vehicle to make safe.
2	Ratchet straps, 25mm x 6m (min) with Hooks (rated)	Used in conjunction with the Tension Buttress kit but can also be used for tying and securing objects together.
2	Ratchet straps, 50mmx 6m (min) with Hooks (rated)	Used in conjunction with the Tension Buttress kit but can also be used for tying and securing objects together.
2	Air hoses (10m)	Used to deliver air from the supply to the tool or airbag.
1	Air impact chisel	Can be used for cutting out panels on vehicles, to remove roofs and exposing door locks.
1	Air impact wrench (c/w sockets)	Used to loosen or tighten nuts and bolts.

Quantity:	Tools & Types:	Application:
2	Air supply (cylinders only)	Used to drive air tools and fill air bags.
2	High pressure lifting air bag (min. 20t) with regulators, hoses and controls to run 2 bags	Lifting, spreading and sealing.
1	Electric reciprocating saw (mains or battery)	Used to cut glass and metal.
1	Drill, Grinder (air and electric)	Boring holes and cutting smaller material.
2 set	Power extension leads (20m)	Used to extend electrical supply to tools.
1	Torch	Lighting in difficult areas.
2 set	Lighting	Flood, spot, bank used for scene lighting and searching.
1	Generator (petrol, diesel)	Used for running electrical tools and lights.
1	Hydraulic Pump, (petrol/electric)	Used to drive hydraulic tools.
1	Spreader	Can be used to relocate metal by spreading and crushing.
1	Cutter	Used to cut components to make space or to make relief cuts.
1	Ram	Used to push components to make space.
1	Combination Tool	Used as a single tool for cutting, crushing and spreading.
1	Hydraulic hose	Carries hydraulic fluid from the pump to the tool and return under high pressure.
1	Chainsaw/Cut quick. (petrol, electric & hydraulic)	Used to cut wood, concrete and metals.
1 each	Debris sheet for tool staging and debris	Shelter and sharps covering, tool dumps and scene preservation.

Quantity:	Tools & Types:	Application:
2	Salvage sheet/large tarpaulin 4m x 4m (approx)	Can be used to cover the vehicle from the elements and in case of deceased persons.
1 set	Casualty protection, various sizes, hard	Protecting casualties and rescuers from proximity of rescue tools and vehicle sharps.
1 set	Casualty protection, various sizes, flexible	Protecting casualties and rescuers from proximity of rescue tools and vehicle sharps.
1 set	Casualty protection, various sizes, soft	Protecting casualties and rescuers from proximity of rescue tools and vehicle sharps.
1	Rescue board – full length (e.g. plastic / fibreglass)	Used to control adult casualty movement and alignment when removing from vehicle.
1	Rescue board – half length (e.g. plastic / fibreglass)	Used to control adolescent casualty movement and alignment when removing from vehicle.
1	Cervical collars (multi fit or full set of sizes)	Maintains spinal alignment in the neck.
1 pair	Ear muffs for casualty hearing protection	Assists with casualty care when operating noisy equipment.
1	Space/emergency blankets, casualty care only (not wool or cotton)	Casualty care and protection.
	Extrication device (e.g. KED or similar)	Casualty packaging.
	First aid kit	For casualties and rescuers.
1	Oxygen therapy equipment	For casualty.
1 pair	Safety glasses for casualty protection	Assists with casualty care and eye protection.
1	Stretcher	For removal of casualty.
4 each	Edge protection soft – protective cover 260 x 300mm and 600 x 600mm	Protects the casualty from the hydraulic tools and flying metal or plastics.

Quantity:	Tools & Types:	Application:
2	Edge protection soft – protective blanket 1500 x 600mm (approx)	Protects the casualty from the hydraulic tools and flying metal or plastics.
4 each	Edge protection rigid - PVC pipe 150mm diameter x 400mm and 100mm diameter x 400mm	Covers the sharp or jagged cut metal from the casualty and rescuers.
1	Glass catcher 1m diameter (approx)	Catches glass and prevents it from falling into the vehicle and onto the road surface.
1	Extinguisher Foam, 9 litre	Foam is used as a smothering and cooling agent for extinguishing Class B fires.
1	Extinguisher Dry Chemical 9kg	Dry Chemical is used as a smothering agent for extinguishing Class B fires.
1	Socket set	Undoing bolts and nuts.
1	Spanner set	Undoing bolts and nuts.
1	Screwdriver set	Used for unscrewing screws.
1	Rubber mallet	Can be used to tap in wedges
1	Pliers	Can be used to hold small objects.
1	Side cutters	Can be used to cut wires.
1	Vice grips	Can securely clamp and hold objects.
1	Seat belt cutter	Cuts seat belt webbing.
1	Windscreen removal tool	Cuts the “H” rubber and bonding behind windscreens.
1	Glass cutting saw (hand operated)	Cuts the laminated glass.
1	Hacksaw	Cuts material objects related to the blade type.
1	Yard Tools. Broom and Shovel, wide mouth, long handled	Debris removal.

Quantity:	Tools & Types:	Application:
1	Bolt cutters – 3ft	Cutting metals and cables.
1	Axe conventional, pry and fire	Cutting and prying of wood or metal.
1	Crow bar (2m)	Can be used to make a gap and pry objects apart.
1	Hooligan tool with cutting tip	Can be used to make a gap and cut the panel steel.
1	Glass breaking tool (e.g. spring loaded Punch)	Breaks tempered glass.
1	Wrecking bar	Can be used to pry and move objects and used in the Holton Foot.
1	Step ladder 1800mm	Embankments, ramps, high vehicles and vehicles on sides.
4	Ropes (12mm X 6m)	Securing and lashing.
1 pack	Spill absorbent material	Cleans up spilt fluids.
1 each	Chains, Steel Wire Rope and Shackles	Anchoring, lifting, hauling and stabilising.
	Winch (power and manual)	Holding and Stabilising.
1	Duct tape	Can be wrapped around sharps as well as assist in holding glass in its original form.

CHAPTER 3
RESPONSE

3.1 Introduction

As with all emergency service operations, the response procedure to be followed should be defined, so the team has clear guidelines in which to operate.

3.2 Response

There are three sequential steps in the response:

a. Receipt of the call

b. Travelling to the scene

c. Arrival at the scene

3.3 Receipt of the call

3.3.1 Initial advice

At the time of making the call, an informant may be in a distressed and / or agitated condition. Considerable self-control, on behalf of the receiver of the information, may be required to gain as much information as possible regarding the incident.

3.3.2 Exact location

The exact location is the most important initial piece of information required and should be confirmed clearly with the caller.

a. Confirm Location:

   i.) Suburb or Town or Premise

   ii.) Street / Road name, including number

b. Clarify location:

   i.) Ask for cross street names; if unknown ask for details of any landmarks;

   ii.) Ask for direction of travel if on road, e.g. freeway / highway

   iii.) In / out bound, north / east / south / west bound

   iv.) Exits / entrances

   v.) Can the responding vehicle approach from either direction?

c. Verify location details.

3.3.3 Number of persons injured

The number of persons involved should be clarified and then the number of persons injured be established. This will give the team an idea of the resources required for initial response

3.3.4 Position of injured persons

If a person is in the vehicle and injured, they are to be considered and treated as being trapped in the vehicle until they are no longer in the vehicle or emergency services arrive on scene and

determine otherwise. This is to cover issues where a person may be positionally trapped seated in the vehicle but not physically pinned.

The decision of whether a person is trapped in the vehicle should always be one decided by ambulance officers or rescuers. A caller should not be asked a question if a person is trapped as the interpretation by these people will differ from person to person.

3.3.5 Type of vehicles involved

This information is required to determine the resources needed.

3.3.6 Hazards

The caller should be asked numerous questions to gain sufficient information to identify possible hazards rescuers may be confronted with whilst approaching the scene. Again the interpretation of what is hazardous differs from person to person. Therefore it is imperative that a safety first cautious approach to the scene be undertaken.

3.3.7 Name of informant and contact arrangements

Personal details will be required if information is to be verified or queried. Contact arrangements may be telephone, radio mode, channel and call-sign. Telecommunications authorities can often determine the location of a telephone number without delay.

3.3.8 Informing other services

After gathering the relevant information regarding the incident, the control centre should alert other services, as required by state / territory procedures. Prompt notification is vital to ensure an early dispatch and attendance of the correct response.

3.3.9 Road rescue response information

If a responding organisation has received all the above information prior to the departure of the response team, the team leader can commence assessment whilst en route. Although experience may indicate that there can be difficulty in gaining this detail, the receiver of the call must endeavour to gain all the information. Additional information may be gathered on route to the incident via your dispatch centre. This may be received from other responding agencies and further information from the scene.

3.4 Travelling to the scene

3.4.1 The driver

The driver of the emergency vehicle has a great responsibility, including the safety of the crew, vehicle, equipment, pedestrians, and other road users. The driver must also possess detailed knowledge of the state or territory legislation applicable to the driving of emergency vehicles, and any limitations of the legislation as enforced by their organisation as part of standard operating procedures (SOPs).

CAUTION

Audio and visual warning devices are only aids to emergency driving and do not guarantee right of way. Safety must be a paramount consideration.

3.4.2 Factors affecting travel to the scene

These include:

- traffic volume
- weather conditions
- detours

- road conditions, and
- access to the incident scene.

3.4.3 Traffic volume

Higher traffic volumes are expected in and around business areas of a town or city. Alternate routes to bypass the slower commercial traffic may be required. The time of the day will define the peaks in the traffic volume. Social and sporting events, school hours etc may also create artificial peaks in traffic volume.

3.4.4 Weather conditions

Inclement weather conditions i.e. rain, fog, hail, ice, will reduce driving speed and increase response times.

3.4.5 Detours

Traffic can be seriously slowed by road / building constructions, repairs to public utilities, floods etc. Detour and lane restrictions can last for varying times from a few hours to several weeks. Rescuers should maintain sufficient local knowledge of issues which may delay response times and prepare appropriate alternative arrangements where applicable.

3.4.6 Road conditions

Road conditions should be constantly monitored to evaluate the effect that changing conditions will have on response time. Information such as traffic trouble spots, schools, railway crossings, shopping complexes, detours and lane restrictions should be noted on a regular basis and teams informed of any change.

3.5 Arrival at the scene

3.5.1 Access

The incident scene may prevent access from a certain direction e.g. wind blowing hazardous materials, vehicles blocking road etc.

3.5.2 Initial actions

Incidents need to be approached cautiously, and with careful observation of the entire scene. Potential hazards need to be identified as early as possible. Rescuers must be aware of ‘tunnel vision’ that may cause them to focus on limited problems and not the overall situation. As a rescue team is arriving on the scene, three activities must be conducted. They are:

a. Approaching the incident

b. Arrival / positioning rescue vehicle (fend off position), and

c. Appreciation - Situation Report (SITREP).

3.5.3 Approaching the incident

As the vehicle approaches a distance at which the general area can be seen, sirens should be switched off, and a mental note made of any feature in the general area which may relate to the rescue operation such as:

- downed powerlines
- spilt fuel
- HAZMAT situation

- unstable vehicle
- casualties on roadway, and
- incident debris.

3.5.4 Arrival

By the time the vehicle comes to a stop, its team should, in the majority of cases, have already completed the initial assessment of the scene. The team leader should have noted the hazards, the most seriously damaged vehicle, whether or not the vehicles are occupied, and the location of the injured persons. All occupants of all vehicles involved in the incident need to be accounted for.

It is imperative this information be discussed between the team before exiting the vehicle to ensure all members are aware of identified hazards and the plan of approach.

3.5.5 Concealed casualties

Any other feature which may conceal a casualty should also be observed e.g.

- long grass and bushes / trees
- holes
- large diameter pipes
- embankments / cuttings, or
- gullies / drains.

At the first available opportunity, a member of the team should search those areas likely of concealment.

3.5.6 Positioning vehicles

Factors to be considered when positioning vehicles include:

a. topography of the surrounding area, including bends in the road, crests, etc

b. positioning the vehicle, in suspected or confirmed HAZMAT incidents safely upwind and uphill at a distance as specified by state / territory SOPs for HAZMAT incidents

c. placing a vehicle in the 'fend off' position to provide protection to team members and casualties (Figure 3:1)

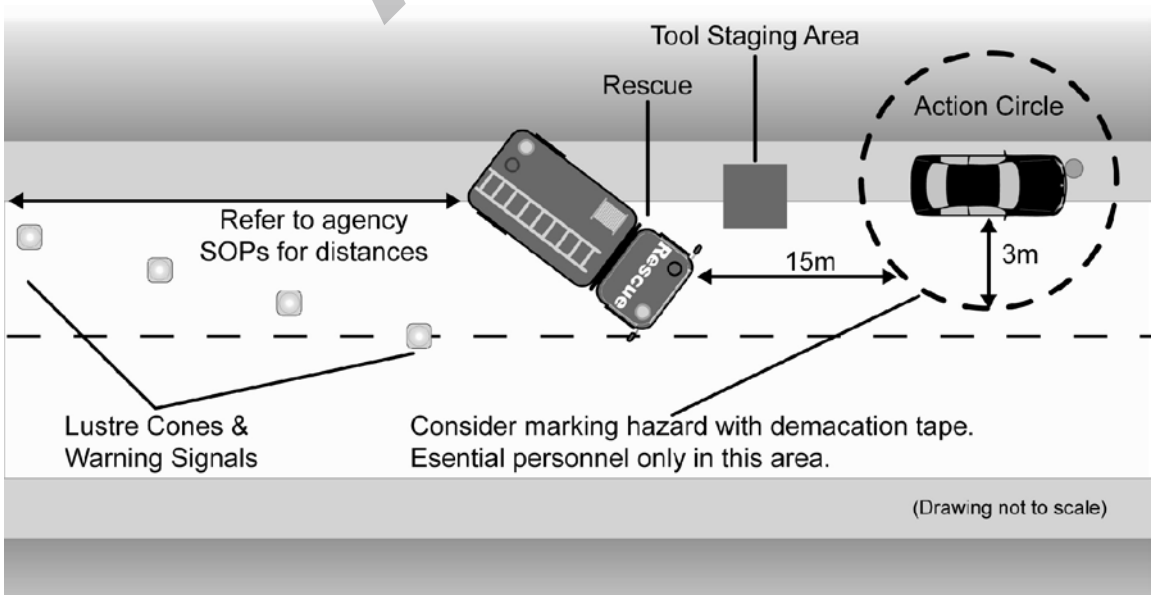

Figure 3:1
Fend Off Position

d. access and egress of other essential services; i.e. maintenance of traffic flow

e. preservation of evidence, and

f. limitations placed by fixed equipment on the vehicle e.g. lighting, hydraulic hose lines, etc.

If the vehicle is located some distance from the incident, it is desirable that the assessing member of the team be equipped with portable two way communications to ensure efficient deployment of resources and transfer of information.

Following the positioning of the primary rescue, fire and ambulance resources all other emergency vehicles in attendance at the incident should be positioned sufficient distance from the scene to ensure the scene is not congested with vehicles and necessary egress for ambulance resources. A recommended distance is a minimum of 50 metres from the scene of all support vehicles.

3.5.7 Situation report (SITREP)

With the preliminary assessment completed, a SITREP should be passed to the control centre. This information enables the control centre to advise, or place on standby, additional resources or other emergency services as outlined in SOPs. SITREPS should be upgraded as required as the operation proceeds.

CHAPTER 4
INCIDENT MANAGEMENT

4.1 Introduction

This Chapter is designed to explain the actions required of a Road Rescue Team Leader from the time of leaving the vehicle to the commencement of the process of gaining access to casualties.

The actions taken during this time are:

a. liaison with other services present and carry out initial on scene assessment

b. establish an Outer Circle (Warm Zone) to define the extended area where casualties who are no longer in the vehicle may be located and will also act to define the support and control working area (*)

c. establish an Inner Circle (Hot Zone) around the immediate location of the vehicle that is to be searched for casualties and will also serve to define the rescue / extrication working area (*)

d. arrange Hazard Control measures as necessary (*)

e. arrange Support Functions as required (*), and

f. establish a Resource (equipment / personnel) Staging Area.

NOTE

The items marked with (*) may occur in any order or simultaneously

4.2 Assessment

Responding rescue team leaders need to have a method of assessment. The following factors should to be considered. Addressing these factors enables the team leader to make a valued assessment on decisions to be made.

a. **Facts**—A limited number of facts will be known from pre-planning material, SOPs, information gathered on receipt of a call and on arrival at the scene, e.g. rescue team's standard response, time of day, type of incident and numbers of vehicles involved.

b. **Probabilities**—There will be a number of events that probably have occurred. These include people being trapped or injured, traffic and non-traffic hazards, and other services responding.

c. **Possibilities**—At any rescue there will be a considerable range of events which may occur, e.g. changes to weather, fire, loss of responding personnel at the scene owing to injury or other duties.

d. **Resources**—When making an assessment, the number of personnel and amount of equipment from all sources required to perform the task, should be noted.

4.3 Establishing liaison

Close liaison is necessary between all attending services and the combined use of personnel and equipment may be required to safely and efficiently complete the task. Each of the services has authority to perform specific tasks at an incident. Although such lines of authority are clear, there will be times when some of the responsibilities overlap. Close liaison will ensure all tasks are carried out smoothly.

4.4 Command & control

At Road Rescue incidents, consideration should be given to the establishment of a designated area for the purpose of command / control functions where attending agencies can liaise.

NOTE

The implementation of specific on-scene command / control systems should meet agency / state / territory requirements..

4.5 Initial on-scene assessment

The initial on-scene assessment is undertaken utilising a systematic 360 degree appraisal of the incident whilst gathering information by using all your senses to establish an overview of the scene. The 360 degree appraisal involves the team leader (and other rescuers) initially walking around the perimeter of the Outer Circle (Warm Zone), and then working in towards the vehicle to establish the Inner Circle (Hot Zone).

4.6 Outer-circle (warm zone) assessment

To complete the assessment, rescuers must search an outer-circle area, looking for additional injured persons and / or hazards. This can be made simultaneously with the inner circle assessment or when other rescue personnel become available. A distance of up to 30 metres (this may vary with the type of incident) from the vehicle(s) may be required. This assessment must take place before any physical action is taken by the team as a whole i.e.

a. smelling for fuel vapours;

b. listening for information from casualties and witnesses, and

c. looking for visible hazards.

NOTE

If practicable, witnesses or persons involved in the accident should be questioned to assist in determining the total number of people involved..

4.7 Inner-circle (hot zone) assessment

To accurately assess the incident scene, rescuers must search around the vehicle(s) at a distance of up to 5 metres (this may vary with the type of incident). This involves looking in, under, above and around the vehicle to determine numbers of casualties, types of injuries, types of entrapment, hazards involved, access and other potential problems relating to the incident.

The Inner-circle (Hot zone) should be kept clear of all vehicles, excess personnel, tools and debris.

CAUTION

Vehicles should not be touched until the possibility of electrocution (e.g. downed powerlines, Hybrid vehicles, traffic light installations etc) and other hazards have been eliminated.

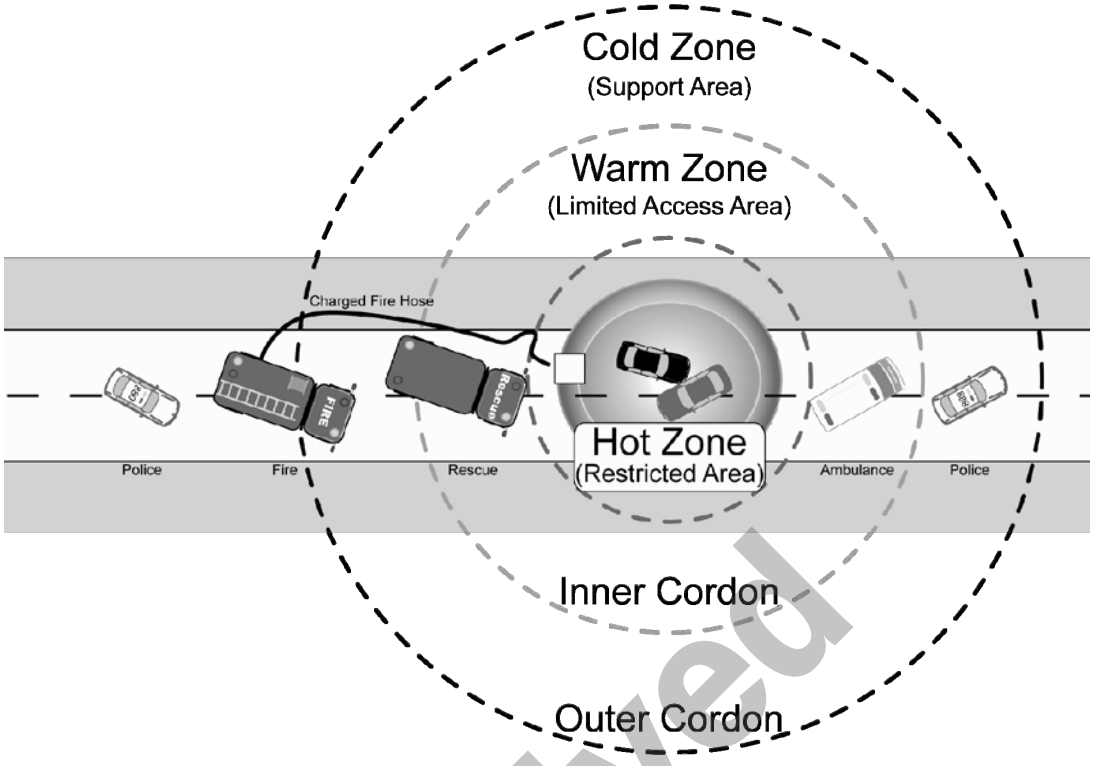

Figure 4:1
Control Zone Circles

4.8 Search phases

Systematic Search Phases should be used at Road Rescue incidents and include a 'Primary Search' and a 'Secondary Search' of all compartments of vehicles involved in the incident, the Inner Circle (Hot Zone) and Outer Circle (Warm Zone).

4.9 Primary search phase

The purpose of the 'Primary Search' is to locate all casualties at the incident scene. If during the Primary Search, casualties who are believed to have been in a vehicle are unaccounted for, then an extended search of the environment surrounding the Outer Circle (Warm Zone) should be made.

Casualties may have been thrown clear, disorientated or wandered away. Additional rescuers may be required to conduct extended searches to minimise the disruption to the extrication of known, entrapped casualties.

4.10 Secondary search phase

When the extrication of all known live casualties has been completed a 'Secondary Search' should commence.

The purpose of the Secondary Search is to ensure no casualties at the Road Rescue incident remain undetected. The Secondary Search should consist of a comprehensive review of the vehicles involved and the surrounding incident scene.

Essential components of all searches should include:

a. Measures to investigate collapsed spaces in motor vehicles and all areas including luggage storage

b. Taking into account any evidence of additional personal articles and clothing, baby capsules and other indications of the likelihood of the presence of other casualties in the vehicle, and

c. A search of the surrounding environment for a missing casualty who may be outside of the Outer Circle (Warm Zone).

The covering of a vehicle, or any area of a vehicle covered with a tarpaulin or similar, should never be taken as an indication that a 'Primary and / or Secondary Search' has been completed.

The importance of continuing the assessment process prior to each individual task and throughout the entire incident cannot be over-emphasised.

4.11 Resource (equipment / personnel) staging area

This area is set up by marking with tape or laying a groundsheet, upon which equipment needed can be placed or located. This area should be adjacent to but outside the perimeter of the 'Inner Circle (hot zone)'.

Rescuers who have not been tasked, or have completed work should stand in an area adjacent to the equipment staging area. This keeps the inner circle (hot zone) clear and indicates to the rescue team leader the personnel available for tasking.

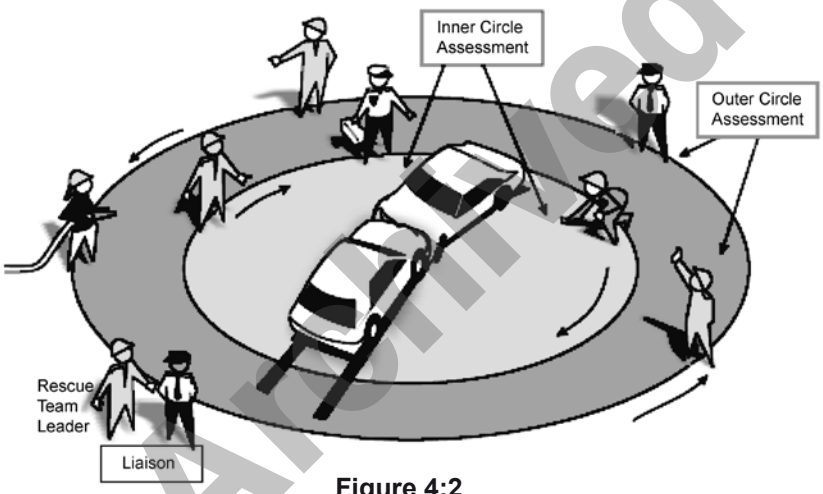

Figure 4:2
Inner / Outer Circle Assessments

4.12 Situation reports

Once the assessments have been completed, a situation report (SITREP) should be sent to the rescue team's control centre. This enables the team leader to state the current situation for recording, and make any requests for assistance or statements of guidance to other responding personnel.

The type of information which could be passed in a SITREP includes:

- scene location and details, e.g. numbers and types of vehicles and casualties
- hazards present
- action being taken
- support functions required, e.g. equipment / personnel, specialised services
- estimated time of task engagement, and
- specific problems, e.g. difficult access, removal or transfer.

Further situation reports should be sent on a regular basis, the frequency of the reporting interval will depend on the team's response requirement.

4.13 Hazard control

4.13.1 Evaluating and managing hazards

Emergency services personnel can be confronted with many hazards when attending Road Rescue incidents. Throughout the incident hazards must be identified and prioritised so that they can be managed in logical sequence.

4.13.2 Types of hazards

There are a variety of hazards which need to be considered by rescuers:

a. Traffic

Road Rescue Incidents will usually cause some form of traffic flow problem. Of the utmost importance is the protection of the incident scene from passing traffic (including the responding services personnel and vehicles). In the first instance consideration should be given to blocking the road with first attending emergency vehicle. This is the safest option until the scene has been assessed and the relevant authority responsible for traffic control arrives at the scene.

Positioning the rescue vehicle in the 'fend off' position generally provides initial scene protection. If further protective measures are required, then lane control or detours or may need to be established.

This is maintained as follows:

i.) Placement of Warning Devices—At Road Rescue incidents, traffic cones, flashing lights, signs and other similar warning devices are used to alert on-coming traffic. Warning devices should be placed so that on-coming traffic will be able to clearly identify them, and be able to react with a margin of safety. Factors that should be considered include:

- road topography
- posted speed limits
- required stopping distances for vehicles
- traffic volume, and
- weather conditions.

Per Australian Standards it is designated a Minimum distance for the placement of the farthest warning device from the incident scene is 2 times the posted speed limit in metres. The spacing of warning devices will differ according to the circumstances and organisations standard operating procedures.

Approaching traffic should be afforded the best practicable warning of the incident ahead. Refer to relevant traffic control manuals for your organisation.

Traffic control measures must be placed an adequate distance from each side of the scene to ensure the traffic flow is taking the required path and at a suitable speed past the incident.

b. Vehicle Instability

All vehicles need to be stabilised prior to rescue operations. Vehicles may be on their wheels, side or roof or on sloping terrain which may present a danger to the entrapped person(s) and the rescuer. Failure to ensure a stable working platform can result in further injury to the casualty, especially when spinal or severe injuries have been inflicted in the initial accident.

c. Fire

The potential of fire at Road Rescue incidents is always present when fuel leakages occur. Adequate measures must be taken to ensure fire protection is present at all times. A charged, manned hose line from a fire appliance or suitable fire extinguishers should be on hand ready to use.

d. Batteries

Electrical hazard - may be caused by a battery being left connected. Arcing of wiring may cause ignition of fuel and other combustible materials. Disconnecting the battery should minimise this risk.

Electrolyte hazard – may be caused by damage to the battery or position of the vehicle. Various forms or acids or gels may be found in modern vehicle batteries. Treatment options will vary with the hazard identified.

NOTE

Prior to disconnecting the battery effort should be made to turn the ignition off and reduce the current draw from the battery. Use of water spray when disconnecting the battery minimises the chance of ignition of flammable materials from electrical arcing.

REMEMBER

The vehicle battery may be required to power electrical systems (e.g. central locking devices, electric seats and windows).

e. Fuels

Where gas or liquid fuel spillages have occurred, dispersing, neutralising with an agent, or covering should be accomplished as soon as possible. Flushing flammable fuels with water will not completely eliminate the risk of ignition and may compound the problem when allowed to flow into drains etc. Ruptured fuel lines can be crimped to stop further leaks and holed fuel tanks may be plugged

REMEMBER

Do not use any plugging method which may cause sparks.

NOTE

Rescue personnel must be aware of the various types of valves and pipe systems to be able to render safe Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG) powered vehicles.

f. Vehicle Safety Systems

Vehicle safety systems designed to prevent and minimise injury to occupants present many inherent dangers to rescuers. A detailed knowledge of the systems should be attained by all rescuers. Refer to Vehicle Safety Systems Chapter 8.

g. Electricity

Downed powerlines are a common occurrence when vehicles collide with electrical installations. All persons should be kept clear until the electrical source has been isolated. Persons still in vehicles which are in contact with live powerlines must be warned to stay in the vehicle and not to touch any part of the metal body. Reassure the casualty from a safe distance and notify the local power authority to disconnect the supply immediately. Treat all electrical conductors as live.

h. Communicable diseases

Rescue personnel who may come in contact with body fluids and tissue must be aware of the possibility of contracting an infectious disease. The wearing of protective clothing, goggles / glasses, masks and rubber surgical gloves under normal rescue gloves will give the rescuer protection. (refer to chapter 6 annex c, for details).

i. Hazardous Materials (HAZMAT)

i.) Many hazardous materials are transported by road. Some of these include:

- explosives;
- poisons;
- radioactive materials;
- infectious substances;
- unstable (reactive) chemicals; and
- cryogenic liquids / gases.
- HAZMAT Responses:

When these materials are accidentally released or exposed to fire, fluids or soil that results from an incident, they may severely endanger the lives and health of road users, occupants of nearby buildings and emergency services personnel that respond to the scene. In some cases a release into, or exposure to, the atmosphere may have similar effects.

Fire services are equipped to handle hazardous materials and must be notified as soon as possible.

Identification of a hazardous material without protective clothing and breathing apparatus should not be attempted. If there is an urgent need, identification must be made from a safe distance upwind and uphill of the incident. No contact should be made with the material. Evacuation of the area should be considered.

4.14 Support functions

Support can best be described as the services or functions which may be carried out in conjunction with and as support to the primary function, e.g. the lifting of a heavy object to enable rescuers to gain access to casualties.

The decision as to who will provide specific forms of support to meet each function is established by emergency plans and systems OR determined by liaison on site.

At a Road Rescue incident the primary activity is usually an extrication effort, and many of the rescue team members will be busy with this activity. Other team members / services may have to support the extrication by providing other support functions.

Determining what support activities are required at the scene is an extension of the rescue team leader's assessment and must cover what, where and when support is required and who will provide it. The request should be made through the appropriate authority.

4.15 Considerations

Some considerations for support are:

- Personnel—When confronted with a Road Rescue incident that requires long term operations or an extended effort, extra rescuers and relief personnel may be necessary.
- Fire / HAZMAT Protection—Requests for fire appliances should be made according to the needs—different situations may require different equipment, some of which may be available from other organisations.
- Scene Security—Consideration should be given to placing a barrier of some kind, e.g. rope or tape around the scene to keep bystanders at a distance from the scene. Location of personal property must be recorded and brought to the attention of the police.

- Utilities—Water, electricity and gas supply authorities may be required to attend an incident to deal with their own facilities. Their vehicles also carry a wide range of equipment which can be used to assist in rescue tasks.
- Communications—If a large number of personnel / organisations are on the scene, or the incident is in a remote location, adequate links and facilities should be considered, such as mobile telephones and other organisations' equipment.
- Medical—Rescuers may have to consider that further medical support may attend the incident for the purposes of treating casualties and providing standby treatment for rescuers. This may vary depending on the incident and may consist of aircraft or triage teams.
- Heavy Lifting / Haulage Gear—For transportation incidents that involve trucks, buses or trains, specialist lifting equipment can be useful and may be available from local authorities, statutory organisations, suppliers and passing traffic.
- Technical support—for incidents of a technical nature such as vehicle construction, loads and systems.
- Transport—Transport such as buses, helicopters, and boats may be available as additional resources to assist with transport of personnel and resources to and from the incident.
- Stock Control—Stock-carrying vehicles involved in a Road Rescue incident may present rescue teams with problems such as injured animals or stock roaming near the scene. Assistance may be required to move animals from the scene.
- Welfare agencies—
    i.) Casualties—Welfare Agencies may be required to take care of displaced persons, upset or grieving relatives.
    ii.) Rescuers—Critical Incident Stress debriefing teams may be required to attend to the needs of responding emergency services personnel. (Refer Chapter 9).
    iii.) Catering—Catering arrangements should be considered to provide sustenance to staff.
- Information / Media—The media may be called to assist in advising the public of necessary evacuation warnings or alternate routes to be followed.

CHAPTER 5
STABILISATION

5.1 Introduction

In many incidents vehicles come to rest in the most precarious positions. Often the slightest movement can unexpectedly place the vehicle and its occupants in extreme danger. To minimise the chance of further danger, the vehicle needs to be stabilised as quickly and as firmly as possible. Stabilisation provides a stable work platform for rescuers and prevents further injury to the casualty by preventing movement of the vehicle.

5.1.1 Process

When applying stabilisation there are two phases that may be used. The phases are:

- Primary Stabilisation
- Secondary Stabilisation

Depending on the characteristics of the crash and resultant position of the vehicle(s) it may be appropriate to apply both primary and secondary stabilisation at the same time.

a. Primary Stabilisation

Primary stabilisation is the initial stabilisation placed to allow access to the casualty(s) by the paramedic. The aim is to eliminate or minimise vehicle movement caused by the entering and movement of the paramedic.

Care should be taken to put in place primary stabilisation that will form a part of the secondary stabilisation as removing and relocating the stabilisation may cause or require further vehicle movement.

b. Secondary Stabilisation

Secondary stabilisation is the completion of stabilisation to allow the extrication of the casualties from the entanglement. The aim is to eliminate or minimise vehicle movement caused by the movement of the paramedic and any extrication techniques required to remove the casualties.

5.1.2 Types of movement to prevent

There are two types of movement to prevent:

a. Lateral movement is movement on a horizontal or sloped plane. A vehicle may roll on its wheels, or slide on its wheels or body panel due to the slope.

Figure 5:1
Horizontal vehicle movements

b. Vertical movement is the movement up and down on the suspension. A vehicle may roll or dip as people step into or out of it.

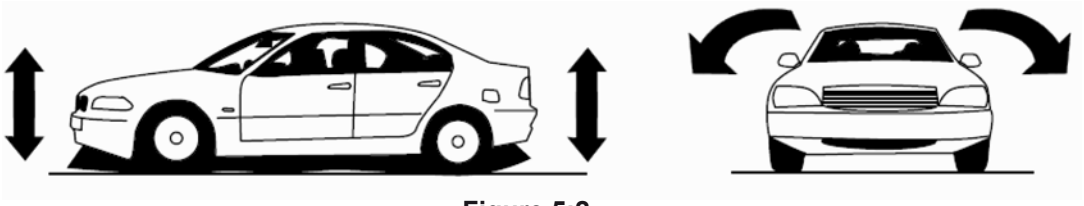

Figure 5:2
Vertical vehicle movements

Stabilisation is completed by:

- Providing additional support at key points between the vehicle and the ground or other solid anchors
- Maximising the area of contact between the vehicle and the ground

Effective stabilisation is done quickly, safely and regularly checked.

You need to be able to identify places on the vehicle to put your stabilisation equipment. Always use the strongest parts of the vehicle, the 'hard points'.

Hard points are usually found at the junction of the A, B or C-pillar with the car body. Hard points should be used for stabilising the vehicle with blocks or wedges. Avoid panels, which are likely to deform and move. If you need to use a panel, spread the load with wide timber blocks.

5.1.3 Stable surfaces and anchors

Stabilisation is the process of applying a force to the vehicle from a stable surface or anchor in order to stop or minimise movement of the vehicle. The stable surface or anchor must be able to support the force applied without sagging for the stabilisation to be effective.

Factors that may influence the ability or capacity of a stable surface or anchor include:

- size (contact area shape, weight)
- condition (age, weathering, deterioration)
- material (concrete, bitumen, rock, grass, gravel, sand, mud)
- moisture content (soggy ground)
- slope (embankment)

Where a stable surface is unlikely to support the expected load:

- distribute the load over a greater area
- use multiple surfaces / stabilisation points, or
- use an anchor system instead

Where an anchor or joining material (rope, strap) is unlikely to support the expected load:

- Use multiple anchors or joiners, or
- use a stable surface instead

5.2 Vehicle on Its Wheels

Vehicle movement in any direction must be prevented.

Lateral movement can be prevented by:

- applying the handbrake, if possible, as this will lock the back wheels (if it's working properly)
- putting the vehicle into low gear (manual) or 'park' (automatic), if possible (will only lock the drive wheels)
- chocking the wheels to ensure the vehicle cannot move forwards or backwards

- if the vehicle is on a severe slope, securing the vehicle to an immovable object by rope, straps or winches e.g. a tree, pickets or another vehicle

Advise Police if you or your team changed any controls.

Vertical movement can be prevented by taking the weight off the suspension at four points, i.e. two on either side of the vehicle, and two front of centre and two rear of centre.

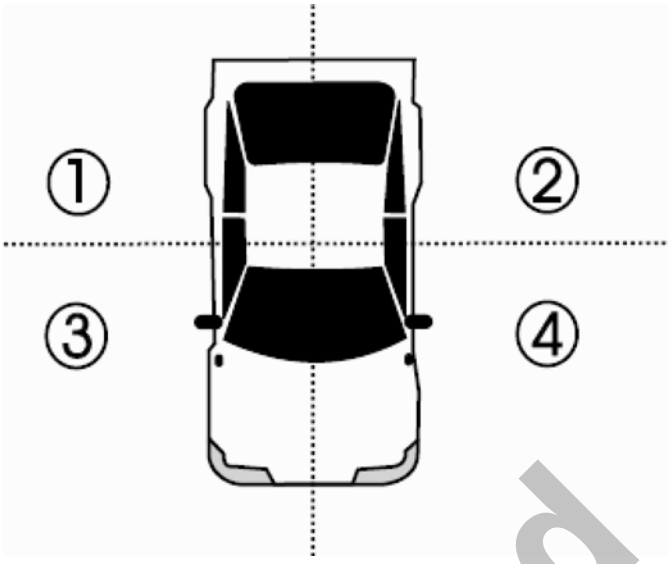

Figure 5:3
Four point stabilisation

Note: Do not block under suspension components. It does little to stop vertical movement.

BEWARE

When positioning blocks or wedges rescuers should not place body parts between the vehicle and the stabilisation.

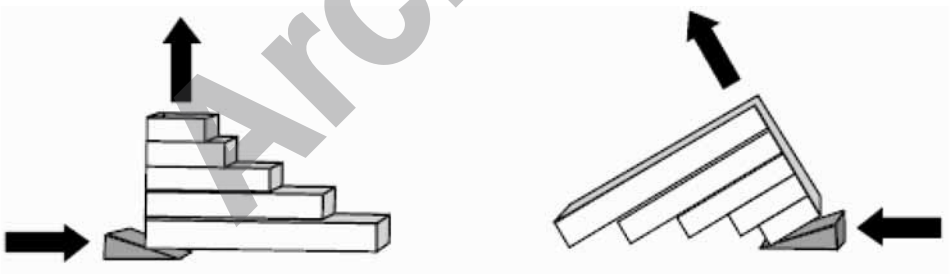

Figure 5:4
Step block methods

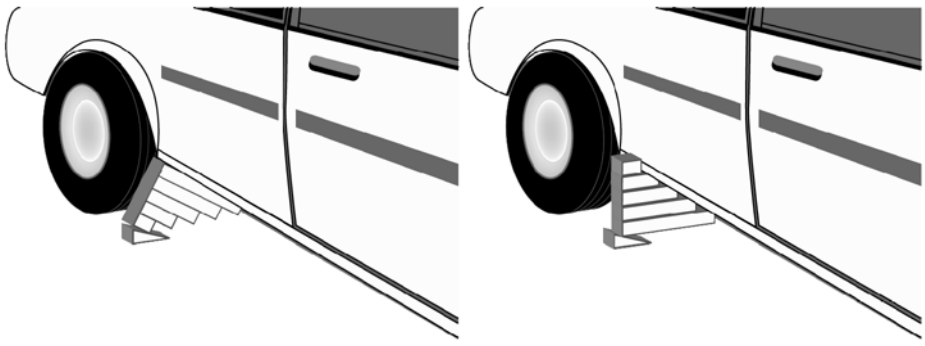

Figure 5:5
Stabilisation in place

The most common method used for vertical stabilisation is the use of step blocks or standard blocks and wedges / shims. Insert the step block and lift the block to the car by using wedges or shims underneath the step block. If you block the vehicle properly, you will have isolated the suspension of the vehicle. This will prevent the body of the vehicle from moving vertically.

Ensure the positioning of the blocks do not prevent access or impede further rescue requirements.

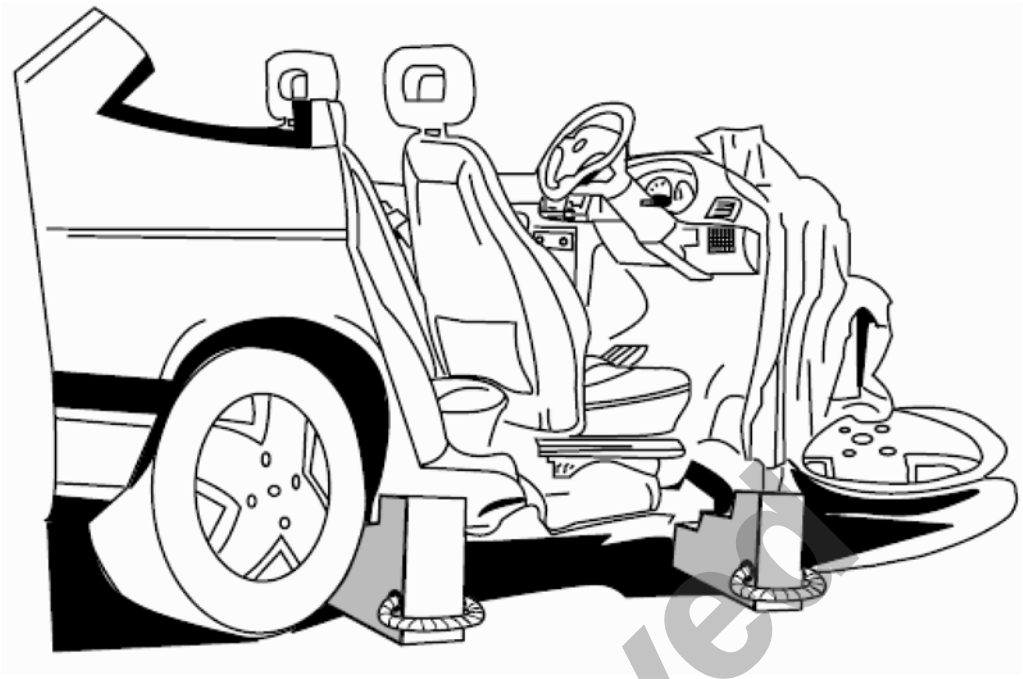

Figure 5:6
Vehicle on wheels

A minimum of three (3) points of stabilisation should be used but four (4) points is recommended.

5.3 Vehicle on its Side

Lateral movement in all directions and vehicle falling onto its roof or wheels must be prevented. Using blocks and wedges can prevent lateral movement along the ground. Chock the vehicle at as many points as practicable.

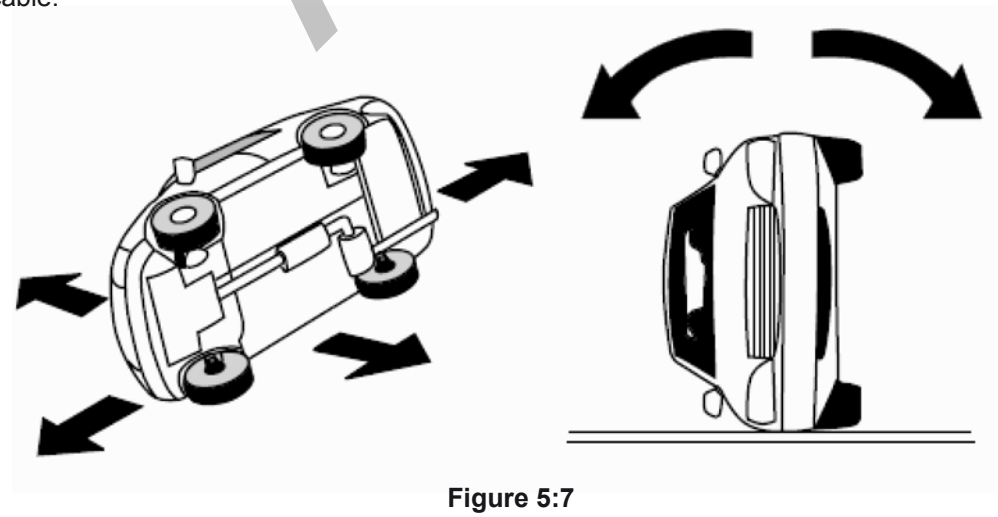

Figure 5:7
Instability – Vehicle on Side

A vehicle may fall on to its roof or back on to its wheels, depending on its position and the slope of the ground. If at all uncertain, treat the vehicle as if it may fall either way and stabilise accordingly. Consider the proposed techniques for extrication. For example, do not place wedges and blocks under the roof section if it is to be folded down.

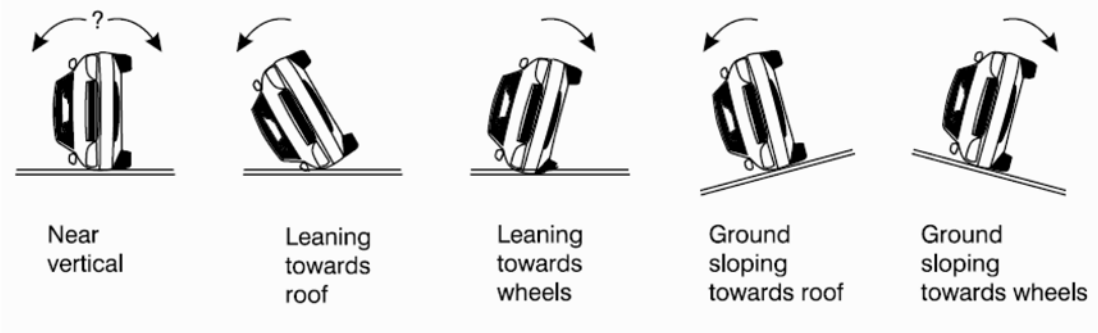

Figure 5:8
Vehicle Instability – On Side

Avoid the topside of the vehicle, if at all possible. Anything placed on top of the vehicle increases the height of the centre of gravity, reducing stability.

Never attempt to test stability as you may tip the vehicle over.

5.4 Stabilising a Vehicle on its Side and Leaning Towards its Wheels

As soon as possible, place a picket in the ground and an Acrow Prop (or equivalent equipment) between it and the top third of the vehicle (against a chassis rail or similar). Secure the prop foot with two tie-down straps back to the lower third of the vehicle.

Drive in another picket (or use a nearby solid object, e.g. a rescue truck or similar) about 3 - 4 metres away. Secure two tie-down straps to the vehicle on the top third (spring hangers, towing points or similar are ideal) and secure back to the picket.

When all systems are in place the strap on the prop base is tightened (being careful not to over tighten and force to car to move). The longer straps are then tightened to hold the car firmly against the prop.

Blocks and wedges are placed on the other side of the vehicle.

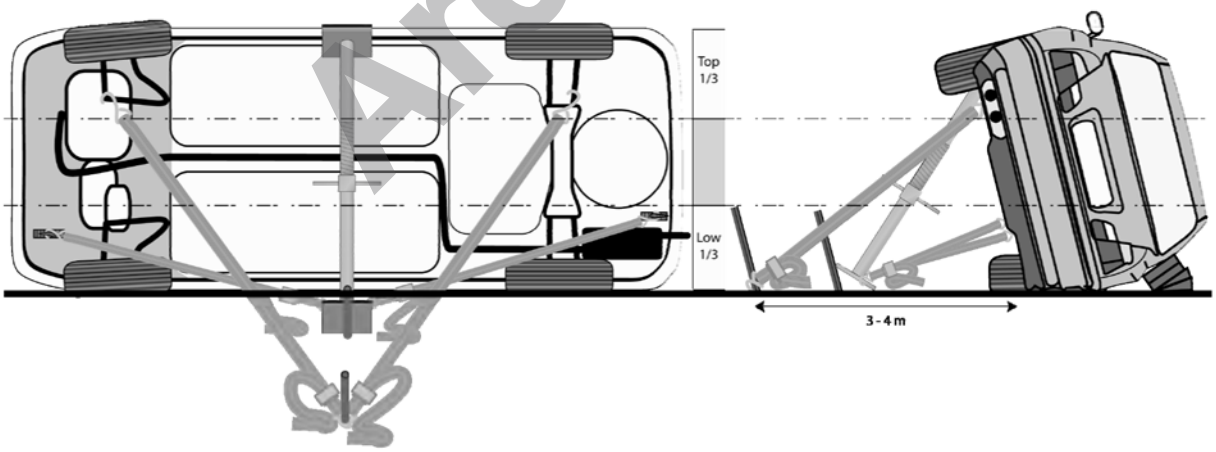

Figure 5:9
Side stabilisation

Alternatively use a stabilising system (E.g. Holton Foot) in accordance with the manufacturer's or organisational procedures.

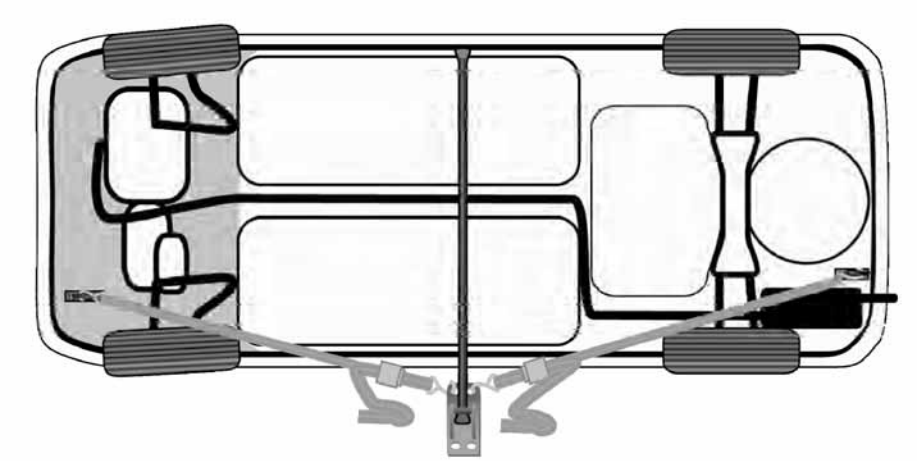

Figure 5:10
Holton Foot

5.5 Stabilising a Vehicle on its Side and Leaning Towards its Roof

As soon as possible place blocks and wedges / shims along the down-facing side of the vehicle. Insert all blocks and wedges / shims from the safe points at the front and rear of the vehicle. Never approach or insert blocks and wedges / shims from directly in front of the roof area.

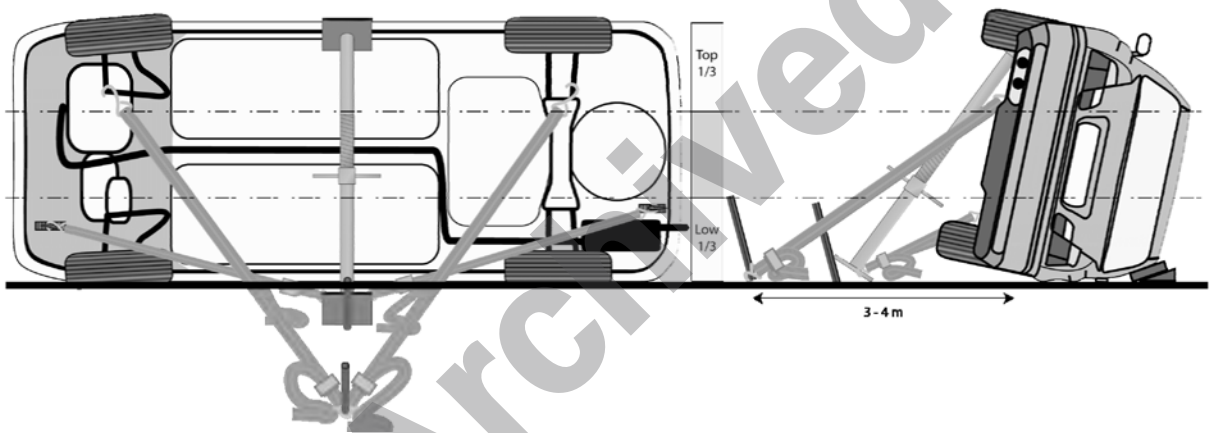

Figure 5:11
Side leaning stabilisation

The vehicle should be secured back to an immovable object or picket using tie-down straps, 'Come-along' or Tirfor winch. Ideally a bar or Acrow Prop should be inserted on the underside of the vehicle. The tie-down straps or winch will hold the vehicle firmly against the prop.

THINK SAFETY
Always work from the ends of the vehicle.

5.6 Stabilising a Vehicle on Its Roof

Generally, an overturned vehicle will come to rest nose down because of the weight of the engine.

Lateral movement in all directions must be prevented by:

- Blocks and wedges to chock the roof area
- Tying off vehicle to a solid object

A vehicle roof is relatively smooth. It can slide easily on a slope, particularly wet or damp grass. Vertical movement can occur from rocking the bonnet area or boot area. It is essential to prevent the roof from crushing any further. Supporting, both the front and rear ends can prevent vertical movement.

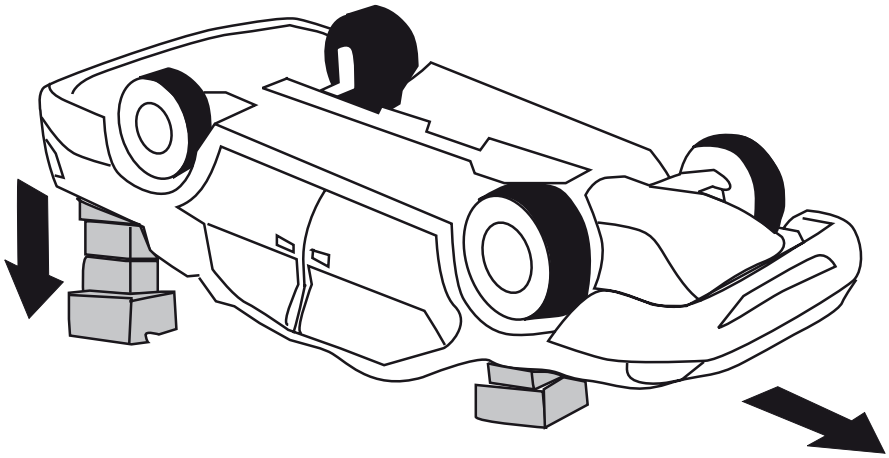

Figure 5:12
On-Roof Stabilisation

5.7 Under-ride position

If the vehicle has collided with a large truck or other type of heavy vehicle, the truck may have ridden up and come to rest on top of the smaller vehicle. This puts the smaller vehicle in an under-ride position.

Figure 5:13
Under-Ride Position.

In this type of crash you should:

- prevent any further movement of the top vehicle
- take as much pressure as possible off the bottom vehicle by cribbing the top vehicle

5.8 Stabilising Large Vehicles

Large vehicles demand extra consideration because of their increased size and weight. Equipment and techniques suitable for stabilising cars may not be suitable for stabilising large vehicles.

WARNING
Equipment load limits should not be exceeded.

Selection of surfaces for stabilising becomes more important as increased size may mean greater distance between ‘hard points’. Increased weight requires greater strength from the stabilising surface, stabilising mechanism and vehicle structure or spreading of the load to avoid movement and sagging.

5.8.1 Large passenger vehicles

Structures are typically large and body panels are made from relatively light materials. ‘Hard points’ are consequently few and far between or hidden behind bodywork.

Multiple stabilisation points are likely to be required.

5.8.2 Cargo vehicles

Cargo vehicles require rescuers to consider their:

- size
- weight
- construction (single unit, prime mover & trailer, multiple trailers, articulated, customised body), and
- the load carried.

WARNING

Where dangerous goods are carried HAZMAT procedures take precedence over road rescue operations.

Stability of the load being carried must be considered. Where the load adversely affects vehicle stability or safety the load should be stabilised.

Figure 5:14

Truck loads with different stabilisation considerations.

Articulated vehicles require two or more vehicle sections to be stabilised.

5.9 Continual Checking

Vehicle stabilisation must be periodically checked throughout the rescue. Stabilisation equipment should be checked for tightness as vehicle components are removed or deformed. Regularly check the wedges and blocks.

Wedges can move, so a designated rescuer should check them regularly by using light, non jarring taps with a rubber mallet or hammer.

Immediately check for movement in stabilisation when a rescuer exits the vehicle or a casualty is removed in a multiple casualty situation. Substantial movement on the suspension can occur at that time.

CHAPTER 6
GAINING ACCESS

6.1 Introduction

Gaining access is the action taken to provide an opening or path large enough for emergency personnel to reach the casualties, provide first aid, provide emotional support and identified rescue needs.

6.2 Provide first aid

At the earliest opportunity, efforts should be made to assess injuries and priorities so that first aid treatment can commence. Treatment of casualties is maintained throughout the entire operation up to the point that hand-over and transportation commences.

NOTE

- All rescuers should wear protection for eyes, hands, feet and body. Additionally, every effort should be made to protect the casualty.
- At no time should casualties be left unattended.
- Gaining access for first aid may be a totally different operation to the disentanglement of the casualty or casualties and their extrication or removal.
- A full length rescue board may be used by first aiders to gain access..

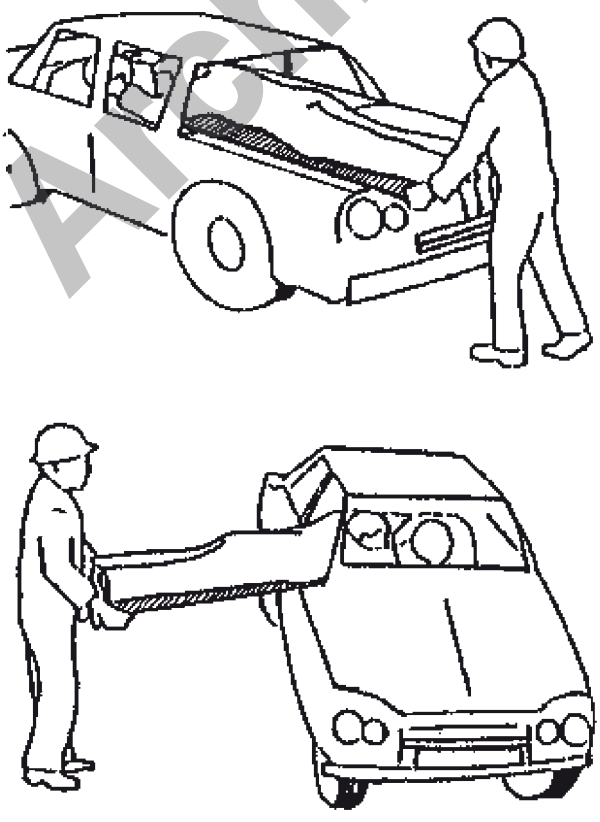

Figure 6:1
Use of a full length rescue board

6.3 Emotional support

Prior to considering the activities involved in gaining access, rescuers need to be aware of the potential for emotional disturbance of casualties when they realise they are trapped. They can become even more disturbed as rescue methods employed to alleviate their situation develop. Panic can result, increasing the difficulties involved in effecting extrication.

6.4 Casualty contact

A person may reject or even physically resist all attempts at assistance. Conversely, they may grasp at their rescuers and fight to pull themselves free. This condition may worsen existing injuries and could also inflict emotional or physical injury to rescuers.

Voice contact on a first name basis should be made as this opens the avenue for communication on a personal level. All communications with the casualty should be positive and reassuring. Note that there will be occasions when a casualty can hear, but will be unable to respond. The casualty must be informed of the progress of the release, including warning of the action / noise of rescue equipment prior to its operation.

Where time permits, an attempt to alleviate discomfort should be made. This may require vehicle sharps or broken glass to be covered with padding or cleared away.

6.5 Door entry

Initially, an attempt should be made to open the doors in the normal manner. All doors need to be checked as one may not be jammed or locked. Similarly, a vehicle occupant may be able to open or unlock the door.

When a door is jammed, it is unlikely that forcing with crowbars and hand tools will be successful until the safety lock is released. If the door is crushed or the vehicle is a late model, it is nearly impossible to force the door open without hydraulic tools. The most powerful and versatile unit for forcing doors is a powered hydraulic rescue spreader. However, its use requires an initial opening to be established. A crowbar or other similar tool between the door and the doorframe (at either the back or the hinged side) is used to make room to insert the tips of the spreader.

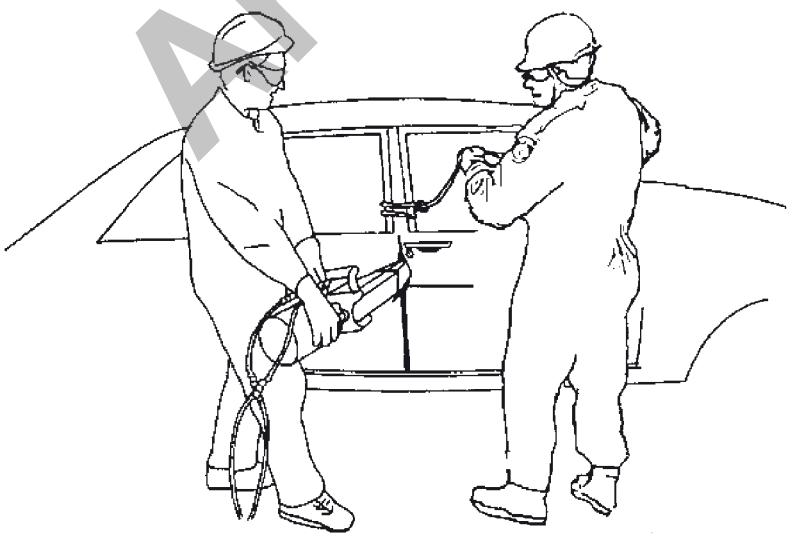

Figure 6:2
Opening Door with Spreader

An alternative method of providing a gap between the door and the pillar is to position a hydraulic tool vertically in the door window. Operation of the tool will force the upper doorframe upward and push the window sill downward so that a sufficiently wide gap is created to allow insertion of the tips at the hinge or lock. One method is to use hydraulic tools in pairs—as one is spread, the other can be repositioned. If only one tool is available, a wooden block can be used to hold the gap open until the tool can be repositioned.

The strongest part of door is within the limits of an imaginary triangle between the hinges and lock mechanism.

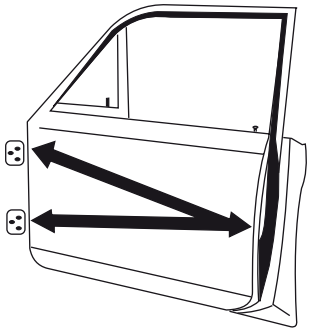

Figure 6:3
Opening Damaged Doors

CAUTION

The use of long large bars can rock the vehicle considerably causing severe discomfort or further injury to persons trapped inside.

When using hydraulic equipment, one rescuer should secure the door being opened using a rope around the pillar. At the same time, the door latch is held open

6.6 Roof entry

When entry is not possible through doors or windows, access through the roof may be required. Depending on access, several options exist for removing a vehicle's roof. Probably the easiest is to cut the 'A' and 'B' pillars, make two cuts in the roof just forward of the 'C' Pillar, and then fold the roof back just forward of the 'C' pillar. Before this is done, the windscreen glass should be removed or broken as described in Chapter 5—'Gaining Access'.

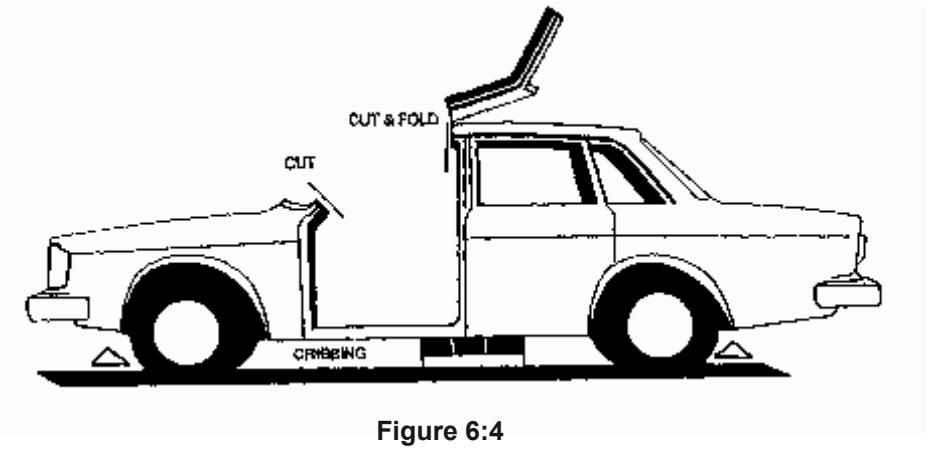

Figure 6:4
Half Roof Hinge

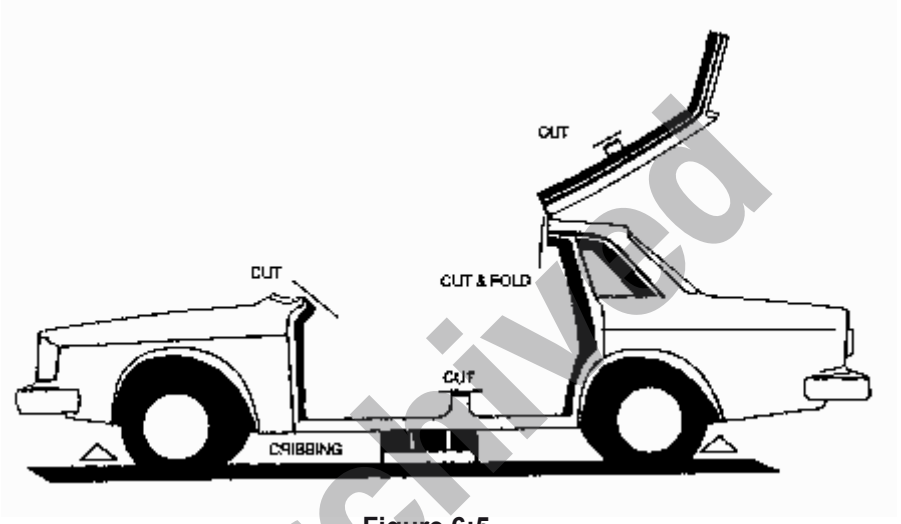

Figure 6:5
Full Roof Hinge

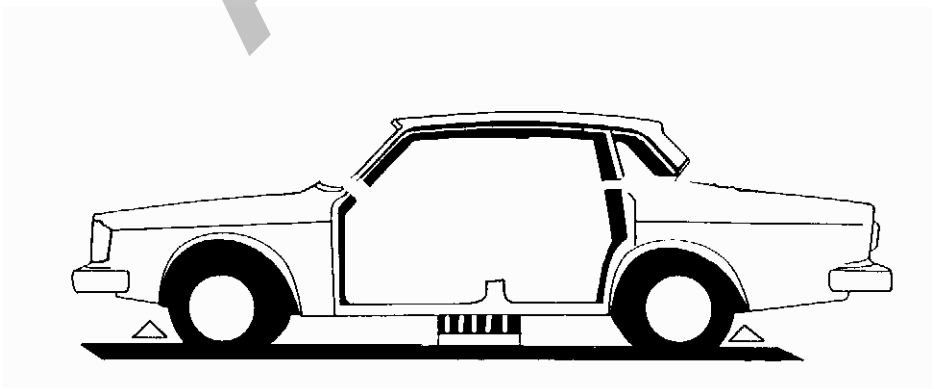

Figure 6:6
Roof Removal

NOTE

The seat belts will have to be cut in order to raise the roof, as the upper belt support bolts are usually located high on the pillars.

CAUTION

The barrel of the inertia reel seat belt mechanism if cut, may disintegrate releasing a steel spring under pressure.

6.7 Casualty protection

A further consideration is that if the casualty is in a vehicle which is upside down or on its side, the release of the seat belt could cause added serious injuries if the casualty is not properly supported. Rescuers need to think carefully before cutting the seat belt or operating the release.

The preferred method of gaining access in the event of a vehicle being on its side is to cut the A, B and C pillars on the upper side, and make relief cuts on the lower side. After cutting seat belts, simply bend the roof down to the ground.

CAUTION

Extreme care must be exercised when cutting roof or floor panels in case casualties are lying against panels being cut

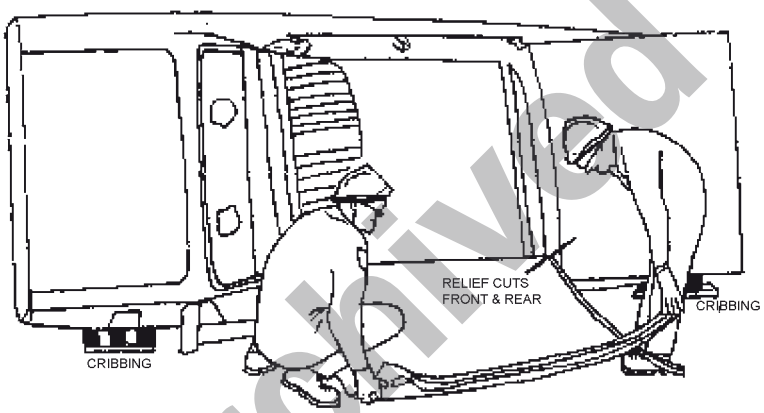

Figure 6:7
Roof Fold Down

Another method is to make a three-sided cut. Tools used could be panel cutter and hammer, air chisel or 'can opener tool'. The preferred tool is the can opener because it is silent, very controllable and relatively fast. All the other tools are noisy and with the exception of the air chisel, much slower in operation.

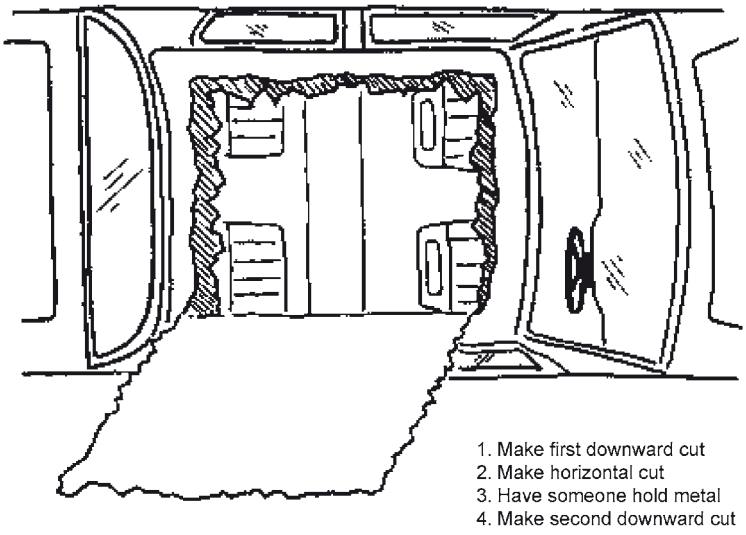

Figure 6:8
Entering Through the Roof

The same hole may be needed for extrication purposes and therefore the cut should be made where possible to leave a smooth, rounded surface. Padding should be provided around remaining jagged edges.

Once the roof panel has been folded back and secured, insulation material and hood lining and support brackets for cabin lights are usually revealed. Heavy gauge wire is often used as support for hood linings and this can be readily twisted out of the holes into which it is placed as the hood lining is cut away with a sharp knife. The light support bracket will need to be cut with a hacksaw or air chisel. Note: Some vehicles have a roll bar incorporated in the roof structure. It is better to cut the panels around these bars as they are substantial and difficult to remove.

6.8 Boot entry

If other access is not possible, the boot area provides a possible route for access. In any event, the boot should be inspected to ensure casualties are not missed.

Some rear seats may be removed by pushing with the feet from the boot area. Alternatively, an opening may have to be cut through the back seat.

CAUTION

Remember fuel and LPG tanks may be installed in the boot area and can hinder access.

6.9 Floor entry

When a vehicle is in such a position that entry cannot be achieved by other means, it will be necessary to enter through the floor. Structural members and the drive train will dictate the best entry point in relation to the casualty. Only limited access will be possible in most cases.

Using an air chisel or similar equipment, a small hole is cut in a suitable panel to ensure no contact will be made with the casualty. The hole is then enlarged to a size suitable for a work area to gain access to the casualty. Assistance to the casualties in the shortest possible time is essential so that treatment and stabilisation can begin.

CAUTION

Remember when entering through the floor area that hazards may be present. These include:

- fuel and LPG / CNG lines
- electrical wiring looms, and
- hot catalytic converters in the exhaust system.

6.10 Bus / coach alternative access

6.10.1 Doors

Normal entrance / exit doors can be used as access if the vehicle is upright or has rolled to the driver's side. A second access door is provided in double-deck and many of the tall (high deck) luxury tour coaches and express coaches. The majority of doors on coaches are air operated. In an emergency air supplying the door must be turned off before it can be manually opened. An external dump valve needs to be located and are normally found under the skirt, under the front bumper bar or behind a hinged front number plate. In some coaches, the valve can be found behind a hinged door located on the outside of the coach near the side door. The dump valve actuator can take the form of a valve with a handle or toggle switch that electrically operates a valve. Another dump valve type may have a push button on the outside of the door itself.

6.10.2 Door air valves

Most city buses and some coaches have dump valves on the inside of the vehicle adjacent to the doorway. These valves release the air pressure and allow the door to be manually opened.

Note: In some systems, the vehicles electrical circuit is required to operate dump valves.

6.10.3 Rear window exits

The usual means of providing a rear emergency exit has been to install the rear window glass in a simple 'H' rubber section with locking key rubber. Whilst the rubber remains in a pliable state, the glass can be removed (pulled out or pushed in). Problems in this system may include the following:

The window glass tends to float in situ, with a tendency to cause water leakage and corrosion of the vehicle frame and panelling. An owner's common solution to the water leak problem is to seal the area with a silicone type sealant. Unfortunately this repair action makes window removal difficult.

The 'H' rubber section has a tendency to harden over a period of time due to exposure. As the rubber hardens it becomes less pliable with the result that it is difficult to remove.

6.10.4 Rear window variations

The rear emergency exit has been referred to as a window glass. However it should be noted that as well as glass, other materials can be used. These include:

- Armourfloat® glass (toughened glass)
- laminated glass
- perspex
- timber
- fibreglass, and
- aluminium.

NOTE

Many buses and coaches have high back seating installed which could hamper access through the rear emergency exit of the vehicle. For this reason the back rest of the seat (known as the squab) will be held by quick release clips which permit the squab to be either folded down or otherwise completely removed

6.10.5 Easy-release windows

Some late model commuter buses which have recently been released onto the Australian market feature a new design of rear emergency exit. The rear window is set into a carrier which is bonded to the rear panelling of the vehicle. The window glass can be easily pulled out of the carrier frame.

6.10.6 Window handles

To aid removal of the rear emergency exit, handles are situated on the outside, usually at the lower corners. Others may be situated nearer to the centreline of the window. Coaches fitted with a toilet / wash facility usually have no rear emergency window exit installed.

NOTE

There have been vehicles imported into Australia that feature a variety of rear emergency exit systems, including special doors and / or windows with a variety of locking mechanisms.

6.10.7 Side emergency exits

Depending on the type of bus or coach (its particular design and style), the arrangement of a side emergency exit may be provided in a variety of ways.

6.10.8 Side window emergency exits

If there is no rear emergency exit, an emergency exit window is usually situated on the off-side (driver's side) towards the rear. Many coaches have emergency side window exits fitted to both sides of the vehicle. Handles are fitted to aid removal. Some buses have handles that swivel or will allow the window to fall out or hinge open whilst others have screw-in handles which will shatter the glass and cause it to fall away.

6.10.9 Other windows

All windows in coaches should be looked upon as potential emergency exits. In an emergency situation one side emergency exit may prove insufficient for the rapid evacuation of trapped passengers. It should be noted that a window is the weakest area of a bus side structure and therefore is the most likely area to gain access by removing the window glass. The front windscreen, once removed, offers a large opening for access.

6.10.10 Through the body

If entry is required to be cut through the bodywork, the most accessible locations for this type of entry are as follows:

Through the roof, between the roof bows. The bows can be identified by the rows of rivets with the distance between the bows usually being 1200 mm.

Through the vehicle body panelling around the rear emergency exit window where there is little in the way of internal structural framework. If there is difficulty in removal of the exit panel, intentional deformation to the surrounding panelling will assist in removal of the exit panel.

In an area between two side window frames, immediately below the window. The panel needs to be cut out as near to the floor level as possible. Access through this area will encounter more steel framework than through the roof structure.

CAUTION

When cutting above the top of the window line or near the air conditioning unit (usually fibreglass) be aware of air conditioning lines as they carry gases which will be dangerous if inhaled.

6.10.11 Floor hatches or through the floor

Buses and coaches have both metal and timber floors, with hatches in certain areas to provide access to various parts. Entry may be made through the floor hatches or floor where possible. The best place to cut through the floor is in the centre of the vehicle between the chassis rails from the luggage bin.

6.10.12 Luggage bin locations

Where the engine is centre-slung between the chassis rails, the luggage bin will be found at the rear. Where the engine is mounted at the rear, the luggage bin is located in the centre of the vehicle between the front and rear wheels.

6.10.13 Lounge hatches

Some newer vehicles now have a lounge area in the rear of the vehicle under the main passenger area. These lounge areas have internal and external entries. Some later model double-deck coaches are fitted with an access hatch between the luggage compartment and the passenger

area. This hatch is usually located beside the toilet on the near side wall panel above the first stair landing. If no hatch is fitted, this panel can be cut to give an adequate opening.

6.10.14 Common roof hatches

There are usually two roof hatches provided in most modern coaches. The centre lid section of a roof hatch is normally a moulded acrylic (perspex) although some previous designs have featured fibreglass. The centre lid sections are typically mounted in 'H' rubber and can be pushed outward or inward. These hatches are quite flimsy in their centre sections and can be dislodged from their mounting rubbers.

6.10.15 Roof hatch variations

Some imported vehicles have alternative methods of roof mounted emergency exits. One of these features a twist handle method of opening with a hinged lid.

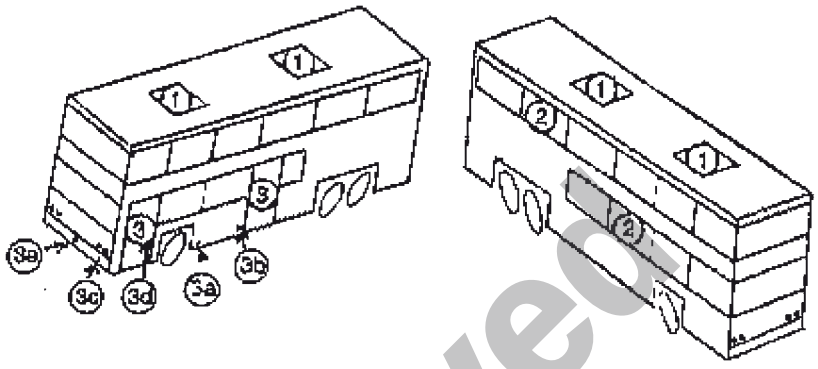

Figure 6:9
Emergency Coach Hatches

6.10.16 Typical emergency access points

Typical emergency access points appear in Figure 6:9 as described and cross-referenced below.

- Push-in, push-out roof hatches. (see 1).
- Pull-out / push windows on vehicle. These are clearly marked. (see 2).
- Doors—pneumatically controlled (see 3) to open in emergencies, and depending on the type and make of the vehicle, open hinged flap to locate the dump valve. This valve may be located:
- behind nearside front wheel arch (see 3a), or
- under skirt in vicinity of door (see 3b).
- Pneumatics can be deactivated by:
- electrically operating toggle switch on near side under front bumper bar and turning off tap (see 3c);
- by pushing black button near door lock (see 3d); or
- by swinging down front number plate & turning tap off (see 3e).
- Doors can then be opened manually (see 3d).

6.11 Bus / coach electrical system

Vehicle wiring is normally 12 or 24 volts. If the wiring is damaged, ignition of flammable material can occur.

6.11.1 Battery switch

The battery master switch should be found and switched off. It may be located near the dashboard or driver's side console or in the engine compartment close to the batteries.

WARNING

When the master switch is used to isolate the power, all power is not necessarily cut off e.g. electric powered battery isolating switch (if fitted) or Tachograph (if fitted) are separate. These items of equipment require constant power for their continued operation. Other items of equipment such as CB radios, parking lights, saloon lights and other accessories may still operate even after the battery isolating switch has been turned off. The most positive way to isolate all power is to disconnect the battery leads from the batteries. (Rescuers should familiarise themselves with different wiring configurations of batteries.)

6.11.2 High voltage wires

Long distance coaches fitted with television, often require an inverter to be fitted to the coach for the supply of 240 volts. Contact with wires carrying high voltages, could result in electrocution.

WARNING

240 volt power may be stored within the system by means of capacitor charged by battery power for a considerable period of time

6.12 Bus / coach fuel

All late model coaches use diesel fuel. Nevertheless, there are a small number of older, petrol-engine buses still in service. Smaller buses use either diesel, petrol or engines converted to liquified petroleum gas (LPG) or compressed natural gas (CNG).

WARNING

Rescue personnel must be aware of the various types of valves and pipe systems to be able to render safe LPG and CNG powered vehicles.

6.13 Bus / coach suspension

If a coach or bus is fitted with air suspension, no person should go underneath the vehicle or lean over a tyre inside a wheel arch without having placed substantial support under the chassis and bodywork. If an air bag ruptures or an airline to the suspension is burnt through or damaged, the vehicle may drop without warning, trapping or crushing persons underneath.

The vehicle can be stabilised by a controlled release of the air suspension, after having established that no persons are under the vehicle.

6.14 Trucks

Trucks follow the ladder chassis and separate body type construction. Running gear has many options: single steer, tandem steer, single drive and tandem drive or a combination of any of the above. Cab styles vary considerably as well e.g. forward control (or cab over engine), 'conventional' or engine in front of cab or a combination of each.

Access to engine compartments also varies from tip-forward bonnet / guard combinations to tip-forward complete cab. This knowledge may help in gaining access to injured persons in the cab. Note: Sleeper cabs are now common on long distance rigs. These are accessible from the driving compartment and side doors (where fitted) and the rescue team must check the sleeper for occupants.

Large trucks, when involved in an incident with a smaller passenger vehicle, are rarely damaged above the floor area of the cabin.

6.15 Semi-trailers

Like buses, semi-trailers pose their own peculiar hazards to rescue personnel. Buses have the problem of mass casualties while semi-trailers provide load problems, along with difficulties associated with identifying the type of goods being carried. Semi-trailers are made up of a prime-mover (tractor) and one or more trailers (multi-articulated e.g. B Double etc).

6.16 Trailer brakes

The prime mover may have single, tandem, or triple (tri-axle) driving axles. One of the safety features built into the whole rig is that once the air brake lines are disconnected between the prime mover and the trailer or trailers, the brakes are automatically applied to the trailer, thus preventing movement of a trailer. During a rescue, this may require the rescue team to employ another prime mover or a specially equipped heavy duty tow truck to remove the trailer or trailers. The brakes may be released manually but to tow the trailer an air brake equipped vehicle is required.

WARNING

Some vehicles may be fitted with vacuum brakes. If this is so then the reverse will apply—i.e. the brakes will release when air is drained.

CAUTION

ALWAYS CHOCK THE WHEELS.

6.17 Refrigerant / air-conditioning gases / liquids

During the process of gaining access or disentanglement during a rescue, a refrigeration line may be cut or damaged, so releasing the refrigerant gas / liquid. Rescuers must be aware of potential problems such as frostbite or asphyxiation and appropriate precautions must be observed.

6.18 Stopping diesel engines

Diesel engines power the majority of present day heavy vehicles. In most accident situations, the engine will be stopped before the rescue team's arrival at the scene. However, if the engine needs stopping, the following steps should be attempted:

a. Turn off the ignition key.

b. Press the stop button. (This may require the ignition key or switch to be turned on for this button to operate.)

c. Pull the stop button (generally located near the driver's position).

d. Operate the shut-off manually on the fuel injector pump.

e. Discharge CO2 cylinder into air intake.

f. Crimp the fuel line on the inlet side of the fuel injector pump (normally rubber tube).

g. Remove or smash the fuel filters (glass or metal screw type).

h. Place a flat piece of timber over the air intake.

On some heavy machinery the engine can be stopped by pushing / pulling the throttle control lever past the low idle stop position or by lifting the accelerator past the low idle stop position. If this fails, the previous methods can be attempted.

WARNING

NEVER pour water down the air intake to stop a diesel engine.

6.19 Fibreglass panels

Most prime movers have fibreglass roofs and body panels. Entry can usually be made with:

- Hacksaw blades—with wide teeth in a 'Pad' holder. The teeth will become clogged and need clearing regularly.
- Panel Cutters may be used, but they sometimes tend to tear the fibreglass.
- Tin snips may be used (with some difficulty).
- Reciprocating saws have proven successful, but like the hacksaw the blade will clog.
- Oscillating plaster saw.
- Disc cutters / angle grinders, providing the normal precautions are taken when using abrasive discs and power leads.

NOTE

Air chisels have not proven to be efficient on fibreglass, as the fibreglass does not provide adequate back pressure on the chisel for correct operation.

CAUTION

Rescue Operators cutting fibreglass must cover all exposed skin, wear safety goggles and dust mask to provide protection from fibreglass dust.

6.20 Summary

The object of gaining access is to make openings in the wreckage through which first aiders can reach injured persons and start lifesaving care.

6.21 Operations sequence

The following general sequence of operations can be followed when gaining access to a wrecked vehicle.

First attempt to open doors. If they cannot be opened, windows should be removed or broken. If windows cannot be removed or broken, an opening in the body of the vehicle will need to be made.

A backboard can be used to facilitate entry through window openings.

When possible, occupants need to be protected from flying particles of metal or glass. They should be covered and ear protection provided.

Windscreens and rear windows should be removed intact if possible. Bonded windows / windscreens can be removed with a glazier's tool. A sharp knife can be used to remove windows. An automatic centre punch in the bottom corner is used to dispose of tempered glass.

Ducting tape or 'contact' prevents the spread of particles when breaking tempered glass close to an occupant of a wrecked vehicle.

When circumstances dictate, entry may be gained via the roof or floor panels.

The boot or luggage compartment of a vehicle needs to be checked for occupants or hazardous materials.

If the lid cannot be opened with a key, a lever can assist in popping the boot open.

Chapter 7
Vehicle Construction

7.1 Introduction

Before rescue teams can gain access into vehicles, they need to understand the basics of vehicle construction, which can vary considerably between manufacturer makes and models as well as construction types.

7.2 Component materials

Most modern manufacturers construct motor vehicles using the production line method, with assembly taking a matter of minutes. Materials such as sheet metal, composite metals, plastics, vinyl, rubber, foam rubber, leather, glass, etc are all used.

Sheet metal is folded, bent or welded to a frame to give it strength. Softer materials are used for padding, trim and cosmetics. Tubular metal sections are often used in the framing of seats, along with foam rubber and vinyl or leather.

It is the task of the rescuer to be able to identify these materials and know their strengths and weaknesses, including materials with the capability to store considerable energy, with the potential to cause serious injury if this energy should be released. Rescuers will need to formulate an effective plan to disassemble, push back into shape, or remove materials from around the casualty, to allow access and permit extrication.

7.3 Terminology

a. **Chassis—**Generally, chassis refers to the frame, engine, front and rear axles, springs, steering system and fuel tank. Because most modern automobiles (apart from trucks) do not have a separate chassis, the body is sometimes called the chassis.

i.) Chassis frame—A frame found on large trucks which are made up of two long side members which are joined by several cross members. The suspension and axles are attached to this frame.

ii.) Sub frame—A sub frame is sometimes bolted to the chassis of uni-body cars. It can be used to support the engine, transmission and suspension instead of having these components directly connected to the main body structure. This more expensive design generally results in better road isolation and less harshness.

iii.) Monocoque—A design of a vehicle's body where a single shell has the engine and suspension attached to it in various places to spread the load evenly over the whole shell

b. **Suspension system—**Cushions the passenger compartment of the vehicle from road vibration. The suspension system also includes springs, shock absorbers, steering linkage, upper and lower control arms, torsion bars, stabilizers.

c. Pillars:

i.) A Pillar—When you look at the side of a car, the pillar that is attached to the windshield and supports the roof is called the "A-pillar."

ii.) B-pillar—The centre body pillar on sedans. It connects from the roof support and the sill.

iii.) C-pillar—When you look at the side of a car, the pillar that is attached to the rear window and supports the roof is called the "C-pillar." There can be another pillar called the "D-pillar" the fourth vertical pillar in a van or station wagon.

iv.) Hinge pillar—The vertical structural element that carries the front door hinges.

d. **Gusset—**A triangular plate secured across an angle to reinforce a joint. Usually referred to where the "A" pillar meets the floor sill.

e. **Sill—**A longitudinal box-section member of the body shell at floor level located below the doors which serves to reinforce the under body. It is also called "longitudinal member" or "side member".

f. **Doors—**The hinged side panels of a vehicle which permit the occupants to enter or leave the passenger compartment. In most cases the doors open so that the hinge is toward the front of the vehicle. When the hinge is toward the back of the vehicle, they are called "rear hinged opening doors."

   i.) Intrusion Beam—A beam in the door or along the side of the passenger compartment that adds additional protection in the case of an accident. It reinforces the side of the car.

   ii.) Hinges—A device that allows the door to open, it can be made of mild steel or cast iron.

   iii.) Nader Pin—A fixed pin that the door latch strikes that securely holds the door shut. That part of the door lock which contacts the striker plate as the door is closed, and springs back when the door is fully shut to hold it in the closed position.

   iv.) Door lock—A mechanism for allowing a door to be opened either by the operation of a key on the outside of the door or by releasing a mechanical switch on the inside of the door.

g. **Roof:**

   i.) Roof brace—A transverse rail that supports the roof panel; there are usually several roof braces.

   ii.) Roof panel—The horizontal outer layer of the sheet metal roof panels that is spot-welded along its edges to the top of the roof door and screen pillars, these can either be made out of glass, acrylic or carbon fibre.

   iii.) Upper or Top rail—A longitudinal side member above the doors to which the roof panel is attached.

h. **Undercarriage—**The structural members and flat panels of the bodywork on the chassis also called substructure.

i. **Firewall—**The metal partition between the driver's and engine compartments. On front engine vehicles, it is located below the windshield; but on rear engine vehicles, it is located below the back window. It protects the driver and passengers from engine fires, noise, and fumes.

j. **Panels:**

   i.) Front & Rear Guards—A formed sheet of metal or plastic that is used to cover the tyre, suspension and to suppress water spray.

   ii.) Bonnet—Bonnet can be defined as a protective covering made up of a hinged metal part used for covering an engine of a vehicle. Usually automobile bonnets are made of steel, aluminium, fibreglass, and carbon fibre reinforced plastic.

   iii.) Hatch Back/Boot—A flap that opens up the rear of the vehicle than can be of a similar construction to the bonnet and may have a rear window fitted into its self.

k. **Crumple Zones—**An area of the vehicle that is designed to compress during an impact and to absorb the energy from the impact.

l. **Locations:**

   i.) Passenger—Denotes the side of the vehicle closest to the foot path or otherwise called the left hand side as facing forward in the vehicle.

   ii.) Drivers—Denotes the side of the vehicle closest to the centre of the road or otherwise called the right hand side as facing forward in the vehicle.

   iii.) Front—The front of the vehicle when driving in a forward direction.

   iv.) Rear—The rear of a vehicle when driving in a forward direction

m. Interior Fittings:

i.) Dash—That part of the body containing the driving instruments, switches, etc, it can also be called the “instrument panel” or “dash panel” or just “dash”. This can also be made of Carbon fibre composites.

ii.) Centre Console—A section of the dash which is mounted between the driver and passenger sections and is mounted over the drive train tunnel, it often houses the gear selector, cup holders, storage space, and possibly the stereo.

iii.) Steering wheel and column—The steering wheel is a round shaped wheel, which is connected to the steering column with the help of one or more spokes. These spokes can be made from composite materials, wood and 8mm round steel rod.

iv.) Removing the steering wheel can be done by carefully cutting the spokes to remove the wheel; care should be taken as the centre of the column houses the air bag.

v.) Steering Column (collapsible)—When a vehicle is involved in an accident, the driver’s chest is forced into the steering wheel. In older cars, the immovable steering column meant that the driver could sustain chest damage. The collapsible steering column telescopes or folds (articulate) so that chest damage is reduced.

vi.) Steering Wheel (adjustable)—A steering wheel which moves up or down or which can be set at a different angle. In this way, the rescuer can make additional space around the casualty rather than cut the wheel.

vii.) Seats—The cushions upon which the driver and or passengers sit which is adjusted by a mechanical means or a control switch connected to a small electric motor so that the seat can be moved forward or back, up or down, or be tipped forward and back.

viii.) Parcel Shelf—General found in sedans and hatches, it can be found located at the rear of the vehicle behind the seat and window.

7.4 Types of vehicles

7.4.1 Sedans

May include up to 5 doors which include hatchback models. Vehicles with an enclosed body type, permanent back panels, and top with full-width/single cross seats front and rear, and passenger capacity from five to seven depending on wheelbase. This can include convertibles.

7.4.2 Station wagons

Small and large cars came in station wagon form with the four door rear single lift-up hatch to the two door single lift up hatch.

7.4.3 Utilities

A term for a vehicle with front seats and a commercial tray over the rear axles to carry loads for tradesmen. Single cab utilities present a specific problem to rescuers. If the cabin is crushed or semi-crushed, access is difficult because of the restricted space.

Panel vans are of a similar make but have the rear of the vehicle totally enclosed.

7.4.4 Forward control vans

Forward control vans are of the monocoque style with the potentially hazardous feature of driver and passenger having their feet against the front panel of the body. In a head-on collision, very little protection for feet and legs is provided. In this type of vehicle, wrap-around of the feet\legs by metal panels is common.

7.4.5 Purpose built vehicles

May include stretched limousines, modified four wheel drive, armoured vehicles, convertibles etc

7.4.6 Trucks:

A general term for a vehicle designed to carry goods, these vehicles usually comprise of various configurations, size and weight.

- Cab over—The cab over is a design in which the cab sits over the engine on the chassis and is fixed by two front permanent cab mounts and the rear with detachable mounts that allow the cab to tilt forward for servicing.
- Long nose—The long nose is a design in which the cab sits behind the engine on the chassis and is fixed by four permanent cab mounts. A bonnet is separate and can tilt forward for servicing.
- Sleeper cab—A sleeper cab can be mounted above or behind the cab independently or as part of the cab structure, it is used for sleeping for the driver and can house items such as TV, video, A/C units, fridge, and many other accessories.

All cabs and sleeper cabs can be constructed of aluminium, various grades of steel and aluminium.

- TRUCK Hazards
- 240 volt invertors for running fridges, microwaves, TV and Video/DVD's.
- Gray and Black water.
- Chemicals used in internal toilets.
- Vehicles may be powered by alternative fuels such as compressed gasses such as LPG.

7.4.7 Trailer types

- Flat bed—A flat tray on wheels that can carry multiple loads exposed to the weather, loads may be shipping containers attached by link pins fitted into the trailer bed or frames, trusses or steel coils attached by chains or ratchet straps.

The bed can come in a verity of heights from the road surface.

- Container—Can be called a torque liner, the trailer has sides, roof, front and rear doors and used to haul cargo that cannot be exposed to the elements.
- Tankers—Can come in a number of configurations, but usually hauls fluids such as fuel, chemicals, water and liquefied gas.
- Tippers—Generally used to cart loose loads from one place to another and can be tipped out from rear or side of trailer. Usually contains coal, landscape supplies, large rocks and boulders, scrap iron and squashed cars.

7.4.8 Trailer configurations

- B Double—Two trailers attached to the rear of the prime mover, called the "A" and "B" trailer units and can carry a variation of loads such as goods, stock, produce and tip configurations.
- Road Trains—Independent trailers attached to a semi trailer combination, can have a multiple number of trailers attached, with a variation of loads and up to 8 trailer combinations.
- Stock Trailers—Can come in either "B" double, road train, flat bed configurations.
- Crate sides and rails can be made of stainless steel, mild steel and plastic.

- Refrigerated—A fridge on wheels, used to transport goods that have to stay at a certain temperature and has its own refrigerant unit and fuel supply, may be backed up with separate and independent batteries.
- Trailer Hazards:
- Stock that is being carried can be agitated and restless when involved in an accident.
- Trailers are top heavy enough and can be affected by other passing trucks, wind and restless animals still in the trailer.
- Animals produce a lot of waste deposits; ensure an effective barrier is between them and each casualty in the event of an over/under-ride.
- Care should be taken when working near or with animals.
- Some trailers and the prime mover can show a HAZCHEM plate indicating what they have stored in the trailer.
- Trailers can carry bladders under the chassis as an additional load of fluid products.

7.4.9 Bus and coach

A large public or private passenger vehicle used for transporting many people either standing or sitting. These can be either articulated, single or double decked.

- Bus Types
    - Mini-buses are one size up from large passenger vans, and seat up to 25 passengers. Some may include a small space for luggage. Many are wheelchair-lift equipped and used in Para-transit capacities.
    - Midi-buses, or mid-sized buses, are larger than minibuses, but smaller than motorcoaches, seating between 26 and 47. They can be front- or rear-engine mounted, and have a variety of designs depending on specific needs.
    - Commuter Bus (Local transit bus or City bus) usually have two axles, and two doors (one front, one mid-rear). Their seats are usually fixed and limited, leaving room for standing passengers.
    - Tour coaches, especially cross-country touring coaches, are often equipped with a lavatory, video system, PA system, and other amenities appropriate for hours of comfortable travel.
- Bus Configuration
    - Articulated Bus; having no need for a luggage compartment, many have low floor design, further easing entry and exit. Double-decker buses, guided buses, articulated buses or extra-long triple-axle buses are often used on urban routes with heavy passenger loads. An articulated bus is sometimes called a bendy-bus.
    - Trolleybuses function as a commuter bus, but powered by an electric motor supplied by overhead power cables rather than by an onboard internal combustion engine. They are not to be confused with buses that are decorated to look like turn-of-the-20th-century streetcars and which sometimes go by the name of “trolleys”.
    - Motorcoaches, also known as intercity coaches, are heavier, with usually three axles, one passenger door and no standing room. Seats are usually soft and able to recline. The floor is high, allowing large under-floor luggage compartments. There is usually a small carry-on luggage rack within the passenger cabin, as well. Besides their use for intercity transportation, motorcoaches are used for long-distance airport shuttle service, local touring and charters for large groups, and so on. They have seats for 47 to 62 passengers.

These coaches can have split levels where passengers can be carried below the raised floor via an access stairwell, either between the steer axle and drive axle or over the steer axle and halfway down the body to the drive axle area,

- Bus Hazards:
    - Carry more people than the average car, up to 65 people = more casualties.
    - Electrical systems on buses can be 6v, 12v, 24v & 240v with inverters attached.
    - Batteries may be in more than one fixed point and may not be connected directly to the main isolation switch.
    - Various types of buses can carry water types as drinking water, grey for washing hands and black for toilets.
    - Luggage can be strewn around the inside of a bus and luggage can contain chemicals and stored gas containers.

7.5 Vehicle construction materials

- Tensile Strength—the amount of force the material can withstand when being stretched. (Picture tug-of-war, the amount of force required to break the rope would be its tensile strength). This is when we cut the metal to gain access.
- Yield Strength—Prior to the yield point the material will deform elastically and will return to its original shape when the applied stress is removed. This is in the accident when the metal deforms such as the “B” pillar.

7.5.1 Metal

- Dent Resistant Steels—Yield Strength 256 MPa / Tensile Strength 378 MPa

  Palm printing and/or denting is caused by a variety of factors such as hail, thrown stones, or out-of-control shopping carts.

  In general, they offer a combination of formability and high yield strength that is not attainable with low-carbon, mild steels or conventional high-strength steels. These parts include doors, deck lids, quarter panels, guards, hoods, and roofs.

- Low Carbon Steels (LCS)—Yield Strength 269 MPa / Tensile Strength 345 MPa

  In addition to being cost effective, low carbon steels has a wide range of key forming characteristics. As a result, these steels can be used for almost any automotive part – from small, flat parts (brackets) to large, deep drawn parts (floor pans). Also, this material can be made for either exposed or unexposed applications.

  It is typically used on truck bed floors and other floor pans with little formability requirements. Other suitable parts are truck cab backs and tailgate access covers on Utes.

- High strength low alloy steel (HSLA)—Yield Strength 420 MPa / Tensile Strength 520 MPa

  HSLA materials are typically found on structural parts of the vehicle. Most HSLA materials have very limited formability characteristics. The materials are found on rocker inners, b/c pillar reinforcements, and cross members.

- Advanced high-strength steels (AHSS)—Minimum Yield Strength 500 MPa / Tensile Strength 800 MPa

  AHSS are gaining popularity in automotive applications because they are easier to form than HSLA grades with similar initial yield strengths but have much higher final part strength. As a result, advanced high-strength steels are ideal for crash energy management, fatigue

and durability sensitive parts, or thin gauge exposed panels that are subjected to denting loads

- Boron—Ultimate Yield Strength between 1,000 and 1,200 MPa / Tensile Strength of 1,400 to 1,600 MPa

  This steel will be found in the new Volvo XC90, Saab, BMW E60, Porsche Cayenne, VW Toureg and many other cars including the Holden Commodore VE and WX. In general it is used to provide extra strength in the sill area, B Pillar, chassis areas, rear cross members and as roll over bars.

  However, whichever new car you are working with now or in the future it is very likely that you will find some Boron steel somewhere.

7.5.2 Aluminium alloys

- Rolled Products—Aluminium sheet applications include heat exchangers, heat shields, bumper stock as well as closure sheet and structural sheet for complete body assemblies.
- Extruded Products—Aluminium alloy extrusions offer designers unparalleled freedom from standard shape restrictions. Applications include: space frames, suspension, seat frames and rails, sun roofs, window and door frames, and aluminium/aluminium metal matrix composite drive shafts.
- Cast Products—Today, the average vehicle has about 600kilo of aluminium built into the vehicle itself. Die castings are used for pistons, transmission housings, and suspension components and aluminium metal matrix brake drums and rotors. Sand castings are used for engine blocks, cylinder heads and manifolds. Structural castings are used for cross members and body structures while; structural die castings are used for body structures. Structural permanent mould castings are used for body structures and sub frames, and permanent mould castings for wheels used on 45 percent of new passenger vehicles today.
- Forged Products—Forged aluminium products include structural forgings for chassis and suspension parts, forged wheels, and airbag components. Aluminium forging technology is notable for the ease with which unusual shapes and extremely large components with excellent mechanical properties can be obtained.

7.5.3 Magnesium

Vehicle manufacturers have been more interested in magnesium alloy since the early twentieth century in engines and drive trains. This light-weight alloy reduces fuel consumption and exhaust emissions, while improving vehicle agility by cutting the mass at the front of the vehicle.

The power train components such as engines and transmissions offer considerable opportunity for light weighting to bring about reductions in fuel consumption and exhaust emissions and improvements in vehicle agility. This is because they generally have a high mass and are located in the front of the vehicle.

7.5.4 Stainless

Stainless steel components can be found in some motor vehicles such as front grills and hinges.

7.5.5 Titanium

Titanium is relatively new into motor vehicles, it can mainly be found in bumpers, where it is integrated into some vehicles at the front and the rear of a motor vehicle between the outer shell off the vehicle body and the frame of the motor vehicle. The purpose of the bumpers is to absorb light impacts and collisions without or with only little damage to the vehicle.

7.6 Glass

7.6.1 Glazing

Front windscreens in modern vehicles are bonded to the “A” pillar and are designed that way so they can make up to 70% of the inaugural strength of the vehicle as additional structure support.

7.6.2 Glass management

Initially, breaking glass for access is to be avoided. Prior to removing or breaking any glass, care must be taken to protect the occupants of the vehicle. If occupants are conscious and able to communicate, they may be able to wind a window down or unlock a door. Two types of glass in common use today need to be considered if breaking of glass is unavoidable. These are as follows:

- Tempered Glass—It is mostly used in side and rear windows however some older cars used tempered glass for windshields.

  Tempered glass can be broken with a spring-loaded centre punch or any other type of pointed tool. Tempered glass will shatter into many tiny glass fragments when struck with sufficient force. Typically a blow (from a centre punch) applied to a corner of the pane will shatter the glass. The rescuer and casualty should be protected from possible glass fragments. Often the glass will shatter but remain in place allowing the rescuer to carefully remove the fragments away from the casualty.

- Laminated Glass—This glass consists of a plastic interlayer, made from polyvinyl-butyryl, sandwiched between two layers of annealed glass. In general this is used for the windshield.

  Laminated Glass can be cut with several tools such as a glass cutter tool or reciprocating saw. These techniques will generate small glass fragments and dust. The protection of the victim and rescuer should be considered before the glass is removed.

- Security Glass—The windshield and all windows, side and rear, have a unique glass/ polycarbonate layer construction (laminated) that resists breakage. The door glass is constructed in five layers consisting of outer glass, thermoplastic polyurethane sheeting, impact-resistant polycarbonate sheet, inner glass and anti-lacerative film.

  Because of the difficulty in breaking of this glass it is suggested to remove this type of glass intact with the door. Cutting this security glass may be achieved with a reciprocating saw once a hole has been made.

- Plastics / Polycarbonate Windows—This new product is lighter than glass and much more theft resistant. The design goal is to replace fixed side and rear glass windows in the automobile. Polycarbonate windows do not react like conventional tempered safety windows and are break resistant.

  Because of the difficulty in breaking of this type of material it is suggested to remove the door with the window intact. A reciprocating saw with a variable pitch blade of 10-14 teeth per inch cut nicely, once a hole has been made.

7.6.3 Safety tips

Sometimes you will have to break windows or manage the glass in windows already broken in the crash. You should always control the removal or breakage of glass by following these steps:

a. Wear gloves, eye and respiratory protection.

b. Tell everyone what is going to happen.

c. Protect casualties, medical staff and rescuers from flying glass and dust with plastic sheet.

7.7 Composites

7.7.1 Carbon fibre

Carbon fibre products are not a common feature in motor vehicles today, but as fuel costs continue to increase then the manufacture of Carbon Fibre composites will increase as the cost of producing the product will decrease.

Some manufacturers such as BMW, Ferrari, Porsche, Lamborghini and many more etc, Mercedes Benz are using it in their SLR McLaren. The entire body shell and the doors, hoods and chassis are made of carbon fibre reinforced plastic (CRP). The vehicle's extremely high rigidity comes from the use of carbon fibre reinforced composite plastics (CRP) for the body components and the monocoque chassis.

Some sport kits on vehicles are made from carbon fibre composites, and are rapidly increasing on Australian vehicles. These are located as:

- External mirrors
- Steering wheels
- Dash consoles
- Sports wheel rims
- Front spoilers and nose cones
- Flared guards
- Rear spoilers
- Engine covers
- Bonnets and boot lids
- Outer door skins
- Some motor homes and coaches:
- Side, front, rear and roof panels

7.7.2 Fibreglass

A mixture of glass fibres and resin that when cured (hardened) produces a very light and strong material. It is used to build boats, car bodies, repair damaged areas, etc.

Fibreglass has been around for a long time in motor vehicles, mainly in the truck and bus manufacture in their outer shells and in some structural sub frames.

These components can be cut using conventional rescue equipment, but they should be treated the same as asbestos and follow Operational and OS&H policies.

7.8 Body design

7.8.1 Safety cell

As a protective cage, the occupant cell must make sure that deformations and intrusions are minimised in a crash. Part of this task is performed by a number of large tailored blanks usually incorporated into the floor area. The wall thickness of each of these blanks varies. They are joined together by laser weld seams.

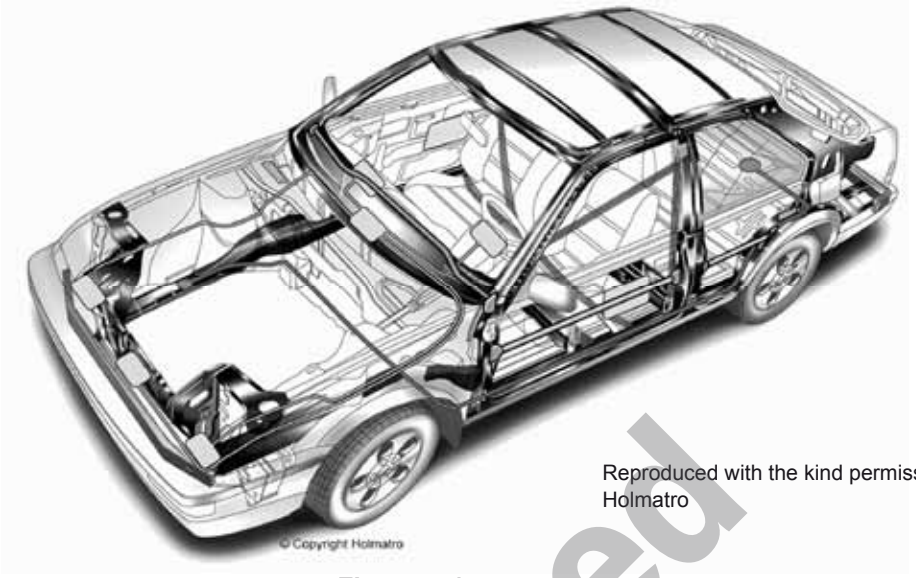

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Figure 7:1
Safety Cell

The safety cell will usually have airbags at both the front and sides, seat belt pretensioners and belt force limiters, side head airbags.

For the passenger cell, the tailored blanks form a stable, homogeneous bond with the forward and rearward structure via a system of support members.

In the rearward structure, the vehicle's longitudinal member – which has to absorb much of the impact energy in a rear-end impact – is made using tailored blanks of varying wall thicknesses and material grades.

The use of tailored blanks at specific points around the doors also helps to save weight. Extruded aluminium sections are incorporated into the doors and sills by way of impact protection.

7.8.2 Dash bracing

Dash bracing has been designed for distributing the impact force, applied to front side members at the time of a front collision of a vehicle, to various portions of the vehicle body to attain an impact-absorbing function.

Figure 7:2
Dash Bracing

For example, a vehicle body structure in which rear portions of front side members are coupled through dash braces to side frame members such as A-pillars, side sills, or the like, so that the impact force applied to the front side members are distributed to the side frame members.

7.9 Chassis

Automobile Chassis are considered to be one of the significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. More precisely, it is a skeletal frame on which various mechanical parts like engine, tyres, axle assemblies, brakes, steering etc are bolted. At the time of manufacturing, the body of a vehicle is flexibly moulded according to the structure of chassis. The chassis is usually made of light sheet metal or composite plastics. It provides strength needed for supporting vehicular components and payload placed upon it. It helps keep an automobile rigid, stiff and unbending. The chassis ensures low levels of noise, vibrations and harshness throughout the automobile.

7.9.1 Uni body monocoque

Monocoque Chassis is a one-piece structure that prescribes the overall shape of a vehicle. This type of chassis is manufactured by welding floor pan and other pieces together. Since it is cost effective and suitable for robotised production, most of the vehicles today make use of steel plated monocoque chassis.

Body and body components, such as pillars, rails, etc, are constructed from sheet metal, all of the body parts are in tension and compression to give overall strength to the vehicle (similar to a roofing truss).

Each component relies on the next to give overall strength. Most uni-body vehicles have crumple zones.

Cutting or removing any car body parts will generally weaken the overall structure of the car. Crib under the sill below the B pillar when cutting the B-pillar to avoid the floor dropping. A pillar needs to be cut or roof flapped prior to performing a dash roll.

7.9.2 Full frame independent

Rigid C or box beams supporting engine and body components. This type of vehicle is more rigid and may have crumple zones built into frame. Found in early model cars, 4WDs and trucks. There is greater strength during impact; however, more energy is transmitted to the casualty, increasing the severity of injuries.

7.9.3 Sub frame

“A sub-frame is sometimes bolted to the chassis of uni-body cars. It can be used to support the engine, transmission and suspension, instead of having these components directly connected to the main body structure. This more-expensive design generally results in better road isolation and less harshness.”

7.9.4 Ladder chassis

Ladder Chassis is considered to be one of the oldest forms of chassis that is still used by most of the SUVs till today. As its name denotes, ladder chassis resembles a shape of a ladder having two longitudinal rails inter linked by several lateral and cross braces.

7.9.5 Back bone

It has a rectangular tube like backbone, usually made up of glass fibre that is used for joining front and rear axle together. This type of chassis is strong and powerful enough to provide support smaller sports car. It is easy to make and cost effective.

7.9.6 Space frame

A space frame is a truss-like, lightweight rigid structure constructed from interlocking struts. The most common automotive uses are motorcycles and race cars where a frame is built and the running gear, bodywork and interior are attached to the frame.

Car manufacturers are exploring and releasing models with hybrid space and monocoque construction. In these cars usually a high-strength aluminium frame structure has integrated panels that they also perform a load-bearing function. These bodies are characterized by exceptional stiffness, above-average crash protection and, substantially lower weight.

7.9.7 Suspension

Automobile suspension and steering are the two paramount parts of an automobile, which are directly related to each other. Automobile suspension is especially created for supporting an automobile's body on its undercarriage, including dampers, springs and locating linkages. While an automobile steering system is basically a mechanical system through which the driver of the vehicle controls and operates the movement of an automobile, truck, tractor or bus. The basic function of an automobile suspension and steering system is to enable the wheels of a vehicle to function independently thereby making it more sound, sturdy and suspended.

7.9.8 Braking systems

A typical automobile braking system comprises of a braking device having different components, which are used for slowing or stopping down a vehicle. More precisely, these devices decrease or stop the speed of a moving or rotating body by absorbing kinetic energy mechanically or electrically. They are widely used in motor vehicles, buses, trucks, trains, airplanes, and other types of automobiles.

There is likelihood that after 2010, the global automotive industry will start using brake-by-wire systems instead of hydraulic braking systems. The various technologies such as electro mechanical braking system and the electronic wedges brake are soon going to replace the older braking systems. With the help of these brake-by-wire systems, automobile drivers will be having more control on their vehicles particularly in case of sheer emergency.

7.10 Panels

7.10.1 Tailor blanking

The concept of combining various steel options into a welded blank was developed to enable product and manufacturing engineers to "tailor" the blank so that steel's best properties were located precisely within the part where they were needed. This process not only reduces the weight of the finished part, but also can be used for part integration, thereby eliminating many reinforcements and stiffeners.

7.10.2 Hot stamping

This process combines hot forming and subsequent quench hardening in a single process. After the part is hot stamped, it has increased its strength, up to 250 percent of its initial value.

Hot-stamping technology can be used for A- and B-pillar reinforcements, roof rails, side-wall members, and beams for crash management structures. And compared with cold-formed parts, hot-stamped parts provide better formability at high temperatures and exhibit with no spring back on the final part.

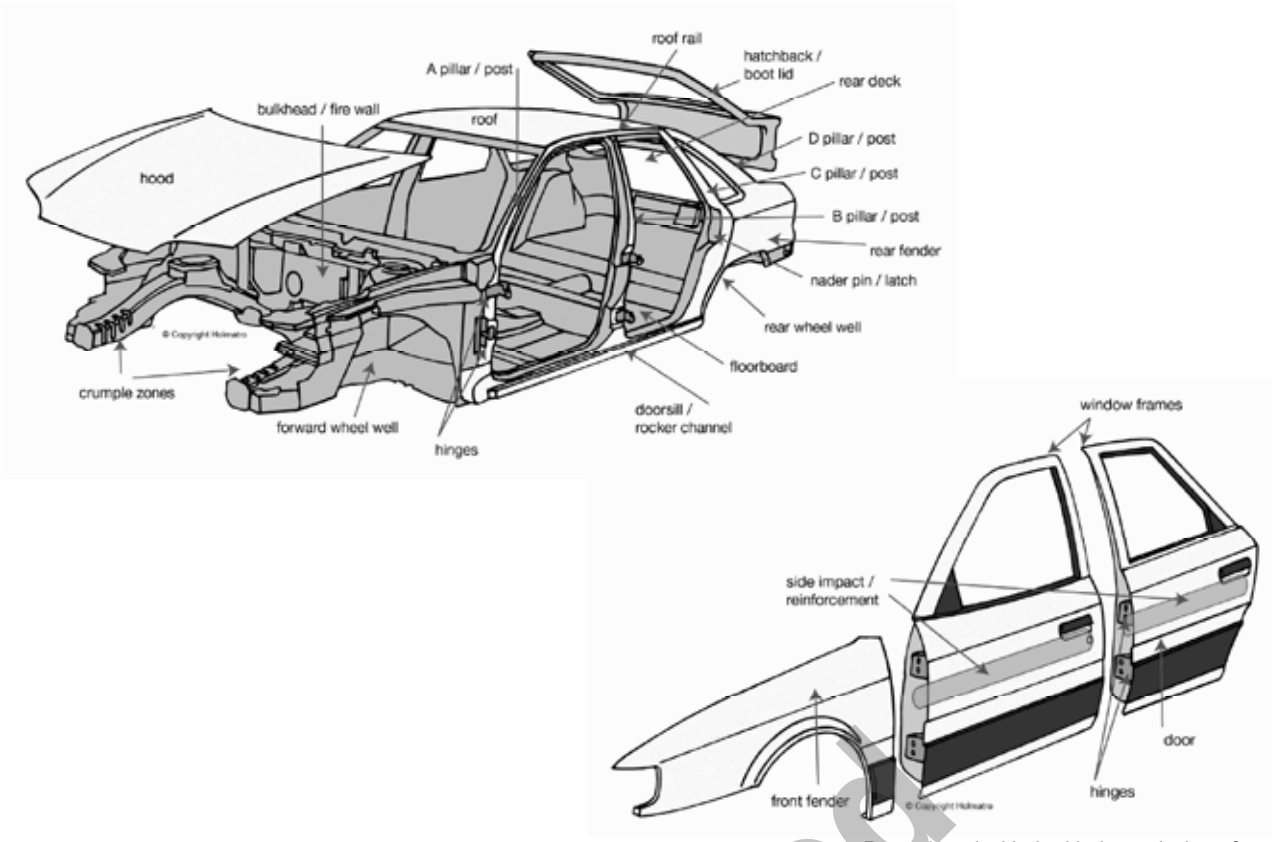

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Figure 7:3
Examples of typical tailor welded blanks

7.10.3 Hydro forming

Hydro forming is a cost-effective way of shaping malleable metals such as aluminium into lightweight, structurally stiff and strong pieces. Hydroforming is a specialized type of die forming that uses a high pressure hydraulic fluid to press room temperature working material into a die. To hydroform aluminium into a vehicle's frame, a sheet of aluminium is placed inside a negative mould that has the shape of the desired end result. High pressure hydraulic pistons then inject a fluid at very high pressure inside the aluminium which causes it to expand until it matches the mould. The hydroformed aluminium is then removed from the mould.

Hydroformed parts can often be made with a higher stiffness to weight ratio and at a lower per unit cost than traditional stamped or stamped and welded parts. In sheet hydroforming there is Bladder forming (where there is a bladder that contains the liquid, no liquid contacts the sheet) and hydroforming where the fluid contacts the sheet (no bladder).

7.10.4 Honeycombing

Honeycombing is a method of sandwiching a material such as foam or a crushable material between two sheets of metal, which form the same structure as a bee hive honeycomb.

7.11 Alternate fuels

Alternative fuels, include ethanol, natural gas, propane, hydrogen, bio-diesel, electricity, methanol, and p-series fuels. These fuels are being used worldwide in a variety of vehicle applications.

7.12 The alcohols—ethanol and methanol

Alcohols have been popular alternative fuels for many years. In fact, Henry Ford's first car was fuelled with alcohol. Both ethanol and methanol are now used as transportation fuels and will likely play an increasingly important role in the future.

7.12.1 Ethanol

Ethanol (sometimes called grain alcohol) is generally made in the United States from corn (a grain). It can also be made from biomass (a fancy name for organic materials), which includes agricultural crops and waste (like rice straw), plant material left from logging, and trash including cellulose (paper).

The alcohol found in alcoholic beverages is ethanol. However, the ethanol used for motor fuel is denatured, which means poison has been added so people can't drink it.

7.12.2 Methanol

Methanol (sometimes called wood alcohol) can be made from various biomass resources (like wood), as well as from coal. However, today nearly all methanols are made from natural gas, because it is cheaper.

Methanol is also very poisonous and very harmful if swallowed. Methanol must not be confused with ethanol. As with petrol, it is also wise to avoid skin contact with methanol, as it can pass through the skin.

7.12.3 Alcohol-fuelled vehicles

Methanol is safer in case of accidental fire than petrol, because it burns cooler. One problem is that the flame from a methanol fire is difficult to see in bright sunlight. Sometimes accidental fires are not detected immediately, because the fire is hard to see. Methanol contains about half the energy of petrol per litre. Lower energy per litre means fewer kilometres per litre of fuel, not less power. The decrease in range with methanol is not a problem for racing cars though, since all of the cars are using exactly the same fuel.

7.13 Natural gas

Natural gas is domestically produced and readily available to end-users through the utility infrastructure. It is also clean burning and produces significantly fewer harmful emissions than reformulated petrol or diesel when used in natural gas vehicles.

Natural gas can be either stored onboard a vehicle as compressed natural gas (CNG) at 3,000 or 3,600 psi or as liquefied natural gas (LNG) at typically 20-150 psi. Natural gas can also be blended with hydrogen; for more information on CNG/hydrogen blends, please see our site on fuel blends.

7.13.1 Natural gas fuel overview

Natural gas may be used as a transportation fuel in two forms: compressed natural gas (CNG) and liquefied natural gas (LNG). Fundamentally, the difference between these two forms is energy density - a liquid fuel carries more energy per kilo than a gaseous fuel.

7.13.2 Compressed natural gas (CNG)

Compressed natural gas (CNG) is pressurized natural gas that is stored in cylinder tanks at pressures up to 3600 pounds per square inch (psi). Usually, CNG is pipeline gas that is compressed at a refuelling station and "dried" (to remove water). Many refuelling stations have been constructed to compress natural gas for use in Natural Gas Vehicles. Currently; CNG is

the most common form of natural gas use as a clean alternative fuel, though it is noteworthy that heavy-duty vehicle fuel markets are developing rapidly for liquefied natural gas (LNG).

7.13.3 Liquefied natural gas

Liquefied natural gas (LNG) is cooled to a temperature of about -260°F at atmospheric pressure where is condenses to a liquid. LNG weighs less than one-half that of water and is odourless, colourless, non-corrosive, and non-toxic. When vaporized, it burns only in concentrations of 5 to 15 percent when mixed with air. Neither LNG, nor its vapour, can explode in an unconfined environment.

7.13.4 Liquefied petroleum gas (LPG)

Automotive LPG consists mainly of a mixture of propane and butane. At any one time the proportion of propane and butane in commercially available LPG can vary, but in Australia it is typically 60% (by volume) propane and 40% butane. This varying composition can marginally influence the exhaust emissions and fuel consumption of a particular vehicle.

Propane or liquefied petroleum gas (LPG) is a popular alternative fuel choice for vehicles because there is already an infrastructure of pipelines, processing facilities, and storage for its efficient distribution.

7.14 Hydrogen

Hydrogen (H2) will play an important role in developing sustainable transportation in some countries, because in the future it may be produced in virtually unlimited quantities using renewable resources. Hydrogen has been used effectively in a number of internal combustion engine vehicles as pure hydrogen mixed with natural gas.

The hydrogen fuel cell was first developed in the 1800's; however, it is only recently that further developments have made it a viable source of power for transportation. In the 1960's fuel cells started to be used as a power source during space flights; today, environmental, economic, and resource issues are driving the hydrogen fuel cell rapidly into the mainstream transport market.

The hydrogen fuel cell is an electrochemical energy conversion device; hydrogen and oxygen are fed into opposite sides of a cell, which are separated by a membrane permeable to hydrogen ions but not electrons. Hydrogen gas molecules entering the anode side of the cell are ionized in the presence of a catalyst to form protons and electrons.

The protons pass through the membrane to combine with the oxygen and electrons to produce water at the cathode. The electrons flow through an external circuit from the anode to the cathode, creating an electrical current, which powers an electric load such as a motor.

To carry gaseous hydrogen on a vehicle, it must be compressed. When compressed (usually to a pressure of about 3000 pounds per square inch), it must be stored in special high-pressure containers. This is similar to the way compressed natural gas is stored on natural gas-fuelled vehicles.

At present, fuel cell vehicles have only been developed to what might be called the pre-prototype stage. That means there are very few fuel cell vehicles in existence, and all of them are actually used for testing. Some manufacturers claim they will have fuel cell cars available for the public in the next ten years.

7.15 Bio-diesel

Bio-diesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant greases. Bio-diesel is safe, biodegradable, and reduces serious air pollutants such as particulates, carbon monoxide, hydrocarbons, and air toxics.

7.15.1 Using bio-diesel in vehicles

Pure unblended bio-diesel can be poured straight into the tank of any diesel vehicle. As with normal diesel, low-temperature bio-diesel is sold during winter months to prevent viscosity problems.

Pure bio-diesel produced 'at home' is in use by thousands of drivers who have not experienced failure, however. The fact remains that bio-diesel has been widely available at gas stations for less than a decade and will hence carry more risk than older fuels. Bio-diesel sold publicly is held to high standards set by national standards bodies. Many conventional diesel car models have been certified to run on bio-diesel.

7.15.2 Bio-diesel safety

As with all vehicles, adequate training is required to operate and maintain vehicles running on bio-diesel. The flashpoint of bio-diesel is significantly higher than that of conventional diesel fuel, which makes the fuel safer in general. Neat bio-diesel is non toxic, biodegradable, and emits fewer carcinogens in the exhaust than conventional diesel fuel.

7.16 Hybrid vehicles

7.16.1 Hybrid vehicle (HV) battery pack

The hybrid vehicles contain a high voltage battery pack; it contains non spill able, sealed Nickel Metal Hydride (NiMH) battery modules. It is enclosed in a metal case mounted to the cargo area floor pan cross member behind the rear seat. This case is isolated from high voltage and concealed by a cover in the cargo area.

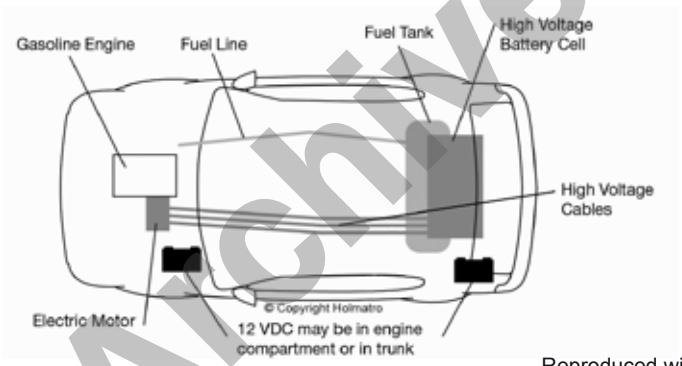

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Figure 7:4
Example Hybrid Vehicle

The proper procedure for safely deactivating or isolating the high voltage battery (as well as how to deal with other hazards) on each hybrid vehicle is outlined in the "Emergency Response Guide" published by each hybrid vehicle manufacturer.

WARNING

Note vehicles fitted with Smart Keys & Smart Electronic Key Technology do not have conventional keys. The smart key can enable the vehicle to recognise the smart key in close proximity to the vehicle. The system can lock/unlock without pushing the smart key buttons and start the hybrid system without inserting the smart key into the electronic slot. **Disconnect the battery**

If this is not possible, carefully cut the battery cables.

If possible, use insulated pliers, and cut the earth cable first. The earth cable is usually black and connects the battery to the vehicle body or engine. Do not allow the cutting tool to short against the vehicle body.

When isolating a battery a fine spray from a hose stream should be directed over the disconnection or cutting area. If a hose line is not available, use the spray from a pressurised water extinguisher or cut the cables under a wet rag to minimise the risk of a spark igniting any flammable vapour.

CHAPTER 8
VEHICLE SAFETY SYSTEMS

8.1 Introduction

Vehicle safety systems can be described as being active or passive. Vehicle manufacturers use a combination of both types of safety systems when designing cars. A good combination of safety systems can reduce the likelihood and severity of injuries to occupants involved in a crash.

8.1.1 Active safety systems

Active safety refers to everything designed to help prevent an accident from happening.

It can include features such as:

a. power-assisted steering systems that give the driver accurate feedback from the road
b. good suspension characteristics
c. optimum traction and good overall handling characteristics
d. effective brakes
e. engines with plenty of power reserve
f. seats that reduce fatigue
g. clear visibility
h. good climate control
i. clear, understandable and uncomplicated instruments and controls
j. electronic vehicle systems such as:
    i.) anti-lock braking system (ABS)
    ii.) traction control (ASR)
    iii.) electronic brake-force distribution (EBD)
    iv.) electronic differential lock (EDL)
    v.) electronic stabilization program (ESP), and
    vi.) voice control systems.

Together with the car's passive safety features, active safety systems help to provide optimum protection for all of the car's occupants.

8.1.2 Passive safety systems

The passive safety system is a general term covering all design measures intended to protect the car's occupants against injury or to at least reduce the severity of injuries.

This term refers in particular to the car's behaviour in collisions (crash tests) and not only includes protection of vehicle occupants but also for other road users (partner protection).

The increasing use of airbags has actually made rescue work more dangerous. Airbags can detonate long after the initial crash, injuring or even killing rescue workers who are inside the car. The addition of side impact airbags to the frame of the car has reduced the number of places that rescue workers can use hydraulic spreaders, cutters or other cutting tools to remove the car roof, or doors safely.

NOTE

Every emergency worker should be properly trained on how to safely deactivate airbags, safely work around them or be aware of the potential hazards. Disconnecting the car battery may be a good precaution.

8.2 Air bags

8.2.1 Air bag system components

An air bag system may consist of:

- crash sensors
- one or more air bag modules (depending on whether passenger or side bags are fitted)
- a back-up power supply
- an electronic diagnostic module, and
- a wiring loom.

The air bag is designed to inflate following a frontal or near frontal impact, or a side impact for side air bags.

Each air bag module contains an inflator (or gas generator), an igniter and a folded air bag, along with the hardware required to package it behind a special plastic trim cover. The trim cover incorporates tear seams which separate during deployment, allowing the bag to inflate.

The electrically-operated system includes a diagnostic module to self-test the system and identify any faults. A back-up power supply is also included in the system, should the battery of the vehicle become disconnected in the initial phase of the impact.

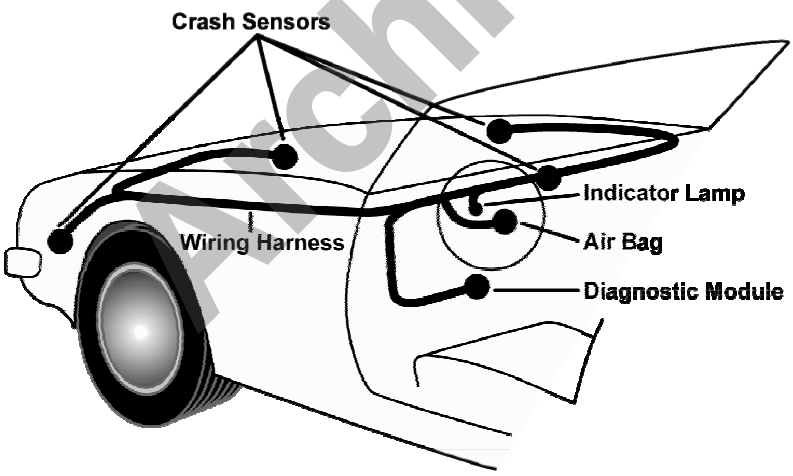

Figure 8:1
Air bag system components

8.2.2 Operation of air bag systems

When the crash sensors detect a deceleration of sufficient magnitude, a signal is sent (either electrically or mechanically) to the igniter. This causes solid chemical propellant sealed inside the inflator to undergo a rapid chemical reaction.

Following deployment of an air bag, some smoke will be present in the vicinity. This will be a mixture of small traces of baking soda combined with corn starch or talc which is used to lubricate the bag during deployment. There are no accessible parts of the system which will be hot. The air bag module is also designed to trigger if it reaches a temperature of 150 Celsius (e.g. a vehicle fire).

8.3 Airbag location

Airbags are a more recent addition to the armoury against road trauma. Most commonly, these are located in the centre of the steering wheel and above the glove box on the passenger side. They are designed to activate almost instantaneously on impact to form a cushion as the head and chest of the driver or passenger flex forward.

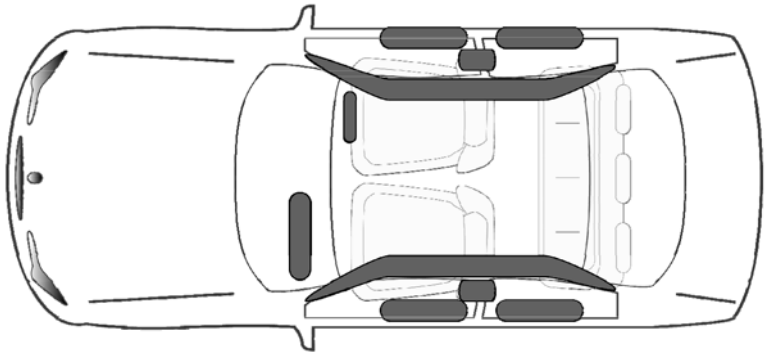

Figure 8:2
Common air bag locations

- Frontal airbags—the most common type of airbags are frontal airbags which are now fitted to almost all new passenger vehicles and trucks as standard equipment.
- Drivers—a basic driver airbag module consists of an inflator with an initiator, a textile bag (cushion), housing and a cover for the steering wheel. The most common inflators are pyrotechnic inflators, which contain a non-azide gas generator.

  Dual stage or "adaptive" airbags are a "smarter" generation of airbags that can optimise the level of airbag deployment to suit the severity of the crash.

  The airbag is of a variable volume and can be inflated in two stages:

  i.) stage one for severe impacts, and

  ii.) stages one and two for more severe impacts.

  The level of occupant protection is improved accordingly and the risk of secondary injury reduced.
- Passenger—the passenger airbag is located in the instrument panel of the vehicle. Passenger airbags vary in size and shape and are matched to the vehicle. The usual cushion size varies from 90 to 150 litres.
- Anti Slide—the Anti-Sliding Bag is installed in the front edge of the seat cushion to reduce the risk of the occupant sliding under the seatbelt in a crash.

  The system keeps the occupants knees and legs at a safe distance from the instrument panel and improves the protection of the seatbelts by reducing the risk of injuries to the abdomen.

  It also improves the protection provided by the frontal airbags by keeping the occupant in a more upright position so the occupant's impact is against the entire bag instead of just the lower part of the bag.

  Anti-Sliding airbags if un-deployed in an accident are able to inflate in some circumstances; all care should be taken when working around this airbag.
- Knee—these airbags work in concert with the normal frontal airbag and seatbelt systems to help balance occupant loading across the body. The bags are shaped to help provide protection for the knees and surrounding parts of the legs.
- Foot well—foot well airbags are usually mounted underneath the carpet and are used to protect the feet and lower legs in two different ways.

  i.) The first method is to provide initial impact energy absorption if the foot or feet are not in direct and flat contact with the floor or footrest. If a foot slides off a pedal or is "in space" then the initial impact can cause significant injuries in a high speed impact.

ii.) The second method is to provide secondary cushioning and foot mobility during the quasistatic loading phase. If there is major intrusion and the ankle locks up, then serious injuries can occur. The additional compliance of the airbag can limit the ankle lock-up load. Also in this circumstance, a degree of lateral mobility provided by the "lubricating" effect of the airbag may be beneficial.

- Seat belt airbag—there are currently two main types of seat belt airbag available.

  i.) The first is a belt from which the bag inflates to provide a greater contact area with the chest. This type can also provide some head and neck protection in side and angled impacts on the diagonal upper anchorage side.

  ii.) The second type of seat belt airbag is a type where the belt is a delivery system for a larger frontal airbag and the airbag is designed to cushion an impact with an object in front of the occupant. That object (such as another seat) provides the reaction load path for the airbag.

8.3.1 Side airbags

Side-impact collisions account for a quarter of all injuries to car occupants, but they account for more than one third of the serious and fatal injuries. One major reason is that the side of the vehicle is a thin crumple zone and the space between the occupant and the side of the vehicle is small.

- Side Airbags—there are several types of side airbags, including door trim, seat and roof mounted 'inflatable curtain' types. Some protect the chest, some the head and neck, and some a combination of these. Side and particularly head protecting airbags are an important addition to any vehicle

  Combination head and torso airbags mostly activate from the seat, but some types deploy from the door, offering protection to both head and body in side impact crashes. Combination designs are however less effective than curtain airbags in rollover crashes. Also, side airbags without the combination of head / torso design only protect the chest and thorax area, not the head.

- Head / Thorax Bag—the Head / Thorax airbags are estimated to reduce serious chest injuries in side-impact collisions by approximately 25%.

  Since the occupant is kept away from the intruding vehicle side, protection of the head is also improved. To achieve more improved protection, the thorax airbag's coverage area is extended to the pelvic area in order to distribute load over the thorax and pelvic parts of the occupant's body.

  The system consists of a sensor and a module. The module can be installed in the back rests of the front seats. The sensor is placed in the door or in the B pillar area and connected to the ECU (Electronic Control Unit) of the vehicle's other safety systems. The bag usually has a volume of 12 litres to make it as gentle as possible but still efficient enough to provide required protection.

- Curtain Airbags—curtain airbags are designed to protect the driver's head in a crash. Curtain airbags activate instantaneously, deploying from the top of the door rails above the side window.

  They form a cushion between the driver and the window and stay in place if the car rolls over to protect the occupant's head.

- Inflatable Tubular Structure (ITS)—the Inflatable Tubular Structure (ITS) was the world's first airbag for head protection and was introduced in 1997 by BMW for cars. The ITS consists of a unique nylon tube, installed in the headlining above the frontal doors and

inflates to a diameter of about 15 centimetres and deploys in the passenger cell.

This module deploys fast to be interposed between occupant's head and any stiff hurting object, thereby being able to absorb energy and decrease any Head Injury Criterion (HIC).

- Door—the Door Mounted Inflatable Curtain (DMIC) provides a large side coverage area in vehicles which have no roof, such as convertibles. Thanks to chamber design, this module offers even protection and real Inflatable Curtain (IC) performances.

  Currently, many convertible vehicles use "combo bags" for side impact protection. These are chest bags with an extension that inflates upwards to protect the head. But the extension can be very wobbly since it is not attached to any roof pillars. There is also a risk that the occupant's head misses or slides off the relatively narrow head extension.

  To address these drawbacks, manufacturers have developed a specially designed door-mounted airbag which is made up of a multitude of small cells in three layers (like a beehive). This structure gives it stability and as a result it can be used in different situations, such as rollovers, since the structure will be strong enough to hold the occupants safe inside the vehicle.

8.4 Inflator / Gas generator

The basis for the fast deployment of airbags is an inflator, which can produce the necessary gas for the inflation of the airbag quickly enough. There are basically two different types of inflators:

- Pyrotechnic inflator—uses a solid propellant that is ignited, after which the high-speed chemical reaction produces a large volume of nitrogen gas that fills the airbag.
- Compressed gas inflator—normally a mixture of inert gases that is stored in a pressurised cartridge at between 200 and 700 bar. The cartridge is opened by a small pyrotechnic charge after which the gas is released into the airbag.

8.4.1 Inflator / gas generator hazards

Crushing inflators / gas generators is a hazard when dealing with airbags because:

- the solid propellant can be health threatening when exposed, and
- cutting an inflator can result in flying parts or deployment of the attached airbag.

8.5 Rescuers guidelines for air bag systems:

8.5.1 Fire in air bag-equipped car:

Use standard fire-extinguishing procedures.

NOTE
Un-deployed air bags may deploy.

8.5.2 Air bag deployed:

Use normal rescue procedures and equipment.

- Wear prescribed protective clothing / equipment (gloves and eye protection must be worn).
- Avoid getting air bag powder / dust into eyes or wounds (this applies to rescuers and vehicle occupants).
- Push deflated air bag aside for access.
- Be aware of hot parts under the air bag fabric (inside steering wheel hub). The air bag fabric, steering wheel column and rim will not be hot.

- Wash hands after handling deployed air bag.

8.5.3 Air bag not deployed:

An air bag is unlikely to deploy after a crash.

- Never cut or drill directly into an air bag module.
- Do not touch exposed chemicals if the inflator canister is opened.
- Deactivate the air bag (disconnect the battery) and commence normal rescue procedures.
- While the air bag is being deactivated, or if it is unable to be deactivated the following should begin immediately:
    - i.) DO move a stabilised occupant as far rearward from the air bag as possible.
    - ii.) DO turn off the ignition.
    - iii.) DO disconnect the battery (be aware this may not deactivate the system).
    - iv.) DO perform rescue efforts from the side of the vehicle away from the bag deployment path.
    - v.) DO keep your body and objects / tools off the trim cover and away from the bag deployment path.
    - vi.) DO NOT apply sharp blows to the steering column or dash board.
    - vii.) DO NOT cut into the steering column or apply heat near the air bag module (it is OK to cut the steering wheel rim or spokes).

WARNING

If in doubt, assume an air bag is fitted to the vehicle.

Back-up capacitors in air bag systems may still be capable of triggering an air bag after power is disconnected (up to 30 min). Refer to manufactures specifications.

Mechanically-triggered systems may be deactivated in the field, however, this action is not recommended during rescue operations.

Further information can be obtained from the latest editions / information of the following:

Further information can be obtained from the latest editions / information of the following:

- Emergency Rescuers Guide to Cars Fitted With Air Bag Supplemental Restraint System (Air Bag SRS).
- Vehicle Manufacturers.
- Automobile Clubs or Associations.

8.6 Seat belt systems

In high-speed collisions, rib and abdominal injuries may be suffered, especially if the seatbelt is not correctly positioned. These risks are minimized with seatbelt pretentioners and load limiters. These seatbelt products are also instrumental in integrated systems, where the effects from the seatbelt and the airbag are optimally tuned to each other during every phase of a crash.

- Location—Seatbelts are generally located where ever there are seats; all modern vehicles are three point belts lap and sash. Apart from some vehicles where they have only a lap belt, usually found in earlier model vehicles.
- Belt in Seat—In a Belt-in-Seat (BIS) system, the shoulder belt is attached to the backrest of the seat instead of to the B-pillar between the doors.

This position allows the shoulder belt to better wrap around the occupant's body, thereby increasing the efficiency of the belt system. In roll-over accidents, it also contributes to keeping the distance between the head and the roof. Moreover, the BIS system is very convenient in the case of removable seats or flexible arrangements. Pretentioners are also located in the backrest of the seats, on the floor or in the seat as in busses.

- Buckles—a seatbelt buckle must be able to withstand extremely high loads during a crash. At the same time, it must be easy to open even when heavily loaded (if, for instance, a person is left hanging upside down in the belt).
- Height Adjuster—Height adjusters improve the seatbelt's protective effect by achieving correct belt geometry. They also increase the ease and the comfort of use for car occupants of above or below average height. Some manufacturers offer both manual and fully automatic height adjusters.

  Height adjusters are made from addition steel for strength and are inserted into the door pillar and can impede the cutting of the pillars if the incorrect cutter or cutting technique is adopted.

8.6.1 Seat belt pretentioners

Seat belt pretentioners are devices which:

- operate in support of air bag systems to further restrain the occupants during rapid deceleration
- are used to make sure a seatbelt restrains an occupant as early as possible in a crash, thereby reduce the load on the occupant in a violent crash
- use pyrotechnic devices that are typically activated by the same sensor as the airbag
- trigger only on frontal or near frontal impacts
- can be either mechanically or electrically-triggered, and
- tighten the belt during the very first fractions of a second in a crash.

Pretentioners also reduce the risk of "submarining", which is the car occupant slipping under a loosely adjusted seatbelt.

Pretentioners can be fitted directly to either or both of the lower anchor points (i.e. Reel or buckle).

- Lap Pretentioners (buckle)—Lap pretentioners offer high-power performance and a long pre-tensioning stroke the pretentioner package can extract large amounts of belt slack during a crash event.
- Pillar Pretentioners (reel)—Pretentioners located in the pillars can use the same pre-tensioning mechanism as found in the Lap setup; they can also have a retractor with a locking mechanism that stops a spool from rotating when the car is involved in a collision.

Identification—as with air bag systems, no standard or required markings currently exist to identify vehicles with pretentioners fitted. Given that seat belt pretentioners are generally found in the presence of an air bag, the rescuer should first establish this fact. Following this, the only tell-tale signs that a pretentioner is likely to be installed, will be either an enlarged inertia reel housing, at the base of the 'B' pillar, or possibly an enlarged seat belt buckle anchor housing. As with air bags expect the device exists until proven otherwise.

Rescue considerations

- Release the belt by cutting at least 30 - 45 cm from any anchor point. This will allow the belt to retract, if the device has not deployed.
- Considerable care should be taken when cutting or ramming at the base of the 'B' pillar, to ensure that the device, if present, is avoided. Extrication should, however, not be compromised.

- Some vehicles are fitted with a height-adjustable shoulder anchor point. From an extrication point of view, this device presents no danger to the rescuer, however, allowance will have to be made, when cutting the top of the 'B' pillar, for an increased diameter and extra metal.
- There is a strong possibility that pretentioners will trigger in a fire situation, given their pyrotechnic nature.

8.6.2 Load Limiters

Load limiters absorb the load in a crash in a very efficient way by keeping the belt force at a controlled and pre-defined level. This is accomplished by a mechanism in the retractor that allows webbing to be pulled out slightly - and in a controlled way - if the load on an occupant's body becomes too high in a violent crash.

The system is typically used in combination with an airbag which then absorbs the excessive energy. This is especially important for elderly, since studies have shown that a 60 year old person can only take half as much load on their rib cage as a twenty year old person.

The load limiter is typically integrated with the retractor, where a specially designed bar holds the spindle with the webbing. When the force from the webbing reaches a pre-set level, the bar will twist, allowing the spindle to turn and thereby limiting the load on the occupant's chest.

Seatbelt systems with load limiters typically also have pretentioners.

- Belt Grabber—the belt grabber prevents the so-called "film-spool effect" - a payout of the belt as loading tightens the stowed webbing. The result is a lower risk of displacement for the occupant during the crash.
- Degressive load limiter—in the initial onset of the crash, when the occupant is only restrained by the belt, the restraining force of the seatbelt is held at a relatively high, constant level. The degressive system gives a high and relatively even load on the occupant's chest during the whole crash.

As the occupant moves forward and into the airbag, the belt's load limiter gradually moves down to a lower restraining force that will reduce the risk of an excessive peak load that could occur if the restraining forces of the two safety systems were added to each other.

- Smart Belts—Smart Belt Systems use a switch mechanism to adapt its restraining force – and hence the load on the occupant – to the severity of the crash and to the restraining force of the airbag.

In a crash, the Smart Belt System starts by tightening the belt, using a pyrotechnic pretentioner. This eliminates slack and makes it possible to release some webbing at a later stage, if the load on the occupant becomes too high.

In a traditional system, the loads to the occupant from the seatbelt and the airbag are added to each other when the bag also starts to restrain the occupant. On the Smart Belt System, however, the system just shifts into the second, lighter gear to maintain the restraining force at a relatively constant level.

In addition, the Smart Belt can adapt its restraining force – and hence the load on the occupant – to the crash severity. In a very violent crash the Smart Belt just stays in the first gear a little longer before it shifts down into the second, lighter gear.

If the vehicle is equipped with an occupant weight sensing system, it is also possible to adjust the seatbelt load individually to each occupant. This is an important advantage since smaller, lighter weight occupants, such as many women, are more susceptible to high belt loads than the average person, and these individuals do not need the same restraining force as a larger occupant.

8.7 Roll over protection system (ROPS)

There are two types of rollover protection systems currently being used, the more common fixed rollbar and a deployable rollbar system.

8.7.1 Deployable ROPS

There are now three auto makers using automatic deployable roll-bars, either a pop-up or flip-up style. Automatic rollbars may be identified by the manufacturer using an icon, or the letters RPS or ROPS. The pop-up model is mounted behind the occupant seat, while the flip up looks much like a conventional flat rollbar and rotates upward from the rear deck toward the front of the vehicle. Unlike the fixed rollbar, deployable rollbars are somewhat concealed until activated then they will rise up to their travel limit in less than three tenths of a second. Once ROPS have been deployed, they are locked into place and must be manually reset.

BMW, Volvo and Mercedes have been using them in production models for some time, but with little publicity until recently published in some automobile periodicals.

Both the Mercedes pop-up and flip-up systems are hydraulically deployed. The Mercedes pop-up system has a single one piece bar with two “U” shaped bends extending up through two openings.

Volvo and BMW use a dual spring mechanism housed in each of the two separate cassettes to launch the rollbars.

Since the roof is normally part of the side impact protection system, other solutions have to be found for convertibles. The structure around the passenger compartment may be formed like a horseshoe to absorb and dissipate the force of an impact together with the floor and side impact protection system structures.

8.7.2 Activating the ROPS

Some ROPS / RPS systems are activated by an inclinometer to sense vehicle inclination and lateral acceleration. There is also a G-sensor that detects vehicle weightlessness. According to BMW, their system will deploy when the control module senses any of the following:

- When the vehicle approaches a lateral angle limit of 62 degrees.
- When the vehicle experiences a lateral acceleration of approximately 3 Gs.
- When the vehicle approaches its longitudinal angle limit at approximately 72 degrees.
- When a combination of longitudinal acceleration and longitudinal angle would cause the vehicle to roll over in the forward direction.
- When the vehicle becomes airborne and achieves weightlessness for at least 80ms.

The RPS / ROPS is like any SRS in that there is a controller with backup power supply capacitors which will allow the system to function even if the vehicle power is interrupted in an accident. The controller looks exactly like the SRS controller box, use the same precautions as you would for the SRS controller. The Volvo and Mercedes ROPS have a reserve power drain down time of approximately five seconds. BMW deactivation time is one second from the point of cutting the power source. Cutting the power source is very important and should be done as soon as possible. Remote batteries are now common and hidden in some vehicles. Another common problem is that you may not be able to access the battery due to the nature of the crash. In this case casualty care should not be delayed; a safe operating distance should be used around all un-deployed RPS until the system has been deactivated.

8.8 Adaptive head restraints

Many current head restraints rely on the occupant to correctly adjust the height to suit their stature. Whilst drivers may adjust the position of their seat for optimum control over the vehicle, it is not necessary to do this with the head restraint and consequently, the height adjustment is often forgotten or neglected. The height of the restraint can significantly affect the injury outcome in a rear impact.

There are possibilities, and one is an adaptive head restraint, which automatically adjusts to the correct height of the occupant. This can be done in one of two ways. The restraint could identify the driver's head position from a sensing device and could subsequently power the head restraint into the correct position. Alternatively, the head restraint could be re-positioned during the impact, using the kinetic energy of the occupant's torso. This technique is used in the Delphi / JCI system fitted to a SAAB 9-3. This particular system also moves the head restraint forward as well as upwards, thereby reducing the motion and relative velocity of the head at impact.

An alternative to adaptive head restraints is a head restraint airbag system. These can deploy from the top of the seat in front of the head restraint, deploy pushing the head restraint upwards or can deploy from the head restraint itself. These have the benefit of providing support further forward and therefore sooner than an adaptive head restraint. The potential benefits may be limited for very tall occupants with very low head restraints, if the airbag does not have adequate reaction load support.

8.9 Collapsible pedals

Collapsible pedals may be used to control initial foot impacts and to reduce the risk of a trap hazard as the pedal remains below the foot. However, the most likely position for the right foot in an impact is on the brake pedal. This pedal absolutely must not collapse under normal use or emergency braking use or control of the vehicle may be lost.

8.9.1 Collapsible pedals

These can occur in a crash when firewall intrusion drives the pedal box back at the driver while the leg is firmly locked and pushing hard on the brake pedal.

This occurs because there is a rigid link between the brake booster (mounted on the firewall) and the pedal box.

The collapsible pedal system works by decoupling the solid linkage between the brake booster and the pedal box, via an ingenious system of actuators that disconnect the brake booster push rod when a deformation threshold is breached by the firewall.

The solid link between the firewall and the brake pedal - and thus the driver's leg - is then removed, helping to lessen the potential for lower leg injuries common in this type of crash.

8.10 Batteries

8.10.1 Lead acid

Lead-acid batteries are physically large batteries that contain lead plates in a solution of acid to create electricity. They are a common power source for many applications; mostly cars, trucks and busses.

The electrolyte is a solution of sulphuric acid (35%) and water (65%). This solution can cause chemical burns to the skin and especially to the eyes. Lead acid batteries produce hydrogen and oxygen gases (highly flammable / explosive) as electrolysis occurs.

When the battery is engaged, it may create a spark that ignites the accumulated gases and causes the battery to explode.

8.10.2 Battery location

Generally accepted procedures require rescuers to access the battery early in their operations at a crash scene. Typically this involves opening the bonnet and looking for the lone battery. Today's reality is that not only can there be more than one battery on the vehicle, there's a good chance that the battery or batteries may not even be under the bonnet.

Vehicles with the engine in the front of the vehicle usually have the batteries located in the engine compartment front and rear, with some having them under the drivers or passenger feet or seat, under the passenger's seat (Hybrid) and in either side of the boot or in the centre. Vehicles with the engine in the rear can be the opposite.

Multiple batteries are common on diesel-powered trucks and busses, the main bank of batteries can be anywhere along the outer chassis on either side of the bus or truck, trucks can also have the battery located on top of the chassis rail just behind the cab. They are usually marked on the body work and are located next to a shut off or kill switch. Supplementary batteries are also fitted for running additional electrical systems such as entertainment systems and refrigeration units, these batteries can be located away from the main battery bank.

8.10.3 Disconnecting batteries

When disconnecting the battery before commencing work on the car, you should disconnect the negative, black lead first, here's why:

a. The battery has approximately a 12v "potential difference" between its positive and negative lead and, due to the construction of the battery; it is able to deliver extremely high currents (around 300A to start the car for example).

   The average car battery is capable of delivering around 2.7KW (KILOWATTS!) for a short time so the potential for excitement and heat are large. Treat the battery with respect! It can't electrocute you in the acknowledged sense as the volts are too low, but it can and will produce enormous heat if connected in a way which shorts the two terminals together.

   In order to save on lots of unnecessary wiring, all cars with metal bodies use the chassis of the car as one of the wires. This is called "grounding" or "earthing" in car electrical parlance and thus saves 50% of the wiring (and associated expense) that would otherwise be needed. (Thus fully fibre-glass cars need lots more wire). It doesn't actually matter which terminal, either positive or negative, is grounded to the chassis.

   Both will work equally as well. However, in order to have standardisation in the motor industry worldwide in terms of how components and equipment are constructed, virtually all vehicles today use a negative earth.

b. Now you will only get a big bang if you connect the two terminals together. So if you leave the negative lead connected and, whilst disconnecting the red positive lead, your spanner happens to touch the chassis while its other end is around the bolt on the positive, you will have connected the two terminals together through your spanner and it will become a permanent part of your chassis as 300 amps flow through it and weld it to the car! You will also probably let go of it very smartly as its temperature reaches that of the Sun!!

   Conversely, if you disconnect the negative lead first, thus also disconnecting the chassis from having anything to do with the battery, then your spanner can be round the positive and touch the chassis with no ill effects.

   Cutting the battery cable is recommended or when you have undone the negative lead, and tuck it safely out of the way so that it can't suddenly spring back and touch the negative of the battery again before the work is finished.

8.10.4 Hybrid high voltage battery isolation systems

How do hybrids isolate their energy system upon impact? Each vehicle is different so it would be improper to generalise a response. The proper procedure for safely deactivating or isolating the high voltage battery (as well as how to deal with other hazards) on each hybrid vehicle is outlined in the “Emergency Response Guide” published by each hybrid vehicle manufacturer.

High voltage systems on a hybrid may be shut down and isolated to the battery pack itself when:

- the sensors monitoring that circuit detect a disruption of continuity

  If any high voltage wire, of the two or three that may be bundled together, or any connectors are damaged and touch any metal object or part of the vehicle itself, the circuit sensors will immediately detect a fault in the circuitry, drop (close) the relay, and isolate the high voltage power to the battery pack itself.
- airbags deploy
- involved in a crash with damage to the battery pack or the wiring or high voltage connectors
- the 12-volt electrical system is lost either due to crash dynamics or rescuers disconnecting the battery
- water reaching the relay at the end of the high voltage battery

8.10.5 Battery disconnect safety devices

Battery Disconnect Safety Device (BDSD) is becoming standard equipment on vehicles produced by many German automakers known for their leadership in technology. This technology could also be used in hybrids, trains, boats and commercial vehicles.

The BDSD serves to interrupt electric connections.

In automobiles, an electric signal from the airbag control unit triggers activation, severing the current that flows through the cable connecting the battery with the starter and alternator. High currents that flow through this cable while starting the vehicle prohibit the use of fuses. If this cable, the largest electrical cable in an automobile, is not protected, current that continues to flow through it following a vehicle crash poses the threat of high-temperature short circuits and arcing, which could lead to a fire.

The BDSD is also available with a safe engine restart option that allows drivers to restart their vehicles following a collision if there are no electrical hazards. This feature enhances safety by enabling drivers to move their vehicles off the road, preventing the occurrence of a possible second collision.

The safe engine restart option incorporates a standard fuse that is mounted parallel to the BDSD. After the BDSD is triggered, severing the current, this fuse allows for a warm-engine restart providing the event that triggered the BDSD did not cause a short circuit. If the crash did result in a short circuit, this fuse blows immediately, preventing an unsafe restart.

8.11 Pedestrian protection

8.11.1 Active bonnet

Active bonnets rise instantly when a pedestrian is hit. A sensor system placed in the vehicle’s front bumper sends a signal to two steel bellows which lift the rear part of the bonnet making the pedestrian’s head contact a deformable and flexible surface instead of a hard and rigid one. The sensor is sufficiently accurate to differentiate between a lamp post and a human leg.

8.11.2 Pedestrian protection airbag

Some manufacturers have further enhanced pedestrian protection systems by developing a pair of airbags, one at each windshield A pillar. As vehicle bonnets tend to become shorter with every new model change, the risk for pedestrians hitting the hard structures around the windshield increases, but this can be prevented by the pedestrian protection airbag.

The windshield itself is a deformable surface and this, in combination with a deformable bonnet and energy absorbing airbags at the side pillars, result in a combination that is both very efficient and comprehensive in terms of addressing the vehicle areas that are most dangerous for the pedestrian.

8.12 High voltage xenon lighting

Xenon light is based on the gas discharge principle, whereby an arc of light is created between two electrodes in an extremely small tube filled with inert gasses. Gas discharge bulbs have no filament, so they need an electronic controller and starter to ensure a fast reliable start and hot re-strike.

Xenon has two decisive advantages over the light of conventional light-bulbs:

a. A xenon light source delivers twice the light output of a modern H7 bulb while consuming only 2/3 of the energy.

b. The improved light output makes the road brighter and illuminates a wider area.

HID headlamp bulbs do not run on low-voltage DC current, so they require ballast with either an internal or external igniter. The ballast controls the current to the bulb. When the headlamps are switched on, the igniter provides rapidly pulsed current at several thousand volts to initiate the arc between the electrodes within the bulb. Once the arc is started, its heat begins to vaporise the metallic salts within the arc chamber, and the ballast gradually transitions from start-up operation to arc-maintenance operation.

8.13 Vehicle ignition

Vehicle ignition systems are turning up in some unlikely positions, due to manufacturers constantly striving to optimise the best location to start your vehicle and the operation to start it.

8.13.1 Keyless authorization systems

Keyless authorization systems allow the driver to keep the key in their pocket when unlocking and starting the vehicle. The key is identified via a proximity sensor in the vehicle and a radio pulse generator in the key housing as soon as the driver is within range of the vehicle. Keyless authorization systems are being used in cars and motorcycles.

Depending on the way the manufacturer has implemented the system the driver may or may not have to:

- actuate a door handle prior to opening the door
- unlock the steering
- actuate the ignition system
- apply brakes or a specific gear prior to starting the engine
- apply brakes or a specific gear prior to shutting down the engine
- actuate a door handle or button after leaving the car to lock it

8.13.2 Starter button

Starter buttons can be found on the dash of the vehicle, console around the gear shift leaver and the top of a gear shift leaver.

Manufacturers use keyless authorization systems under different names:

Vehicle Make	Name
Acura	Keyless Access System
Audi	Advanced Key
BMW	Comfort Access
GM	Adaptive Remote Start & Keyless Access
Lexus	Smart Access System
Mercedes Benz	Keyless Go (integrated into Smart Keys)
Mitsubishi	Fast Key
Porsche	Entry & Driver System
Toyota	Smart Key System
Mazda	Advanced Keyless Entry & Start System
Volvo	Personal Car Communicator “PCC” and Keyless Drive
Renault	Hands Free Keyless Entry

CHAPTER 9
EMERGENCY CARE

9.1 Introduction

Ideally all Road Rescue personnel should be trained to a suitable level in first aid procedures as occasions will arise where rescue personnel will have to take first aid initiatives in the absence of ambulance or qualified medical personnel. This chapter is a guide to those primary first aid principles.

For further information on this aspect of Road Rescue consult your state / territory first aid authority's doctrine.

Rescues will be conducted under almost every conceivable adverse condition. The method used for casualty removal will depend on the location of the casualty and the type of injury sustained. In some rescue operations, casualties may be lifted directly from the wreckage, whilst other extrications may involve a large amount of debris removal and disentanglement. When casualties are handled by rescue personnel, care must be taken to ensure that further aggravation of injuries does not occur.

Be aware that the safety of the casualty is paramount, even when immediate evacuation from a hazardous environment is necessary.

Make a careful assessment of the casualty's injuries, condition and possible entrapment and make a final check to ensure that the casualty is actually ready to move and is not caught or entangled in an unseen object.

Speed of removal is important, but it must be consistent with safety and proper handling to prevent further injury.

WARNING

The importance of first-aid training cannot be overstated. All rescuers must be trained to a reasonable qualification level of first aid and life support in order to be able to handle casualties safely and effectively.

The method used will depend on the immediate situation, the condition of casualties, types of injury and available equipment. Rescue leaders should conduct frequent exercises in the removal of casualties, using live people as casualties to give team members understanding and confidence in the various methods, enabling them to make decisions promptly in times of emergency. As important as learning the methods, rescuers should experience the physical effort required in extricating casualties from a vehicle wreck as it can be a hazardous and extremely awkward operation requiring a degree of personnel fitness.

9.2 First aid priorities

In a medical emergency it is necessary to have an action plan, one that will work every time, regardless of the type of incident. The following action plan can be used as a guide and is based upon the Australian Resuscitation Council (ARC) guidelines. For current practice consult the ARC guidelines.

The following is a suggested sequence for action.

9.2.1 First aid priorities

First aid priorities are:

a. Dangers

b. Response

c. Airway maintenance

d. Breathing

e. Circulation

f. Haemorrhage control

g. Crush injury management

h. Fracture immobilisation, and

i. Communicable diseases.

NOTE

All casualties need to be treated as if they have a communicable disease.

9.2.2 Dangers:

a. Yourself - universal PPE (e.g. medical gloves, safety glasses)

b. Casualty

c. Bystanders

If unsafe, wait for expert assistance to arrive.

Do not become the next casualty

Remove danger from the casualty, or if necessary remove the casualty from the danger.

Warn bystanders of any danger and ask them to keep a safe distance.

9.2.3 Response:

Gently touch and talk to get a response.

If no response (casualty unconscious) proceed with Airway maintenance, Breathing and Circulation (ABC). Preference would be to position casualty in lateral position (on left or right side). In the event of a casualty being entrapped it may be impossible to change casualty position so the ABC may need to be maintained in a sitting position.

If casualty has response proceed to systematic assessment and treat life threatening complaints as needed.

9.2.4 Airway

Look, Listen and Feel

Open the mouth, clear if needed and keep the airway open by head tilt and jaw support

9.2.5 Breathing

If breathing has stopped, the rescuer must breathe for the casualty after first clearing the airway (i.e. Rescue Breathing).

If breathing take a note of breathing rate, rhythm and effort.

9.2.6 Circulation

If the casualty's heart has stopped beating, artificial circulation must be provided (External Cardiac Compression / ECC)

If a pulse is found take note of pulse rate.

NOTE

That if a casualty is breathing they will have a pulse

Problems with airway, breathing and circulation are all separate problems dealt with individually. However, they must also be considered collectively as part of a total package. Any casualty may need management of only one or possibly all three of these areas.

NOTE

Refer to local medical / first aid protocols for first aid and CPR.

9.3 Haemorrhage control

Since body functions depend on an adequate and uninterrupted supply of blood, any opening in the circulatory system through which blood may be lost should be considered dangerous.

Severe or continued bleeding may lead to collapse and death.

Bleeding may be external, internal or both. When bleeding occurs internally, treat for shock and elevate the lower extremities if possible. This casualty must be transferred to a medical facility as quickly as possible, since surgical procedures may be required to stop the bleeding.

The rescuer must be able to recognise, and if possible, control and manage a haemorrhage.

NOTE

External bleeding from the ear canal must not be stopped under any circumstances. Given this situation the blood and or clear fluid should be allowed to drain freely from the ear.

9.3.1 Types of external bleeding

Bleeding is classified according to its source:

- Arterial bleeding

Arterial bleeding is characterized by the flow of bright red blood that issues from the wound in distinctive spurts.

- Venous bleeding

Venous bleeding is characterized by a steady flow of blood that appears to be dark red. Although it may be profuse, it is much easier to control than arterial bleeding.

- Capillary bleeding

Capillary bleeding is characterized by the slow oozing of blood, usually from minor wounds such as abrasions. It is easily controlled. Normally the threat of contamination may be more dangerous than blood loss.

9.3.2 Control and management

There are very few situations in which external bleeding cannot be controlled. Since this is one of the most common conditions that rescuers will encounter, they should be thoroughly familiar with the techniques of bleeding control.

Severe external bleeding from sometimes gruesome wounds taxes the presence of mind and self-control. The ability to think clearly, act calmly and keep a tight rein on emotions is most important. The methods of controlling external bleeding will be discussed in the order of priority.

9.3.3 Direct pressure

The most effective method of controlling external bleeding is by pressure applied directly over the wound and then elevation of the site if possible. This should then be followed by the application of a suitable dressing pad and bandage.

9.3.4 Pressure points

If bleeding cannot be controlled using direct pressure in conjunction with elevation, especially when an extremity is involved, pressure on a strategic pressure point may be required.

A pressure point is a site where the main artery to the injury lies near the surface of the skin and directly over a bone.

9.3.5 Constrictive bandage

If direct pressure and the use of pressure points do not effectively control external bleeding, a constrictive bandage should be used, but only as a last resort. Another method could be the use of a blood pressure cuff and pumping it up till the bleeding has stopped. Such situations are rare and usually involve traumatic amputations. If a constrictive bandage is applied to a limb, it must only be removed by a medical officer.

REMEMBER

A constrictive bandage must be at least 3 cm in width and should be used only to control life threatening bleeding that cannot be controlled by other means.

Even then it should be used only with the complete understanding that it may mean the loss of the limb to which it is applied.

9.4 Spinal injury

Spinal cord damage from injury causes long-term disability and can dramatically affect quality of life. In vehicle incidents, spinal injuries are often overshadowed by more obvious and gruesome injuries like fractures, lacerations to the face and body and chest injuries.

Poorly trained rescue personnel often have trouble identifying spinal injuries and if they do find a spinal injury, it is usually after the more obvious wounds have been treated and the casualty has been moved. By this time any spinal injury caused during the accident will have been made worse, and the casualty may now have permanent and irreparable damage.

For this reason it is vital that the rescuer be able to recognise a spinal injury and be able to immobilise the spine quickly and correctly. Correct immobilisation may mean the difference between complete recovery, a lifelong paralysis, or even death.

9.4.1 Recognition

For any person who has been involved in a motor vehicle accident, the rescuer should assume a spinal injury if that person:

- is unconscious or has a significant head injury
- complains of pain in the neck
- complains of numbness, tingling, or ‘pins and needles’, in any limb or limbs
- complains of inability to move, or decreased strength in any limb or limbs
- complains of electric shock sensation on movement
- has obvious deformity of the spine, or
- is paralysed

9.4.2 Management

NOTE

All casualties with neck pain, injury or deformity should be managed as follows.

a. ABC of first aid

The most important thing to remember is the 'ABC' (i.e. Airway, Breathing, and Circulation) of first aid, resuscitation being the primary function.

b. Immobilise

If an injury to the neck or back is suspected, the spinal column must be immobilised.

i.) The head and neck supported by hand until other support can be arranged; this is most important if the casualty is found in a sitting position, as when trapped in a motor vehicle.

Figure 9:1
Head and neck support

When the manual in-line stabilisation is first preformed, your hand positioning is important as the cervical collar can be applied without readjustment of the in-line stabilisation which will decrease the chance of movement.

ii.) The application of a cervical collar if available. A correctly fitted cervical collar only provides approximately 50 % protection to the cervical spine; it provides no thoracic or lumbar spinal support.

iii.) The application of an extrication jacket (KED or NIEJ or device approved by your service) should also be used for all sitting casualties to decrease movement in the spine during extrication.

iv.) The use of a long board in conjunction with the cervical collar and extrication jacket in the extrication process allows the casualty to be moved smoothly and safely with the most amount of protection to the spine. It also takes away some of the OS&H issues of lifting a casualty in the crash environment which rescuers face on a day to day basis.

c. Lift casualty in position found

It is most important not to move the spine prior to immobilisation.

d. Don't move casualty unnecessarily

WARNING

If you don't think about a spinal cord injury

YOU WILL MISS IT!!

9.5 Crush injury / syndrome

Crush injury results from the application of a crushing force to any part of the body. A major crush injury may lead to the development of 'crush syndrome' following release of the crushing force.

9.5.1 Crush syndrome

Crush syndrome is a complication which may occur following the release of a compressive force which has compressed a major muscle mass for a period exceeding sixty (60) minutes. The crush syndrome may lead to sudden death, shock or other heart and lung emergencies. The syndrome occurs as a result of harmful chemicals being released from the damaged muscles and the reabsorption of these chemicals back into the blood stream following removal of the crushing force.

9.5.2 Signs and symptoms

- Compression in excess of 60 minutes
- Involvement of a large muscle mass
- Absent pulse and capillary refill return to distal limb
- Cold clammy pale skin
- Weak, rapid pulse
- Usually absence of pain in affected region
- Onset of shock

9.5.3 Approach to removing the compressive force

It is important that rescue personnel be able to recognise a trapped casualty suffering a compression (crush) injury and to have an understanding of the techniques in releasing the compressive force and the management of the possible resulting syndrome. If this situation is not understood and correctly managed, it can lead to death of the casualty.

NOTE

Refer to local medical / first aid protocols.

9.6 Triage

Where multiple casualties need attention, select casualties for treatment and rescue by order of priority. This selection or sorting of casualties is known as triage.

9.6.1 Priorities

Effective triage requires the identification of different priority groups. Casualties may differ in their severity within these groups, initial sorting and treatment can at least occur. While triage categories may differ slightly between States / Countries, generally accepted categories are as follows:

a. First priority (red)—life threatening injuries in need of urgent medical care, requiring priority transport, with or without appropriate resuscitation.

b. Second priority (yellow)—significant injuries, condition stable and treatment can wait. Or for casualties not expected to live, or whose resuscitation may over-utilise available resources and prejudice the survival of other casualties.

c. Third priority (green)—walking wounded who may not require ambulance transport according to priorities, to treatment centres. Casualty will not require hospitalisation. Psychological

casualties are included in this category.

d. Deceased (black / white)—used for the dead.

NOTE

It will sometimes be necessary to treat and rescue casualties of relatively low priority in order to access or to clear the way for treatment of high-priority casualties. Additionally, adopt the principle of 'remove the casualty from the risk or remove the risk from the casualty' where a site hazard presents a risk to casualties being treated prior to rescue.

The principle of triage is common to all States and Territories, but triage tags are not uniform and local information is essential. Refer to state and territory policy for current information.

9.7 Communicable diseases

Communicable diseases (also called contagious or infectious diseases) are those diseases which may be transmitted from one individual to another.

There are several ways diseases can be transmitted:

- Direct—From the infected person
- Indirect—From dressings, linens or surfaces
- Airborne—From the infected person, coughing or sneezing
- Vehicle—Via ingestion or contaminated food, drugs or blood
- Vector—Via animals, e.g. ticks

Communicable Diseases have always existed, but only a small number should concern the rescuer.

This Annex will cover the two Communicable Diseases (AIDS and Hepatitis) where the rescuer is considered to be most at risk in managing a casualty involved in a Road Rescue.

9.7.1 Hepatitis

Hepatitis is an inflammatory disease of the liver, the major causes of which are Type A, B and C Viruses.

a. The following sections describe the three types of Hepatitis:

i.) Type A hepatitis—is caused by a virus. It is spread primarily via the Fecal-Oral Route.

Blood and other body secretions are infectious. Type A Hepatitis is generally mild in severity and has an excellent prognosis.

ii.) Type B hepatitis—is caused by a virus. It is usually transmitted by injection, or sexual contact.

The injected route may involve transmission of contaminated blood or blood products.

The Type B virus is present in blood, saliva, semen and urine of infected persons.

Sexual partners of Type B Hepatitis casualties are at risk of infection.

Among the at-risk population are intravenous drug abusers, homosexual or bisexual males and medical personnel. Rescuers may become infected from the blood or saliva of an infected casualty, from contact with body fluids that enter the rescuer's body or from contaminated or soiled clothing.

Type B Hepatitis is a serious illness and is often life-threatening.

iii.) Type C hepatitis—is caused by at least two different viruses that are unlike those involved with either Types A or B.

Transmission of this type of Hepatitis is usually related to a blood transfusion or contaminated needle puncture.

b. Signs and symptoms of hepatitis

Hepatitis may vary from a minor flu-like illness to fatal liver failure. The usual signs and symptoms are:

- Loss of appetite
- Weakness, exhaustion
- Nausea
- Vomiting
- Fever
- Skin rash
- Dark urine, and
- Jaundice

c. Precautions

Precautions with managing casualties with Hepatitis, especially those with Type B are similar to those identified for suspected or identified AIDS casualties.

If a rescuer is exposed to Type B Hepatitis or work in a high-risk environment, vaccination should be considered. Vaccination will provide active immunity against Type B Hepatitis infection.

9.7.2 Acquired immune deficiency syndrome (AIDS)

a. Definition

AIDS is caused by a virus that attacks the immune system of the body and damages a person's ability to fight other diseases and ultimately causes death.

There is presently no cure for AIDS.

b. Risk groups

Ninety-eight per cent of reported cases of AIDS in Australia fall into the following categories:

- Homosexual or bisexual men
- Intravenous drug users
- Recipients of blood or blood products
- Sex partners or of persons in these groups
- Children born to infected mothers

c. How is aids transmitted?

AIDS is transmitted mainly by blood, body fluids or sexual contact.

Rescue personnel are often involved in critical trauma situations that may expose them to casualties who may be in the above mentioned high risk groups.

These situations may involve direct person to person contact when CPR is being performed, or by coming into contact with an infected person's blood or body fluids during rescue attempts.

Although the AIDS virus is found in several body fluids, e.g. saliva and tears, there have been no reported cases of emergency service personnel contracting the virus by the application of mouth to mouth resuscitation.

d. Precautions

It is important that the rescuer takes precautions to prevent or reduce the transmission of AIDS.

The following is recommended for all Road Rescue personnel who manage the extrication of casualties from motor vehicles:

- Wear latex rubber gloves if hand contact with body fluids is likely to occur.
- In addition to gloves, if the casualty's environment involves high risk or a high blood profile, additional protective measures may be necessary. The use of eye goggles, and face masks may be prudent protective measures.
- If the casualty requires respiratory resuscitation, use a face mask and avoid mouth to mouth contact if possible.
- The rescuer should wash hands and any affected skin areas thoroughly with soap and running water.
- If the rescuer has been exposed to the blood or other body fluids of a suspected aids infected casualty, for example, blood that has entered a cut on the finger or the splashing of another body fluid into the mouth or eyes, a doctor should be contacted without delay.

9.7.3 Summary

Rescue personnel when managing the extrication and treatment of road accident casualties will in general not be aware if those persons are infected with the Hepatitis or AIDS virus.

Therefore all precautions should be taken to minimise the risk of contamination and infection.

Hepatitis is a much easier virus to contract and is more prevalent than AIDS.

The AIDS virus is a very fragile virus and is more difficult to contract.

NOTE

When extricating a deceased person who is a known or suspected AIDS carrier, it is possible to contract the virus while the deceased still has a recordable body temperature

CHAPTER 10
DISENTANGLEMENT

10.1 Introduction

Disentanglement is the removal of wreckage from around a casualty, not the removal of a casualty from the wreckage. Disentanglement also involves making a pathway through wreckage which facilitates the safe and easy extrication of casualties.

Appropriate conduct of this portion of the rescue is critical as it holds the greatest potential for further harm and discomfort.

10.2 Process

10.2.1 Aim

a. Casualty release

i.) Controlled release

The preferred method of extrication is controlled release. The objective of a controlled release is to make enough space to safely remove each casualty from the vehicle without further injury or discomfort. This is done using well-practised, systematic procedures.

Controlled release ensures you control the pace of the extrication. It is slower and more systematic than immediate release.

ii.) Immediate release

If the condition of an injured person deteriorates rapidly, medical personnel at the scene may request the urgent release of the casualty. An example of immediate release is when CPR is required to save the casualty's life.

For an immediate release, you will need to quickly select the tools and techniques to provide enough space to free the injured casualty from the wreckage. In many cases you may only have a matter of minutes to release the casualty (if possible) to allow medical personnel to perform lifesaving techniques.

The immediate release decision is only taken under the direction of medical personnel. Injured persons should NOT be removed from a vehicle without medical supervision unless they are in imminent danger.

NOTE

Information that will determine the type of release for the casualty is:

- Is the casualty physically trapped?
- Does the casualty have any critical life-threatening injuries?
- Are there any imminent life-threatening uncontrollable hazards?

10.2.2 Strategies

When formulating a disentanglement plan the rescue crew should consider:

a. Assessment of the disentanglement setting

i.) Collision type

ii.) Vehicle

- Position and orientation of the vehicle, for example in a gully on its roof.
- Damage sustained.
- Surrounding objects, for example other cars, posts / trees, uneven ground or buildings.

iii.) Vehicle construction that may influence techniques

- Materials
- Safety systems
- Fuel or electrical power

b. Planning evolutions and techniques

Consult with relevant agencies about how the extrication should proceed to ensure the best outcome. E.g. paramedics for ideal direction of extrication, power utilities for electrical hazards etc.

Multiple casualties may affect the techniques used through the impact of the techniques on another casualty.

Vehicle movement may limit techniques as the disentanglement progresses.

A secondary plan to achieve immediate release should be made.

At each step in the evolution consider proceeding in order of:

i.) Adjustment—the movement of vehicle components through in-built adjustment mechanisms.

ii.) Disassembly—the separation of components by reversing the order in which they are assembled.

iii.) Distortion—the forcible twisting of a vehicle's parts to get them out of the way.

iv.) Displacement—the movement of a component from one place to another or the removal of a component.

v.) Severance—the cutting of components so that they can be removed.

c. General disentanglement related practices

i.) Communicate with casualties to reassure them by explaining what will be done and what the casualty can expect to see, hear and feel happening

ii.) Protect each casualty by:

- Providing PPE when they will be exposed to a hazard, for example safety glasses.
- Cover the casualty with soft, medium or hard protection to match the hazard.
- Ensure adequate ventilation for the casualty when covered.

iii.) Conduct operation

- Maintain constant awareness of vehicle movements and effects
- Cover and manage sharp edges

10.2.3 General safety

a. Site layout (embankments, traffic)

b. Site conditions (weather, low grip surfaces, soft surfaces)

c. Ensure vehicle is stabilised prior to conducting disentanglement evolutions. See Chapter 5 for details of stabilisation

d. During disentanglement evolutions a rescuer should, where possible, be positioned as a safety observer. This safety observer's task is to closely monitor the specific operation to detect at an early stage any potential danger to the rescuer or the casualty

e. Casualty protection

f. Never position your body between a hydraulic tool and the side of the vehicle.

g. When a hydraulic tool grips (or 'bites') against the vehicle and supports its own weight the operator should not force the tool

h. Separating parts under compression, tension and / or torsion will result in some movement of the parts. Prior to conducting any techniques consider the likely direction, size and speed of the movement and how the movement will impact:

   i.) Rescuer safety

   ii.) Casualty injuries and discomfort

   iii.) Vehicle stability

   iv.) Other objects, for example

i. Cover and manage sharp edges as they are created.

10.3 Collision types

The resultant forces of collisions/impacts generally affect a vehicle's integrity in three different ways; resulting in components being either under compression, tension or torsion. These forces need to be considered by rescuers when assessing what type of equipment and techniques need to be applied to affect the release of the casualty.

Common types of collisions

- Frontal impact collision - head-on and front ¼ oblique
- Side impact collision
- Rear impact collision
- Roll-over
- Vehicle over-ride/under ride.

10.3.1 Influence damage

a. Frontal impact

   i.) Head-on

   A head-on impact occurs when a vehicle strikes a static object such as a tree, a pole or another vehicle. The impact is relatively square on to the front of the vehicle. This impact causes the rearward movement of the engine, transmission, firewall and dash, towards the passenger compartment. This movement traps the driver and/or passenger in the front seats. Airbags are designed to deploy in this type of crash.

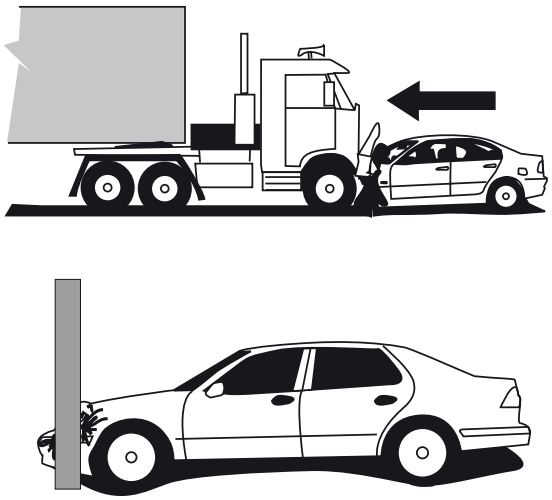

Figure 10:1
Head on impacts

ii.) Front ¼ Oblique

This type of crash is similar to a head-on impact, but the impact is taken at an angle to the front of the vehicle. The impact can trap the passengers in the front seats, as in a head-on impact. Additionally, the front ¼ oblique impact may compound the entrapment due to the rearward movement of the road wheel, suspension components and foot-well. Airbags may deploy, depending on the angle of impact.

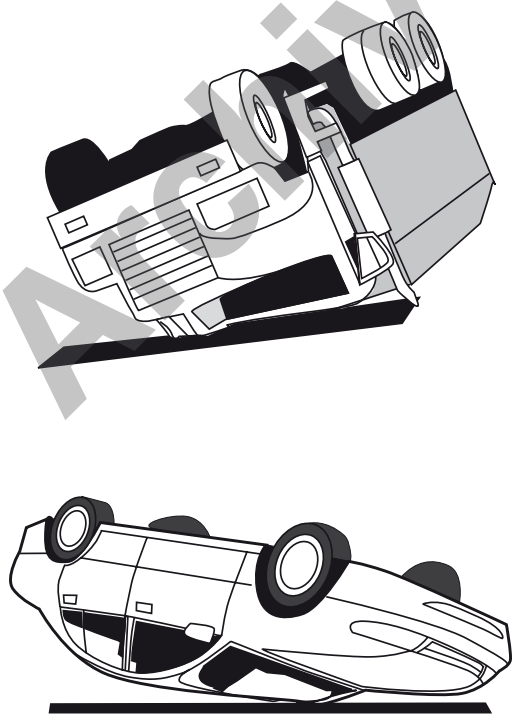

Figure 10:2
Front ¼ oblique impact

b. Side impact (T-bone)

This type of crash occurs when a vehicle has been in a side-impact with an object such as another vehicle, a tree or a pole. In this type of crash, the side of the vehicle collapses inward in varying degrees. The hinge pillar can trap the casualty(s) legs against the transmission tunnel. This type of crash is often referred to as a T-bone. Driver and passenger airbags should not deploy. Side airbag systems are designed to deploy in this type of crash.

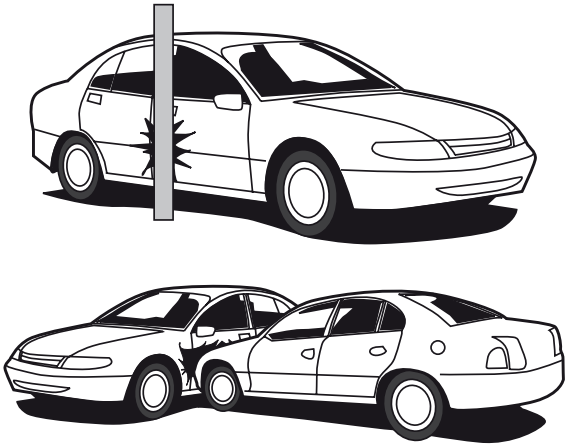

Figure 10:3
Side impact

c. Rear impact collision

This type of crash occurs when a vehicle has been run into from behind by another vehicle, or when a vehicle is rotating and impacts an object. The impact can trap the rear seat passengers and cause whiplash type injuries. The rear-end collision may severely damage the rear end of the vehicle, possibly rupturing fuel tanks. When the impact is small, the rear bumper, back panel, boot lid and boot floor panel may be affected. The back quarter panels may bulge out. If the impact is increased, the quarter panels will collapse and the mid (usually B) pillar will bend. Doors may jam and the roof may bulge upwards.

Figure 10:4
Rear impact

d. Roll-over

This type of crash occurs when a driver loses control of the vehicle and it overturns. The roof structure may collapse to some degree. The roll-over will probably cause fuel to spill and battery acid to leak. The roll-over may be further complicated by impact with a static object, before or during the roll-over. If this additional impact occurs, the roll-over will be combined with one of the crash types already mentioned. SRS may or may not deploy.

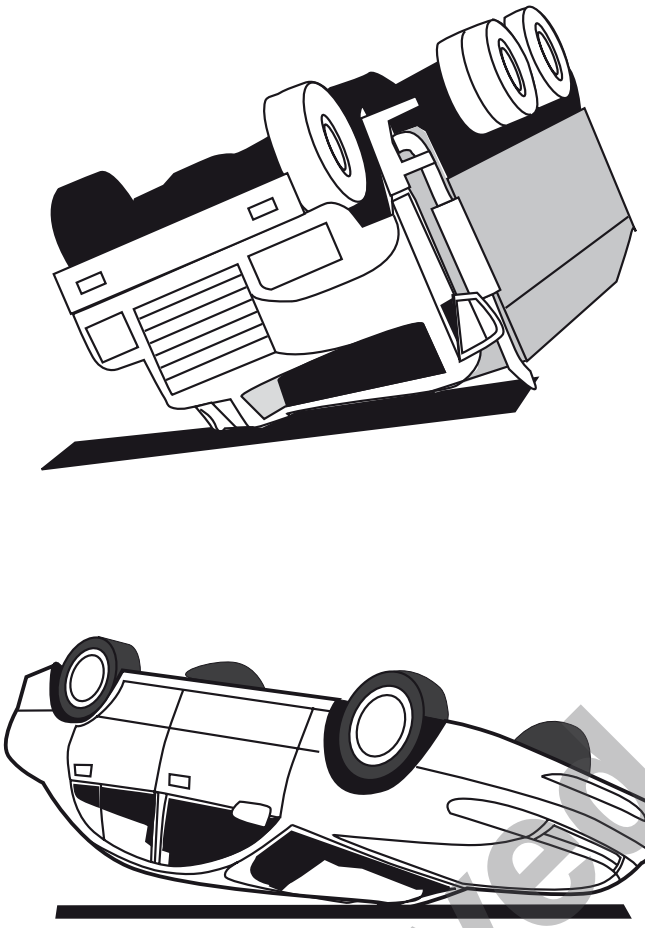

Figure 10:5
Roll-over

e. Vehicle under-ride / over-ride

This type of impact usually happens when a vehicle runs into the back of a truck. In some collisions, a truck may ride up onto and come to rest on top of another vehicle. This type of crash can cause a rearward movement of the transmission as in a head-on collision. It can also cause a downward movement of the firewall, dash and steering wheel column. The stability of the truck on top of the motor vehicle is also a major concern.

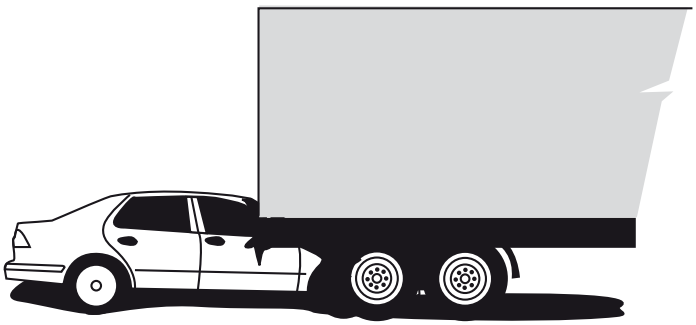

Figure 10:6
Under-ride impact

10.3.2 Resting position of vehicle

Vehicles involved in collisions invariably come to rest on various terrain types and in one of three positions; on its wheels, roof or side, or slight variations with other vehicles, objects or on their own. Rescuers need to be aware of how the final position that a vehicle has come to, may affect the disentanglement and extrication evolutions.

a. On wheels

i.) 'Normal' orientation, no special access problems

ii.) Suspension remains in effect till stabilisation is in place

iii.) Need to deal with affects of surroundings. For example obstructions, embankments, objects lodged underneath or resting on top.

b. On side

i.) Contents of the vehicle fall towards doors on low side.

ii.) Typically debris will be on, under and around each casualty. Door trimmings or external items could become hidden protrusions.

iii.) Multiple Casualties will likely be in the same space or hanging towards the same space.

iv.) Access becomes much more difficult. Working space inside is extremely restricted, little if any standing, bending or working area inside. Top side windows are at a much higher level. Breaking glass will fall towards casualties. Windscreen access is limited at the best of times and complicated by glass management in the restricted space environment.

v.) Manual handling issues, especially if a casualty is still supported by seat belts. Doors and B pillar become heavier to lift on high side and lighter on low side (if accessible).

vi.) Potential for disentanglement evolutions to cause movement of the vehicle is higher due to the upward change in vehicle's centre of gravity and body panels that slide easily and may compress / change shape under load.

vii.) Need to deal with affects of surroundings. For example obstructions, embankments, objects lodged underneath or resting on top.

c. On roof

i.) Contents fall towards roof

ii.) Typically debris will be under each casualty supported by seat belts and around each casualty on the roof.

iii.) Access becomes much more difficult. Working space inside is extremely restricted, little if any standing, bending or working area inside. Side windows are at a much lower level. Windscreen and side window access is limited at the best of times and complicated by glass management in the restricted space environment.

iv.) Manual handling issues due to 'ground' level work and restricted head room, especially if a casualty is still supported by seat belts.

v.) Potential for disentanglement evolutions to cause movement of the vehicle is higher due to the upward change in vehicle's centre of gravity and body panels that slide easily and may compress / change shape under load.

vi.) Need to deal with affects of surroundings. For example obstructions, embankments, objects lodged underneath or resting on top.

10.3.3 Entrapment

There are two recognised forms of entrapment:

- Physical entrapment, and
- Confinement

a. Physical entrapment

Physical entrapment occurs when the casualty is physically pinned by a deformity in the structure of the vehicle, or impaled by vehicle components or outside items. Crush injury/ syndrome may be a factor involved with the entrapped casualty, and should be considered before any release of the casualty is attempted, refer to Chapter 9 Emergency Care.

i.) Hidden protrusions

These could be penetrating the casualty's body, legs or feet. If further pressure is placed on the vehicle, considerable internal injury could occur to the casualty by either forcing the protrusion further into, or dragging it across the body. In the case of penetration to the trunk, this may open or extend the wound, with every possibility of fatal consequences.

ii.) Minor obstructions

A casualty may be trapped by minor obstructions, for example their shoe is physically trapped but the foot is held in place by only the shoe.

b. Confinement

Trapped by confinement occurs when the casualty is only trapped in the interior of the vehicle and not physically pinned. A full rescue response should continue until all casualties have been removed from the vehicles or been assessed by ambulance officers.

c. Ejection

Partial or total ejection is a third event that is not classified as an entrapment, but is still a likely scenario that rescuers may come across. It occurs when the casualty has been either partially or totally ejected from the vehicle during the collision/impact. Examples could be an unrestrained occupant in a roll-over being found outside of the vehicle, or partially held through a windscreen.

10.4 Techniques

A **technique** is a procedure used to accomplish a specific activity or task.

10.4.1 Use of hands

Disentanglement should not be commenced until all hidden areas which can be reached have been thoroughly explored by hand. Many rescues are accomplished by using the hands or simple tools rather than specialised equipment.

CAUTION

When using hands (even in gloves) around unseen areas of a vehicle, particularly when checking under seats or in glove boxes etc, be aware that syringes may have been hidden. Syringes can be the cause of HIV/Hepatitis B and C infection.

Minor obstructions

A casualty may be trapped by minor obstructions. Some examples and actions follow:

- If an apparently free casualty cannot be moved, unclip or cut the seat belts (the decision to unclip or cut may be dictated by state / territory policy or operational requirements)
- The casualty wedged against steering wheel and/or knees pinned under the dash:
- Depress the seat slide and at the same time firmly push the seat back or use the electronic seat controls to adjust the seat to desired position.
- Steering wheel adjustments vary depending on the vehicle, but generally can move in 2 ways; telescoping in and out from the driver and up and down.
- Should the seat and steering column adjustments be inoperable, the seat back may be relocated by cutting/disconnecting the seat adjuster. Full exposure of the area to be cut should be undertaken to identify if any SRS is fitted.
- Casualty's feet trapped:
- Slide the trapped foot from the shoe (untie laces).
- Cut the shoe away from the foot.
- Displace pedal by attempting to move sideways by hand, by hydraulic spreader, or by tying a rope around the pedal and using a door to gain leverage (see Figure 10:7).
- Sever pedal.

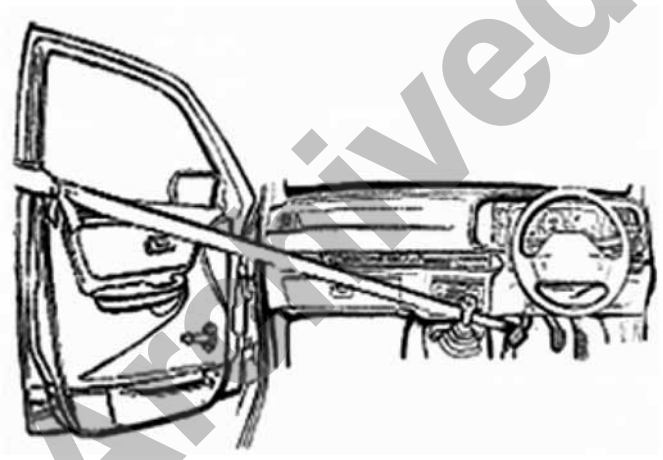

Figure 10:7
Displacing pedal

10.4.2 Opening doors

The best methods for opening doors are often the most obvious:

- Try to open the doors by unlocking and operating the door handles and electric locking mechanisms;
- Try to wind down the windows;
- Try to open the rear hatchback;
- See if the keys are still in the ignition. You can use them to unlock and open the doors or the rear hatch;
- Try using a pinch bar or similar to lever a door open; and
- Support the casualty if you open a door next to them.

Forcing open doors may be your only option. You may have access to a variety of hydraulic tools including single or double-acting spreaders or a COMBI tool. Try using hand tools such as wedges, a rescue tool, wrecking or pinch bars to make initial space to insert a spreader.

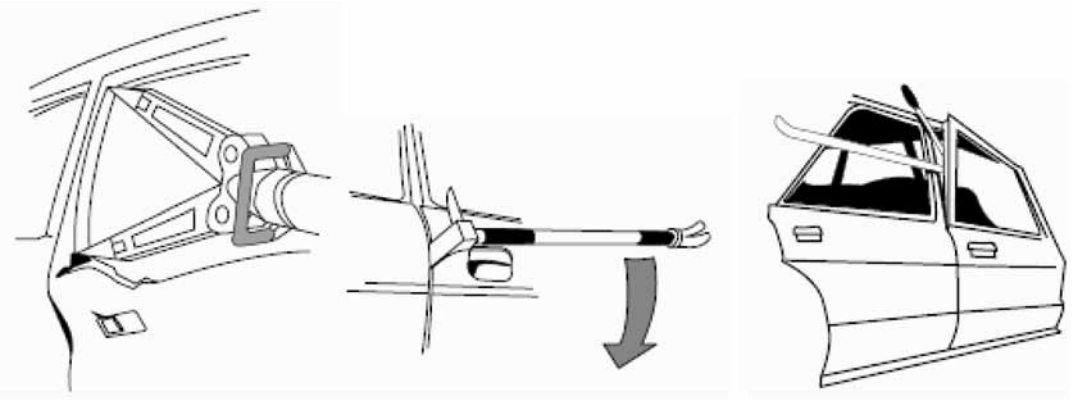

Figure 10:8
Creating an opening

Once you have created a gap you need to prise the door open. The door of a motor vehicle consists of an inner skin and an outer skin. The inner skin is the one you concentrate on when you use the hydraulic spreaders to force open a jammed door. If you can get the spreader tips between the inner skin and the doorjamb, you can usually open the door by spreading open the gap. The principle of spreader operation is to force the door open by rolling or spreading the lock off the Nadir bolt or latch.

The strongest part of a door is within the limits of a triangle drawn between the hinges and lock mechanism. Use the spreader to force the door open through its natural arc. Start at the top or the bottom of the door, above or below the latching mechanism (the weakest points of the door).

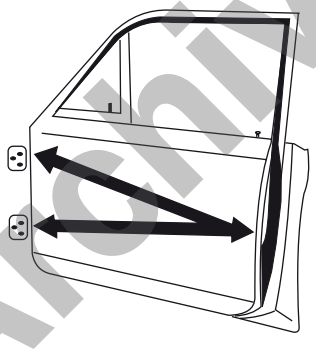

Figure 10:9
Door strong points

a. Hints for spreading open doors

- Create access for the spreader tips by using a bar and/or wedge spreader;
- Alternatively, open the spreader vertically between the window sill and the edge of the roof to create a gap;
- Use the crush capacity of a double-acting spreader to grasp the door skin and lever it back to create a gap.
- Alternatively, hold the spreader vertically and crush the door;
- Use wooden blocks or wedges to hold the gap open while you reposition the spreader;
- Spreaders usually develop more force as they open. This means that positioning the spreaders to allow them to open as much as possible will give you the most force;
- Position the spreader at a 45° angle to the door opening, forcing it open through its natural arc;

- Use a series of spreads up or down towards the door lock until the door is opened;
- If the door is too strong to be opened by one spreader, try using a second spreader to increase the force;
- As an alternative method, use the spreaders to expose and unbolt the hinges; and
- Use the spreaders to expose and cut the Nadir bolt or the latching mechanism with bolt cutters.
- Apply the greatest amount of force only on parts of the door that are reinforced, e.g. where the door locking mechanisms are attached, these are usually indicated by countersunk screws;
- Reposition the spreader if the outer door skin begins to separate; and
- Use hard protection as a barrier to protect the injured person.

b. Safety points

i.) Never position your body between the hydraulic spreader and the side of the vehicle;

ii.) Be careful that the door does not fold inwards onto the casualty;

iii.) Once the door has been opened, secure it or completely remove it;

iv.) Do not place your body on or adjacent to the door being forced. It is safer to use a tape sling to secure the door, to prevent a jarring effect when you force the door open. Alternatively, brace the door by facing and supporting with both arms bent. Do not 'bum' the door, this practice is dangerous and can harm the rescuers; and

v.) As you spread, ensure some other component of the vehicle is not forced against the casualty.

10.4.3 Removing doors

You may need to completely remove the doors from the vehicle to make enough space to free the casualty(s). On modern cars an alternative is to open the front door fully, cut the door travel limiter in the hinge pillar and use at least two people to push or pull the door forward as far as possible. You can also use a hand winch and/or tie-down straps to pull and hold the door forward.

a. Using a socket set

One of the easiest ways to remove the door is to unbolt the hinges, using a socket set. This has the considerable advantage of not jarring or moving the car. In some cases, the crash damage exposes the heads of the bolts. If they are not exposed, you may be able to use a spreader to spread the mudguard and door apart, lever back the outer skin of the door or by crushing the mudguard above the wheel arch. This then allows access to the bolts. Alternatively, some hinges are designed with small release bolts that allow the door to be lifted off the hinge pillar or B pillar.

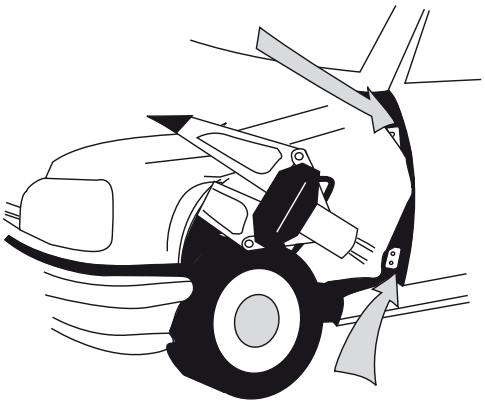

Figure 10:10
Making openings

b. With spreaders

If the casualty is trapped by the hinge pillar, avoid using spreaders to remove the doors unless it is absolutely necessary. Here are some points to keep in mind if you are forced to use spreaders to remove the doors:

- Spread the doors from outside the vehicle.
- Make extra space by pulling the door forward.
- Use the spreaders to lever back the outer skin of the door or crush the mudguard above the wheel arch to get access to the hinges.
- Place the spreaders at the strongest points on the door. The strongest points are the pillars above the top hinge and below the bottom hinge.
- If the hinge is too strong, place one tip on a hinge flap and the other on the metal of the door or pillar. The hinge will then be torn free of its surroundings.

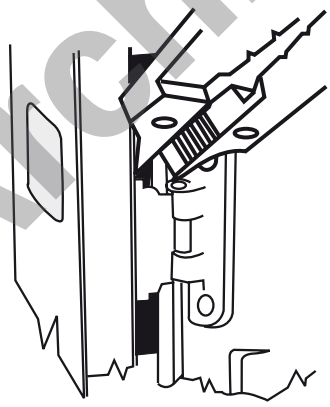

Figure 10:11
Spreading a hinge

- Place the removed door in a designated scrap dump.

c. With hydraulic shears

Shears should not be used as a standard method of removing doors. Door hinges vary in construction style and materials, using hydraulic shears on materials they are not designed for can damage or destroy the blades. Only consider using shears to sever a door hinge when no other method is possible or the hinges are a lightweight steel construction.

10.4.4 Side removal

You may have to remove the side of the vehicle to make more space for removing a seriously injured casualty. Removing the side exposes the interior of the vehicle and gives you better access for casualty handling.

a. B pillar removal

Removing the B-pillar is a standard technique used on four door vehicles.

B-pillar removal can be conducted:

- after removing both front and rear doors, or
- in conjunction with removing the doors.

Expose the areas to be cut by removing all inner trim and plastics. Avoid cutting top seat belt mounts, airbags, pretentioners and side impact sensors.

Removing the B-pillar on an early model vehicle is relatively easy, but on later model vehicles that are constructed from high strength low alloy (HSLA) steels is more complex.

DANGER

Due to the high strength of HSLA materials, when the cuts are made a loud bang will occur and the roof or pillar will move excessively or vibrate to the point where any loose glass or metal could become projectiles.

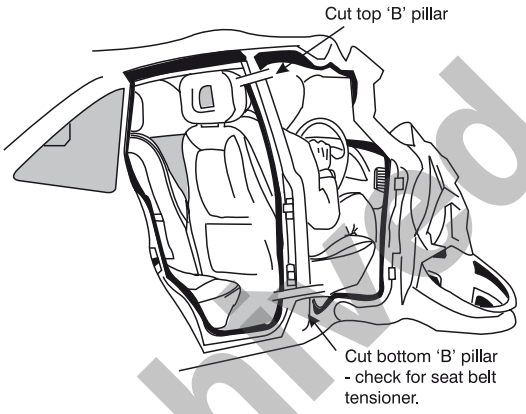

Figure 10:12
Full side removal

i.) Spreading the base of a B-pillar

It is possible to spread the base of the B-pillar instead of cutting. This is particularly useful when removing the B-pillar while doors are still attached. Partially cut the base of the B-pillar (not the sill), then spread the base of the B-pillar away from the sill.

b. B pillar rip

The B pillar rip technique is an alternative method for removing the side of a vehicle. The technique involves commencing operations from the rear door (may open by hand or require spreading the latch) then removing the B-pillar and hinging at the front door and securing by tying off.

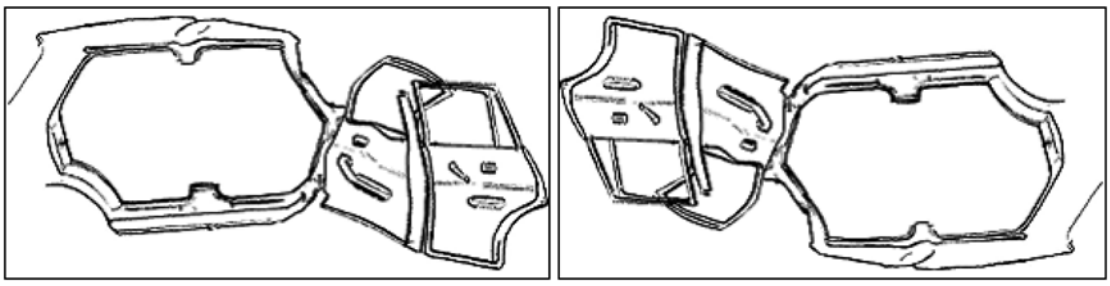

Figure 10:13
B pillar rip and inverted B pillar rip

c. Side Fold down

Folding the side of the vehicle down is an option for creating space for access and removal of a casualty. The B pillar is cut at the top, and the rear door latch and front door hinges spread/cut. The hydraulic spreader is then clamped onto the top of the B pillar and is used as a lever to fold down the side of the vehicle. A relief cut should be placed at the base of the B pillar to assist.

The side of the vehicle (doors and B pillar) can then be left in situ or the base of the B pillar cut through to remove the complete side section away from the vehicle.

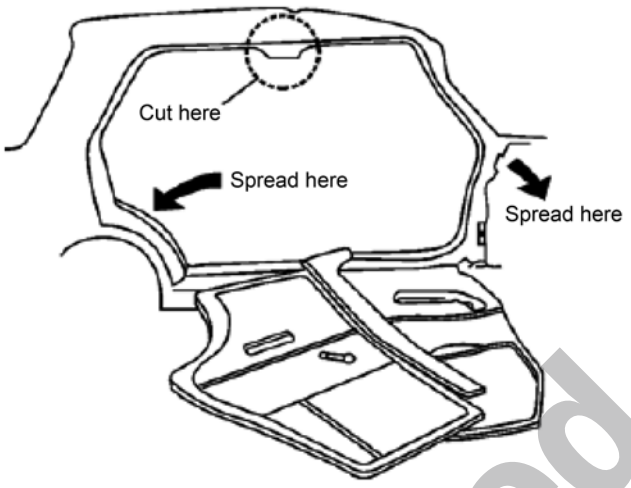

Figure 10:14
Side fold down

Use of this technique should be limited due to a potentially large amount of movement created when folding down the side of the vehicle, particularly if no relief cut is placed at the bottom of the B pillar.

d. Third door entry

You can use this technique when you need to gain side access to the interior of a two-door car where either the driver or the front passenger is severely trapped or when a casualty is trapped in the rear seat.

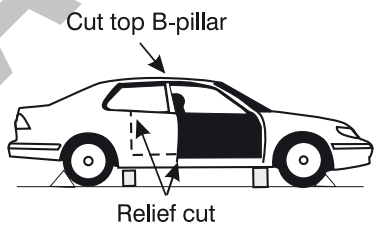

Figure 10:15
Third door conversion plan

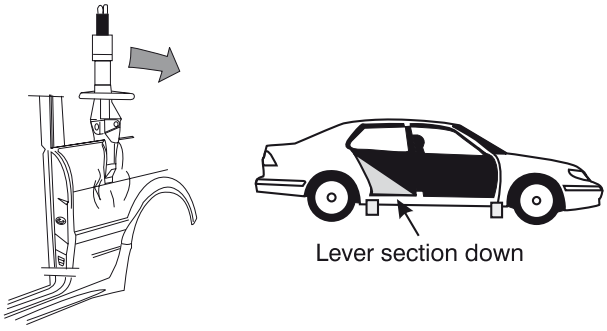

Figure 10:16
Third door conversion technique

You may need to remove the rear quarter panel trim and/or the rear seat cushion.

Folding down this part of the body work can place unnecessary force on the tool's handle, alternative options to this technique include:

- Using a hydraulic spreader to tear the base of the third door along the upper section of the sill.
- Using a hydraulic ram off the tunnel.
- Using a reciprocating saw to cut from the base of the sill, and then follow the wheel arch up to the rear quarter window.

e. Points to consider

- If you need to ram the dash, you should cut the B-pillar above the gusset and leave a suitable base for the ram.

10.4.5 Roof removal

You can gain maximum access to the casualty by removing the roof of the vehicle. Taking the roof off also allows more light and fresh air to reach the casualty and gives greater access for medical personnel.

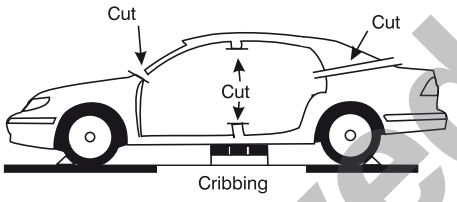

Figure 10:17
Roof removal

Removing the roof may also weaken the vehicle structure to facilitate other techniques, e.g. a dash lift or dash roll.

At more severe crashes removing the roof early in the extrication process will provide an emergency exit to get the casualty out quickly if their condition deteriorates.

10.4.6 Flapping roof or floor pan

Flapping is the process of folding a section of the vehicle's bodywork out of the way to gain access to a casualty. This technique is applied to the roof or the floor pan.

a. Roof

Provided there is access to the roof it is normally easier to flap the roof or a section of the roof than the floor pan because of the larger area and fewer substantial fittings. A roof can often be distorted without the use of a spreader or ram while the floor pan will normally require the use of hydraulic tools.

i.) Rearward roof flap

C-pillars are strong, often very wide and can be hard to cut. Cutting through some larger C-pillars will often require four or five cuts, especially when using smaller shears.

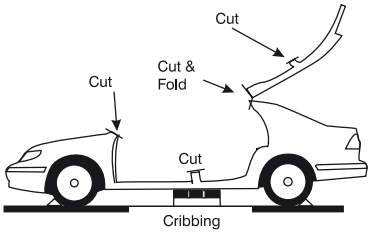

Figure 10:18
Rearward Roof Flap

If cutting the C-pillar will be too time consuming, you may find it faster and more effective to cut or weaken the roof just in front of the C-pillar and flap the roof back. This technique can also be used to flap a roof to the front or side of the vehicle.

The section of the roof that was flapped should be secured or may be completely removed when convenient, often referred to as a two-stage roof removal.

ii.) Forward roof flap

An alternative method to avoid the removal of the bonded windscreen is to cut a forward roof flap. The roof can be flapped forward by placing relief cuts in the roof past the end of the A pillar meets the roof.

Figure 10:19
Forward Roof Flap

You may need to use this method if the rear of the car is embedded under an obstacle or other vehicle.

The roof can also be flapped forward on the A pillar by either flattening/squashing a length of the mid-section of the A pillar with a spreader, or by partially cutting the A pillar. The roof is then secured and is generally left in situ.

iii.) Side roof flap

You can use this method if you find that access is restricted to one side of the vehicle, but it is more useful when vehicles are on their side.

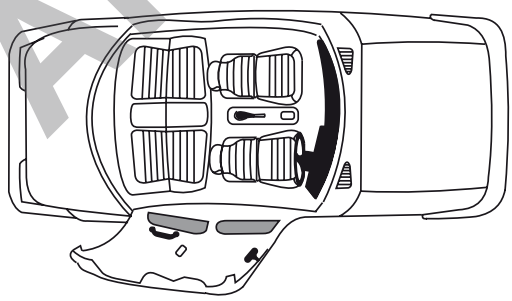

Figure 10:20
Side Roof Flap

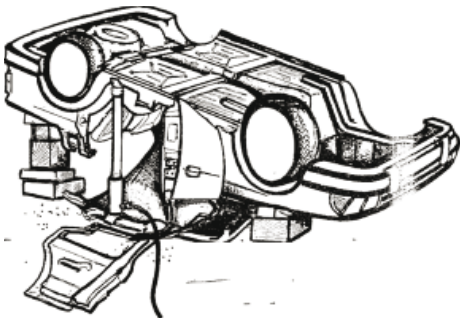

Figure 10:21
Roof oystering / inverted ramming

iv.) Roof entry / tunnelling

Where working space outside the vehicle is restricted it may not be possible to conduct a regular roof flap. In these cases it may be practicable to make entry via the roof by cutting out the central area of the roof.

This method may be quicker to achieve than a roof flap, however, it creates a smaller access space and long sharp edges that need to be managed.

To achieve the roof entry:

- Make first downward cut
- Make horizontal cut
- Have someone hold the metal
- Make second downward cut

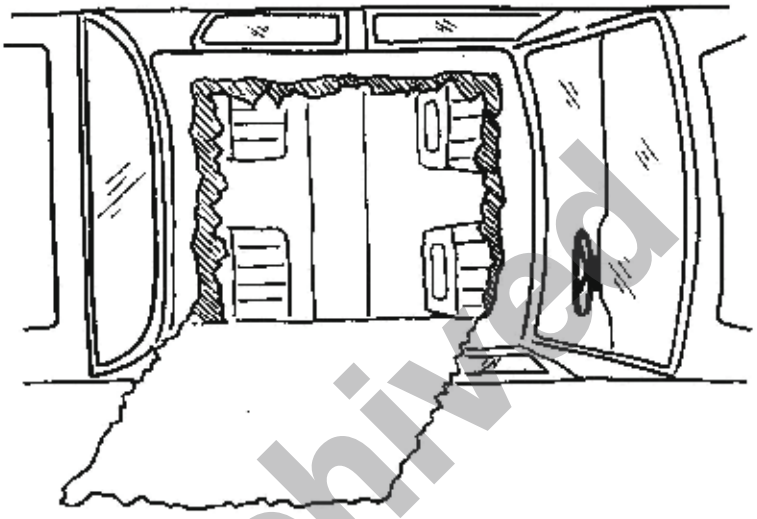

Figure 10:22
Roof entry / tunnelling

b. Floor pan

Flapping the floor pan will normally be done when a vehicle is resting on its roof

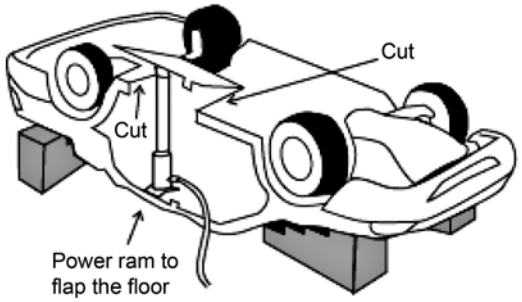

Figure 10:23
Flapping the floor pan

i.) Considerations

- seats or other interior fittings may need to be removed prior to flapping
- exhausts, drive shafts, fuel tanks, batteries or other vehicle systems may affect the flap size and degree of movement available
- cuts may adversely affect vehicle rigidity and stabilisation

WARNING

Fuel delivery lines may be located in the areas to be cut.

High Voltage wiring may be present in electric or hybrid powered vehicles.

Vehicles with remote batteries may have wiring in the areas to be cut.

10.4.7 Dash

Casualties are often trapped between the front seat and/or the foot-well and the dash.

When this happens the simple methods of extrication are often the best and most effective. Here is a list of some common sense approaches to help the casualty.

- Use your hands to determine exactly how the casualty is trapped.
- Remove any debris that is causing a hazard or discomfort to the casualty.
- Operate the seat slide lever, tilt the seat or slide the seat backwards.
- If the steering column is adjustable, tilt the steering wheel upwards.
- Unfasten or cut the casualty's seat belt.
- If the front seat has a vertical adjustment and it is operable, lower the front seat.
- Use a tape sling, rope or tie-down strap to displace the pedals.
- Remove or cut away the casualty's shoes to release their feet.

In a head-on collision the A-pillar as well as the dash can collapse and trap the casualty.

a. Roll

The dash roll technique relocates the dash and associated attached components forwards away from the casualty. It relies heavily on the correct placement of the relief cut, at the base of the hinge pillar where it meets the sill. This ensures that the hinging action associated with the dash roll occurs through the generally lighter metal panel of the hinge pillar.

In the dash roll you push the dash away from the casualty by using a hydraulic ram between the base of the B-pillar and the A-pillar at dash level.

The base of the B-pillar will need to be supported by blocks of timber or other suitable packing material to minimise movement of the B-pillar and the potential for loss of grip by the hydraulic ram.

Where it is not possible to use the base of the B-pillar options include a separate bracket or attachment to another section of the sill or using the centre of the dash and the base of the rear seat or a Central Dash Lift.

During this operation, it is important that a safety observer monitor the movement of the floor pan and pedals for the protection of the operator and casualty.

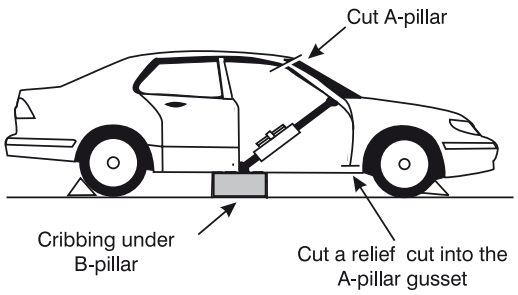

Figure 10:24
Dash roll cuts

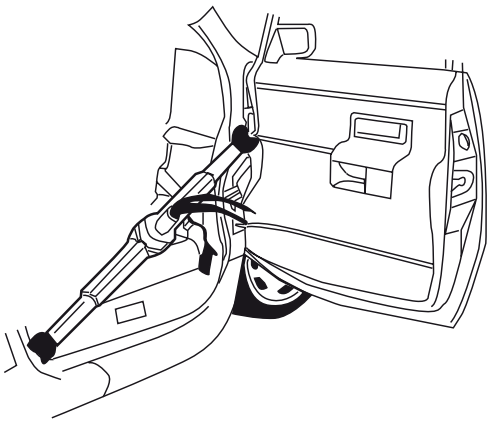

Figure 10:25
Dash roll (Sedan)

Forward control vehicles such as vans, pose further considerations for the rescuer when utilising the dash roll due to limited space by design.

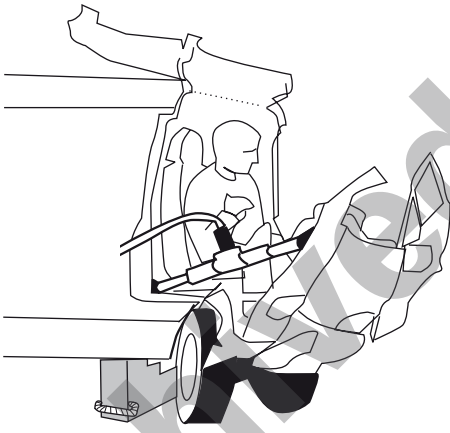

Figure 10:26
Dash roll (Van)

b. Lift

Under-ride and head-on crashes may cause the dash to collapse downwards and trap a front seat casualty by the legs. In this case, you may need to lift the dash to free the casualty.

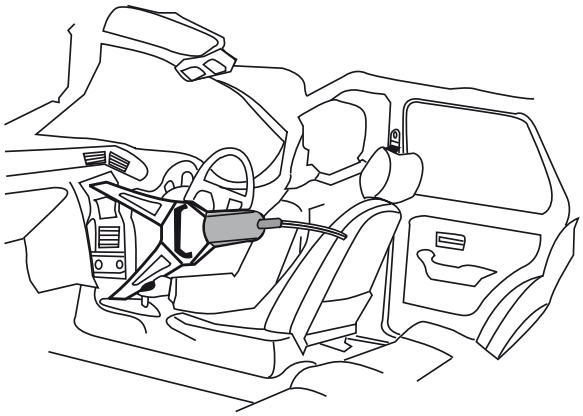

Figure 10:27
Central dash lift

An alternative method is to first conduct a foot well exposure using method 1 and then using spreaders in the resulting opening to lift the dash.

c. Dash winch

This technique is not considered for use generally, but as a last option when standard techniques or equipment cannot achieve the task. Some agency policies may not support this technique; alternatives may need to be considered.

Although you should first consider the hydraulic rams to roll the dash forward, you can use a winch to displace the dash, by considering a straight or reverse dash winch.

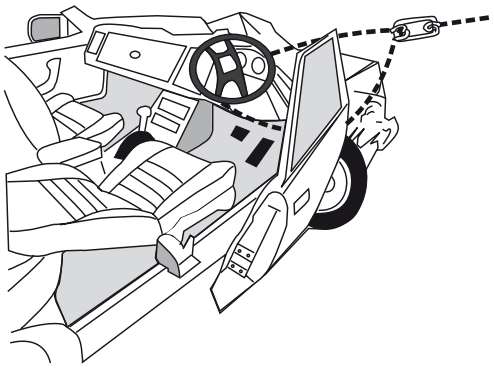

Figure 10:28
Dash winch

i.) Considerations

- slippage of the winching system is a possibility
- distortion of the steering column may activate an un-deployed air bag

d. Steering wheel relocation

This technique is not considered for use generally, but as a last option when standard techniques or equipment cannot achieve the task. Some agency policies may not support this technique; alternatives may need to be considered.

The steering column can be displaced by using existing design adjustments or by undoing bolts on the column bracket. Alternatively, hydraulic rams, power hydraulic spreaders/rams and chains or hand winches can be used. In some cases, you can pull the steering column up, which in turn lifts the dash, to free the casualty.

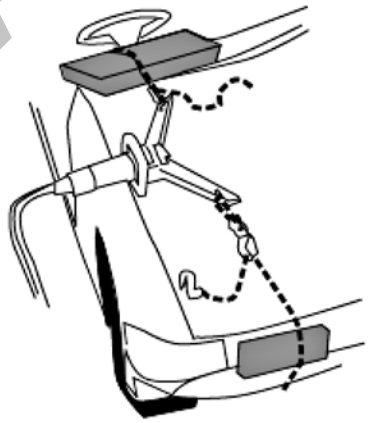

Figure 10:29
Steering Wheel Relocation

i.) Considerations

- collapsible steering columns may not lift the dash and could break resulting in further injury
- distortion of the steering column may activate an un-deployed air bag

10.4.8 Foot well exposure

During a side impact or when a frontal impact causes rearwards movement of the hinge pillar, the casualty's lower limbs and/or feet may become trapped in the foot-well. Techniques to expose the foot-well area are beneficial to the rescuer to assist in identifying entrapments and/or providing an extrication path.

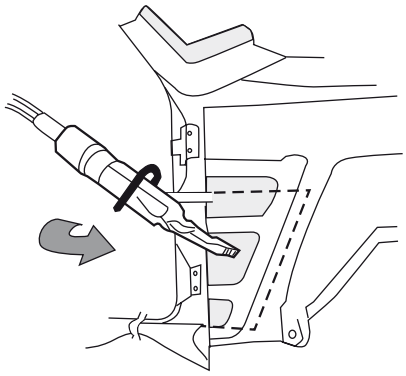

Figure 10:30
Foot-well exposure 1

a. Method 1

Use hydraulic shears and spreaders to expose the foot-well like a hinged door.

- Remove the front door;
- Use shears to cut the hinge pillar under the dash, and along the top of the sill, as far forward as possible;
- Clamp spreaders to the hinge pillar, then use as a lever to fold the hinge pillar outwards revealing the foot-well space.

Figure 10:31
Foot-well exposure 2

b. Method 2

Use hydraulic shears and spreaders to expose the foot-well by rolling the hinge pillar upwards.

- Ensure stabilisation is in place under the vertical section of the hinge pillar;
- Remove the front door;
- Use shears to cut the hinge pillar along the top of the sill, as far forward as possible; and
- Place the spreader tips against the sill (above the stabilisation point), and into a section of the cut hinge pillar and spread the base of the hinge pillar away laterally.

10.4.9 Internal space making

a. Moving seats

Vehicles may have electronic controls which enable the seat to be moved in any number of directions. Try these controls for movement if you need to move a seat before disconnecting any power source which controls them.

Figure 10:32
Seat movement range

A hand winch and chain may be used to pull the seat back. One method is to use the technique shown in Figure 7:2.

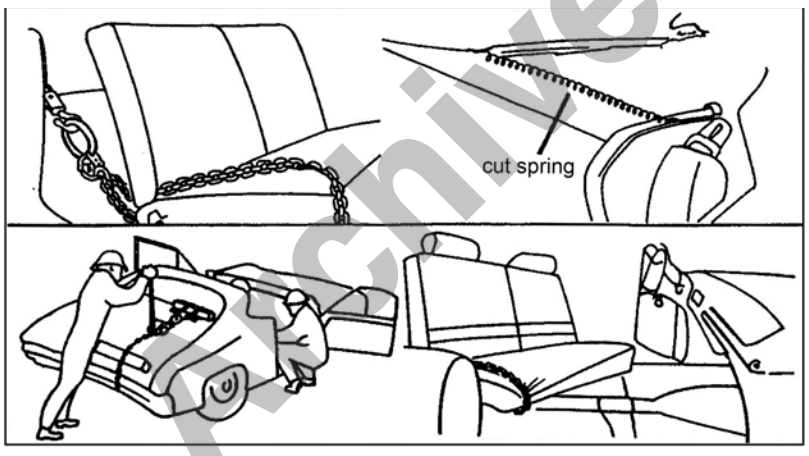

Figure 10:33
Displacing Seat (Pull)

The boot lid is removed or raised, the winch positioned in the boot and a cut made through the squab of the rear seat. The winch cable is passed through this opening. Alternatively, either the squab can be removed or the seat removed by unbolting the seat supports using a socket and ratchet handle. Rescuers should ensure that the winch is positioned as low as possible in the boot.

CAUTION

Because of the danger to an entrapped person, only as a last resort should the chain pass over the rear seat and through the rear window. If this procedure is necessary, the roof should be removed first (as shown in the diagram).

Another technique is to use hydraulic equipment or a mechanical jack of high capacity (10t) to push the seat back off its rails/track.

CAUTION

Extreme care should be exercised when pushing or pulling seats with casualties in position. The release of the seat from the runner may cause further injury to the casualty.

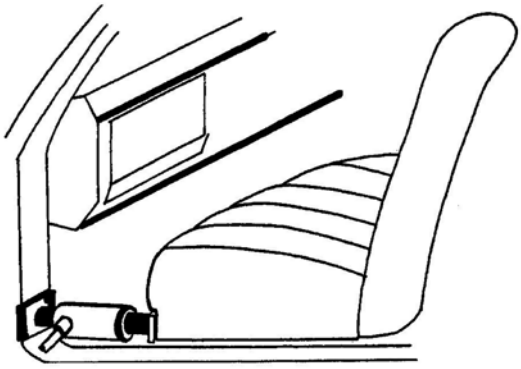

Figure 10:34
Displacing Seat (Push)

b. Cross ramming

Cross ramming is an option for creating internal space in an attempt to return the vehicle back to a similar 'pre-crash' shape. This technique utilises hydraulic rams that are placed between 2 points in the vehicle, and can be utilised at any phase of the extrication. This generally requires a rescuer to enter the vehicle to operate a hydraulic ram and to closely monitor the entrapment of each casualty.

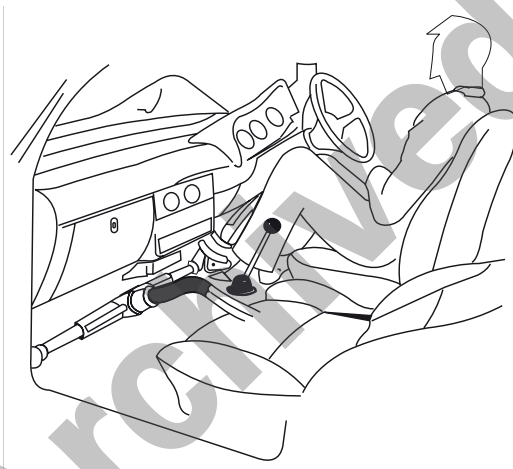

Figure 10:35
Cross ramming from the opposite pillar

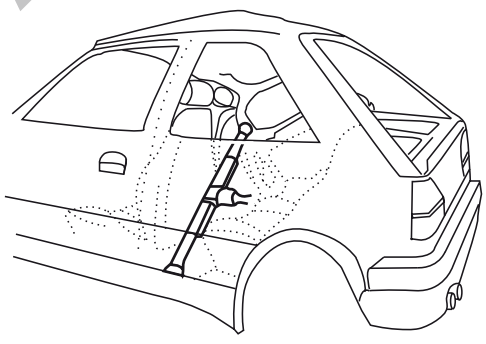

Figure 10:36
Cross ramming

10.4.10 Parcel shelf removal

May be required to assist in creating and/or expanding space if removing a casualty in an in-line position (upwards and outwards) from their seat. The parcel shelf section of a vehicle is the part of the body shell that is the structural component between the back of the rear seat and the boot.

A number of components can be fitted to the parcel shelf, including seat belts, child restraints, speakers and high level brake lights. Therefore exposing the area to be cut prior to commencing this technique is crucial to avoid cutting through these components.

Some hazards exist under the parcel shelf; earlier model vehicles used tensioned steel bars to facilitate the opening of the boot lid. Cutting through these, or in the area they are fitted under the parcel shelf can create an impact hazard to the rescuers.

10.4.11 Removal through glazing

This situation may occur when an unrestrained occupant of the vehicle is thrown into the vehicle glazing. If the body part is pulled back, shards of glass may be driven in further.

a. Shard removal

When satisfied that the casualty is properly stabilised, the rescuer should look for long shards that are hinged to the glazing and pressing against the skin. These are bent away from the casualty and the point of a sharp knife is run in the fracture line to cut the plastic sheeting that holds the layers of glazing together. This will allow the removal of the shards.

b. Collar or dressing fitting

When all the shards have been removed from direct contact with the casualty's body part, a dressing or collar can be fashioned from a pad and bandages. The dressing or collar is then placed and worked between the casualty's body part and the glazing surface.

Before the casualty's body part can be guided back through the glazing, it is necessary to enlarge the opening. Broken glazing segments should be removed continually.

c. Alternative methods

An alternative method of freeing the casualty involves removing the top of the glazing. After first aid and stabilisation have been completed, the roof is cut just forward of the B pillars, followed by cutting the A pillars at the windscreen edges parallel to the hole. The glazing is then gently chipped with a ballpein hammer working in a straight line from the hole to the outer cuts. The sheeting plastic can then be cut with a sharp knife and the top of the windscreen lifted clear, by creasing the roof and folding backwards and clear.

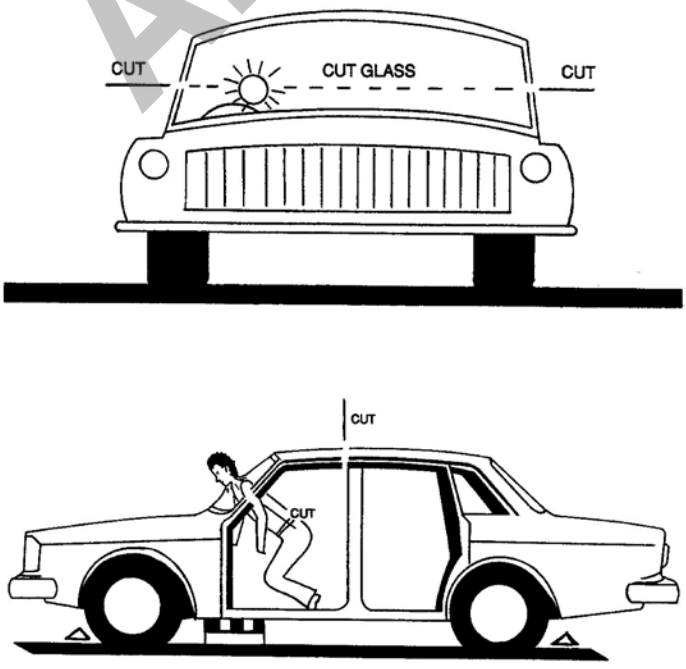

Figure 10:37
Extrication of casualty with head through glazing

10.5 Evolution examples

An evolution is a combination of techniques that achieve final extrication.

Use the techniques in combination to achieve release of each casualty.

10.5.1 Example 1—Frontal impact and on wheels

a. Description

i.) Frontal impact

ii.) On wheels

iii.) Doors open by hand

iv.) Driver physically trapped by steering wheel and legs

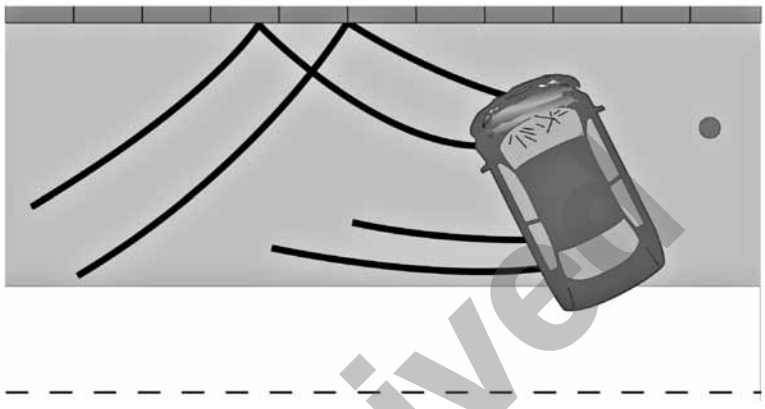

Figure 10:38
Front impacted vehicle on wheels

b. Plan & reasoning

i.) Remove front doors using a socket set. Adjustment (securing doors open) did not allow for the foot well exposure so used disassembly.

ii.) Flap roof to rear and secure. Need to reduce downward forces on the dash for the lift to follow. Displacement of the roof ensures maximum space for casualty removal. Large C-pillar would take longer to cut through.

iii.) Foot well exposure conducted to provide better access to the area of entrapment to assess the casualty's condition. Makes space for the spreader to conduct the dash lift.

iv.) Dash lifted to release the casualty from entrapment.

10.5.2 Example 2—Side impact and on wheels

a. Description

i.) Side impact (T-bone)

ii.) On wheels

iii.) Doors pushed in on impact side and stretched tight on the away side. Doors do not open by hand. Other vehicle is still solidly against impact side doors.

iv.) Driver physically trapped by foot well and against driver's door. Seat squashed between door and console and will not adjust away from dash.

Figure 10:39
Side impacted vehicle on wheels

b. Plan & reasoning

i.) If adequate access to the rear passenger compartment, conduct internal space making by cross ramming (displacement) the impacted side doors, off the driver. This creates early space and may relieve entrapment and creates lateral space.

ii.) Remove passenger side doors by spreading and cutting (severance) to gain access to interior. To ensure doors do not interfere with roof removal.

iii.) Roof removal with driver's A and B-pillars cut high and passenger side B pillar cut low (the time critical casualty may dictate extrication prior to the roof being removed). High cuts on driver's side are to provide protection from the car against the driver's door and to create. Low cut on passenger side is to provide greater access.

Roof removal also reduces downward pressure on dash for the dash lift.

iv.) Central dash lift used to release the casualty from entrapment.

10.5.3 Example 3—Rear impact and on side

a. Description

i.) Rear impact

ii.) On side and unstable, balancing on kerb

iii.) Doors do not open

iv.) Driver confined between seat and steering wheel

b. Plan & reasoning

i.) Roof entry / tunnelling used to maintain stabilisation which relies on the A and C pillars.

ii.) Adjust seat base away from steering wheel using the seat runner adjustments. No steering wheel adjustment is available.

iii.) Adjust seat back away from the steering wheel using back rest adjustment to release casualty.

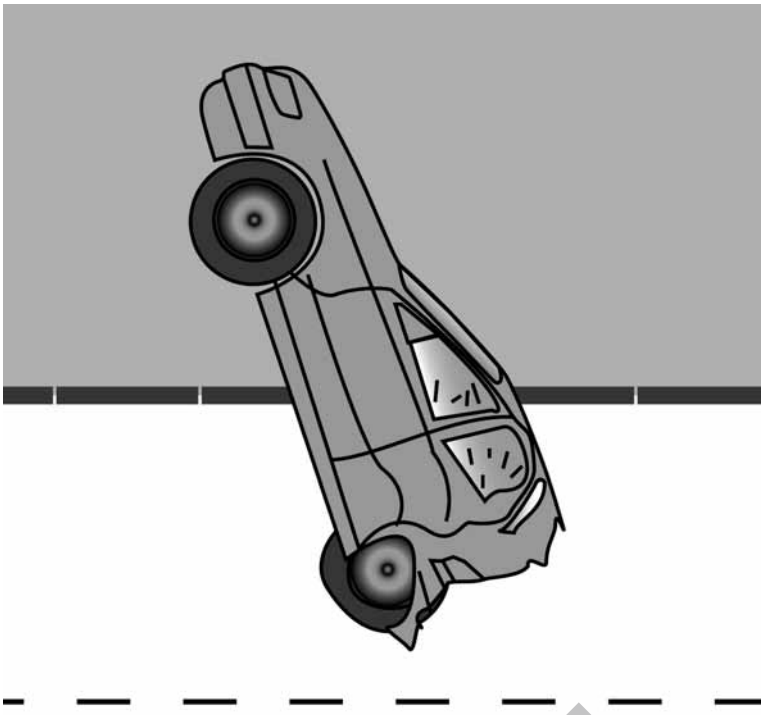

Figure 10:40
Rear impacted vehicle balancing on kerb

10.5.4 Example 4—Roll-over and on roof

a. Description

i.) Roll over

ii.) On roof with roof substantially collapsed. Limited access to passenger side caused by surrounding.

iii.) Driver's door does not open

iv.) Driver physically trapped by hanging in seat belt

b. Plan & reasoning

i.) Remove driver's side doors by spreading and cutting (severance) to gain access to interior. To ensure doors do not interfere with roof removal.

ii.) Cut seat belt to release the casualty from entrapment.

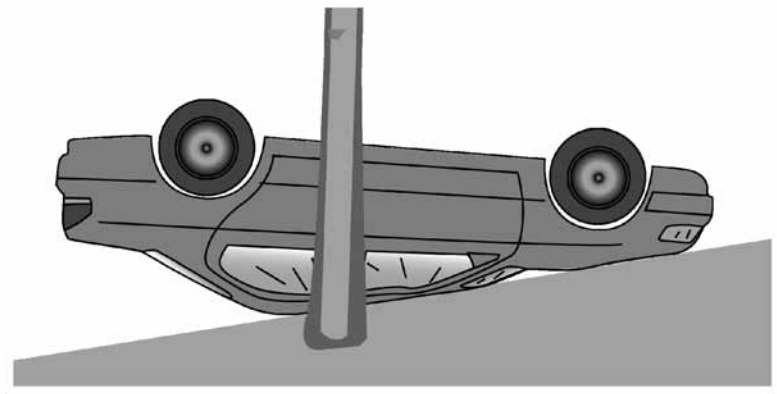

Figure 10:41
Rolled over vehicle on roof

10.5.5 Example 5—Under-ride and on wheels

a. Description

i.) Vehicle under-ride, sedan driven under rear of fully loaded 8 tonne capacity truck

ii.) On wheels

iii.) Doors open by hand

iv.) Driver physically trapped by steering wheel and dash on legs

b. Plan & reasoning

i.) Heavier equipment required to lift truck

ii.) Full side removal of car

iii.) Front roof flap

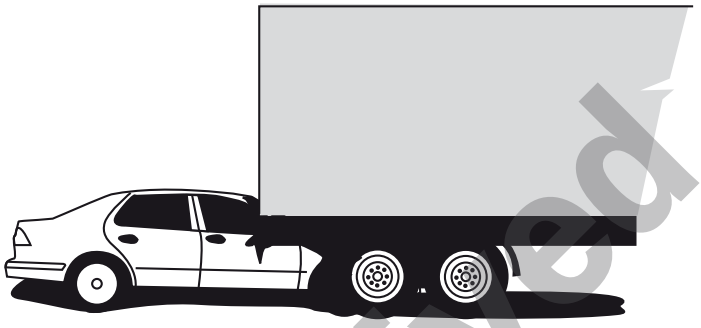

Figure 10:42
Under-ride and on wheels

Chapter 11
Removal and Transfer

11.1 Introduction

Casualty removal and transfer involves two distinct operations. These are defined as follows:

a. **Removal—**The movement of a casualty from the wreckage to a location outside the vehicle.

b. **Transfer—**The movement of a casualty from that location to an ambulance or other transportation mode.

11.2 Removal

There will be occasions when removal may be a simple operation, whereas the transfer may be over difficult terrain and involve the use of special techniques and equipment.

11.2.1 Personnel liaison

To prevent further injury during removal, the casualty must be fully supported and protected. Close liaison is essential between the rescuers and the person responsible for casualty care.

11.2.2 Techniques

Various techniques for casualty removal may need to be employed and include the use of short or long rescue boards, cervical collars, head blocks and straps, etc. These techniques must always be employed in conjunction with correct casualty preparation and should be conducted under the direction of the medical personnel.

11.2.3 Post-removal

After the removal phase has been completed, all action from this point will be to assist in the transfer of the casualty to the ambulance/transportation mode

11.3 Transfer

The transfer may simply be moving the casualty a short distance over level ground or it may involve a long distance over difficult terrain. Some casualties may be seriously injured or unconscious, therefore speed of transfer may be paramount, but must be consistent with safety and correct handling to prevent further injury.

11.3.1 Techniques

The technique used will depend on the condition of the casualty, injuries sustained and the availability of equipment. Frequent inter-service training and exercises should be conducted in removal and transfer techniques, using live persons as casualties to give rescuers and those responsible for casualty care understanding and confidence in the various methods.

11.3.2 Moving the casualty

To move the casualty, a rescue board, or other device should be used so that the casualty can be immobilised and moved as one. The body of the casualty should not be flexed, extended or rotated. If possible, injured parts should be immobilised in the position in which they are

found. The degree of recovery of a casualty will depend on the extent of the initial trauma, the prevention of further trauma during rescue operations, and the transporting of the casualty to hospital.

11.3.3 Lifting

If the rescuer must move the casualty or assist the medical personnel, the casualty can be moved with relative safety if lifted by three or more persons. Rescuers must make every effort to prevent all active and passive movements of the spine of the casualty. The casualty's head must be held securely. The shoulders are supported by a rescuer's hands. During the lift, the trunk and limbs must be aligned and supported by other rescuers. The casualty can then be moved slowly and carefully.

Figure 11:1
Moving the casualty

11.4 Planning

Rescue and casualty care personnel must carefully plan the transfer and ensure that the casualty is constantly monitored.

11.4.1 Techniques and improvisation

There are many techniques of transferring casualties under adverse circumstances. It is not enough for rescuers to have a variety of equipment and appliances at hand. They should have a wealth of ingenuity to assist in improvisation.

NOTE

Approval should be sought from the police prior to moving or removing deceased persons from the wreckage unless essential to preserve life.

CHAPTER 12

TERMINATION

12.1 Introduction

The termination phase of any Road Rescue must include the following considerations:

a. Final Check

b. Removal of Debris

c. Termination of Operations

d. Clean-Up and Preparation

e. Reports

f. Operational Debrief

g. Critical Incident Stress Debriefing (CISD)

12.2 Final check

Prior to departure from the incident the team leader will undertake a final review of the search protocols completing the primary and secondary search and surrounding environment.

Liaising with other emergency service personal present will determine that all casualties at the incident have been located, treated and removed from the incident.

12.3 Removal of debris

Preservation of evidence and scene-integrity are vital, to ensure police can conduct an accurate investigation. Therefore, if debris needs to be relocated it must be noted and reference given to the police OIC. The smallest piece of wreckage and its location may be vital in any subsequent investigation.

12.3.1 Responsibility

The responsibility for removal of broken glass, debris etc, from roadways, varies throughout Australia. However, where this is a major task, rescuers may assist with debris removal, but only after all unit operations and requirements are complete.

12.4 Termination of operations

The rescue leader must check with the other authorities involved prior to leaving the scene as they may still require the assistance of the rescue unit even though the casualty may have been released.

Rescuers need to be aware that it may be necessary to stand by for some time while police carry out functions such as Disaster Victim Identification (DVI) or Collision Investigation.

12.5 Clean-up and equipment servicing

12.5.1 Equipment

Equipment used is to be cleaned and serviced as adequately as possible at the scene, ensuring the vehicle inventory is complete. Safe stowage of equipment on vehicles must not be overlooked when concluding the operation. Engines on motor driven equipment must be cool, and safe to stow, and each item is secured in its correct location. Power units are to be re-fuelled and ready for use. The unit must maintain a continual state of readiness for immediate response.

It is imperative that teams, on return to their Station/Headquarters, carry out a vehicle and equipment service to maintain total operational readiness.

12.5.2 Hygiene

Personal hygiene should be addressed at this stage. Body fluids which have come into contact with rescuers or equipment should be decontaminated as indicated in the Communicable Diseases segment in Chapter 9 of this Manual, or as per agency/state/territory requirements.

12.6 Reports

It is essential that incident reports are completed as soon as practical, while details are still clear.

12.6.1 Operational debriefs

The time for operational debriefs will be decided by the team leader but should normally be as soon as possible after the activity. The 'whole of the activity' debrief may be held in two stages, the first immediately after task completion and the second some days after the event to allow collection of facts.

Uppermost in the mind of the team leader should be the need to maintain accurate records of events as they evolve. This record will be used to form the basis of the operational debrief and after-action report.

The purpose of the operational debriefs and after-action report is to:

- evaluate the successes and shortcomings of the operation;
- identify the ways used to overcome problems as they occurred;
- ensure the record accurately reflects the timing of events;
- amend operating procedures and plans to include the lessons learnt from the activity;
- indicate any training needs; and
- indicate any resource needs

12.7 Critical incident stress (CIS)

Stress is an individual experience, what may be stressful for one person may not be stressful to another. CIS can be described as any situation faced by rescue service personnel that causes them to experience unusual emotional reactions which have the potential to interface with their ability to function either at the scene or later. There are some instances when an incident is more likely to have an impact on rescuers these may include:

- The casualty is known to you
- A rescuer of emergency service member is killed
- The incident involves children

- There are mass causalities
- The rescue is ultimately unsuccessful
- Bodies are badly mutilated

Critical Incident Stress can occur whenever the individual's reaction to stress or the situation is such that it overwhelms their normal ability to cope. It is a NORMAL reaction to an ABNORMAL situation. Any incident has the potential to lead to CIS.

12.7.1 Critical incident stress debrief

Rescuers have well developed coping mechanisms and normally handle the day to day situations well. However, from time to time there may be a job that causes rescuers to think and feel quite differently from the others that they have attended. Some of the thoughts and feelings experienced may include: not being able to stop thinking about the scene, difficulty in sleeping, flashbacks or dreams of the scene, frustration, digestive problems, becoming withdrawn, headaches, and a general feeling of pre-occupation.

A well structured operational debrief may be all that is required to maintain operational efficiency. However, an operational debrief should never be confused with, or conducted as a CIS debrief. They are separate entities. All rescuers need to be aware of changes in behavioural patterns of individuals and the symptoms relating to emotional stability and conditions. These may require a rescue team leader to encourage rescuers to seek professional counselling. Information relating to identifying symptoms and the processes of initiating counselling or CIS debrief are identified within each organisation.

As part of pre-planning and ongoing training, existence of local Critical Incident Stress Management teams should be established. They will provide advice on types of assistance they can provide.

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