



Swedish Civil
Contingencies
Agency

Editor Dan Wargclou

Extrication from Cars during Road Traffic Accidents



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Swedish Civil Contingencies Agency (MSB)

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Introduction

Every year around 70,000 road traffic accidents occur in Sweden. According to the 2009 statistics from Transport Analysis¹ 397 people were killed on the roads in 2008². 26,248 people were injured, of which 3,657 seriously³.

A road traffic accident in which one or more seriously injured people are trapped is a demanding situation from both the technical and medical points of view. The condition of casualties must not be made worse by the extrication operation, and medical treatment must not be delayed.

Research suggests that damage to the cervical spine occurs in most types of accident. According to the survey, conducted by the insurance company Folksam, How Safe are Cars 2009 on serious injuries that have resulted in 10% or more incapacity, neck injuries have shown the greatest increase. In the mid-seventies 30% of these injuries involved the neck. During the nineties this proportion rose to 60%.

It must be possible to lift a casualty out of the vehicle without his/her neck and back being twisted. We know that twisting or incorrect lifting can incapacitate the casualty for life. This means that it may be necessary to lift off the roof of the car, even if the casualties are not trapped.

It is important that we can attend to people involved in road traffic accidents quickly and in the best way possible. The Swedish Civil Contingencies Agency has therefore produced routines for each person in the crew, zones around the accident site and an action plan for extrication that follows the action plan for medical assistance.

Time is precious!

The main message is that time is precious. There is a need to coordinate the work of medical personnel and fire brigade personnel and to make use of natural breaks in one another's activities. It is important that the fire brigade, emergency medical services and police interact well to ensure a good outcome. The aim is to shorten the extrication time and improve care of the casualty so that he or she is in a better or no worse condition after being extricated than when the units arrived on the scene. The concept of the extrication time means that a casualty is to receive hospital treatment within one hour of the accident happening. The extrication work should be carried out after the medical care work.

All parties involved have to work as a team, in which everyone

Time is precious!

has to know about the various operations that take place. Fire brigade personnel have to create space for medical care according to the L-ABCDE principle, pay close attention to the casualty's cervical spine and back during lifting and be able to lift in the longitudinal direction of the spine and control extrication in a medically appropriate manner. All this necessitates joint exercises between the emergency medical services and the fire brigade.

As everyone is aware, no two road traffic accidents are the same. Good knowledge is therefore needed both in pre-hospital emergency care according to the L-ABCDE principle and in extrication, so that fire brigade personnel can tailor their response to the situation. It is important to be able to read accident situations and keep track of developments so that cutting techniques can be adapted to vehicles on the road. Vehicle design is constantly changing, and it is obviously not good to be left at the scene of an accident not knowing how to continue with extrication because your own cutting technique is not working.

Good medical care is built on joint exercises between the fire brigade, the emergency medical services and the police.

Good medical care is built on smooth cooperation between the fire brigade, the emergency medical services and the police.



Book layout

This book was first published in 2007. In this revised version we have corrected errors, cleared up ambiguities and added some new material. Two new chapters on fuel and road environments have been added. We have also added to the sections on Euro NCAP, crash recovery system, safe accident sites and in-depth studies. Various safety systems are presented first and then we describe how different fuels affect the work of the emergency services. We later describe the road environment, equipment, organisation of the work on scene, and extrication in accordance with various flowcharts. The book concludes with a section on various measures that ought to be taken after an operation.

Dan Wargclou edited the Swedish version of this book. The section on gas and hydrogen vehicles was written by David Gårsjö, MSB. The section on electric, hybrid, and E85 vehicles was written by Ingvar Hansson, MSB.

In this book medical care is only dealt with in general terms.

Thank you!

We who have created this book have been assisted by many people and organisations. To try and list them all would be risky because it would be so easy to forget somebody. Many thanks for your help in producing this knowledge as a book.

Dan Wargclou
David Gårsjö
Ingvar Hansson



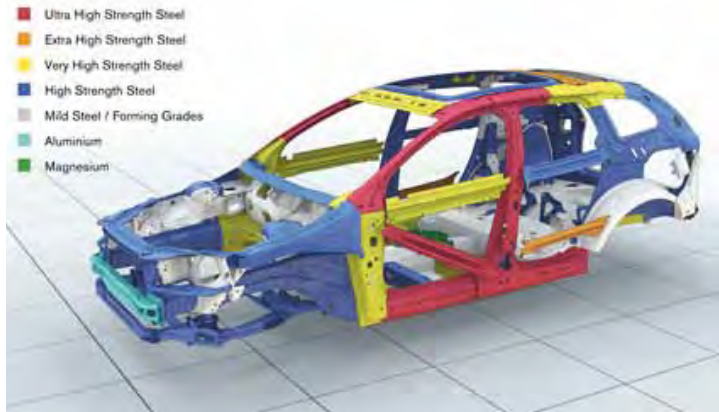
Volvo V50.

1. Safety systems

The technical progress taking place in the car industry is obviously of benefit to road-users. But new materials and new designs are also making ever greater demands on those of us who work at the scene of accidents. We have to keep abreast of the latest technology and constantly ask ourselves what the latest situation is. For example, can we cut in the same way and at the same places as we used to? It may also be difficult to work on new cars with older tools. The toolmakers too have to keep up with the latest developments and adapt their equipment to new car designs with regard to strength, design, working pressure etc.

Car-makers aim to make sure that drivers and passengers can travel in safety, and the impact protection system of a modern car is designed to provide the best protection possible in an accident. The interior is the part of the vehicle that is being strengthened most. Various grades of steel such as HSLA, which have been strengthened with alloys such as aluminium and various boron steel admixtures, are used. The mechanical strength of different grades of steel varies. HSLA steel has a strength of 700 N/mm^2 and boron steel 1380 N/mm^2 . Pure boron steel is, at present, the hardest and strongest steel in use. It is difficult for us to cut into it, and in some cases it is so strong that it can damage our tools.

The fire brigade must keep up to date with new technology and new designs. The pictures show how the B-pillar has changed over a period of ten years.



Steel qualities – Volvo XC 60.

B-pillar in Saab – 1990.



B-pillar in Saab – 2000.





Cutting attempts on a B-pillar reinforced with boron steel.





Euro NCAP

Euro NCAP is an organisation that conducts vehicle crash tests to ensure that all new car models meet the EU's requirements for passenger safety for frontal and side impacts. The organisation has conducted crash tests since 1997 and is supported by a number of European governments including the Swedish. The former Swedish Road Administration has cooperated with Euro NCAP since the start. The tests on new car models are extensive to ensure that a car's construction is safe, to assess child safety, to test how passengers are protected against whiplash, and to see what happens if the car collides with an unprotected person.

The following tests are conducted:

- frontal collision against a barrier at 64 kph
- side-on collision where a barrier is crashed into the driver's side at 50 kph
- side-on collision against a post at 29 kph
- Car collision with a crash test dummy, representing a pedestrian, at 40 kph

The result of the tests is that all car models are awarded a combined rating in the form of a number of stars. The rating scale is from one star (worst) to five stars (best), whereby the cars that have been awarded five stars ought to be able to provide good protection even in situations that haven't been tested for in the crash tests.

It is not possible however to make comparisons between vehicle classes because small cars undergo milder tests than large cars. A small car can therefore appear to be as safe as a large car but in reality the consequences of a crash will be greater on the small car. Five star cars now exist in all classes.

Crash test.



Details about how the tests are conducted are taken from the Swedish Transport Administration's traffic safety information about Euro NCAP.

Frontal impact

The Euro NCAP frontal impact test occurs at 64 kph. The car impacts with a barrier that can deform and extends sideways beyond the width of the car. This is a situation that resembles a real frontal impact. Two adult crash test dummies are placed in the front seats; after the impact, measurements are taken from the dummies to assess the protection provided to the driver and front seat passenger. The dummies "bodies" are divided into zones, and when the results are reported the zones are colour coded to show how well various body parts are protected. Green means the protection is good; red means the protection is poor and that there is therefore a great risk of injury to that part of the body.

Two child size dummies are placed in child seats in the back seat of the car. One dummy is the size of an 18 month old child; the other is the size of a 3 year old child. Acceleration in the chest during impact is measured on the larger dummy and on the smaller one acceleration is measured in the head. The results from the child dummies are an important aspect of the assessment of a car's child safety.

Side impact

The side impact test occurs at 50 kph - the car is hit by a barrier mounted on a sled that drives into the driver's side of the car. The barrier can deform. A supplementary test is conducted whereby the side of the car is crashed against a post or a tree as this type of collision causes many injuries, especially in Germany. During the side impact test an adult dummy sits in the driver's seat and two child dummies in the back seat. The adult dummy's body is divided into zones and when the results are reported the zones are colour coded in the same way as for the frontal impact test. Green means the protection is good; red means the protection is poor and that there is therefore a great risk of injury to that part of the body. The child dummies in the back seat are measured in the same way as for the frontal impact test.

Pole test

Euro NCAP also conducts a pole side impact test whereby the car travels on a wagon sideways and collides at 29kph with a fixed pole that has a diameter of 254mm. The only crash test dummy in the car is placed in the driver's seat, seatbelt on, seat set in its medium position. The crash test dummy (Euro SID-1) weighs the same and is the same size as an average man. The results of the test are shown in graphic form on the dummy, and in the form of side impact points where 2 is the highest. Side impact points indicate how great the risk is for head injuries.

Colliding with a pedestrian

Euro NCAP tests to see if cars are so designed as to protect pedestrians from serious injuries in the event of a collision. Pedestrian protection is determined via a number of tests that simulate collisions with children and adults, therefore dummies of various sizes are used. Tests are in accordance with the guidelines from the European Enhanced Vehicle Safety Committee (EEVC) and are conducted at 40 kph, which is a common speed in urban areas. How serious the injuries are to pedestrians during an accident depends a great deal on how a car is constructed at the point where the pedestrian collides with it. When a person is hit by a car it is usual for the lower leg to collide with the bumper and for the thigh to collide with the car at headlight level. Adults' heads hit the bonnet close to the windscreen, whereas children's heads hit the middle of the bonnet. The points on the dummies that make contact with the car are studied and assessed. If the material used on the car gives a bit on contact the injuries will be less than if the material is stiff. But the construction under the bonnet is also important. If there are hard parts directly under the bonnet then injuries to a pedestrian will be more serious than if there is space under the bonnet to allow it to bend inwards.

Euro NCAP presents the results of its pedestrian collision tests separately. The best rating is four stars.

Child safety

Since 2003 Euro NCAP has been testing child safety in cars. The most important aspect of child safety assessments is how the child size dummies respond in frontal and side impact tests. Consideration is however also given to other factors, for example, how easy it is to install child seats and if there is any warning sign for a front passenger airbag. The assessment of child safety is however limited because tests are only conducted on safety equipment for 18 month old and 3 year old children. Furthermore, the car manufactures themselves choose the safety equipment, which is primarily a child seat.

Sweden is doubtful about these assessments because they don't have as a condition that the child will sit facing backwards for as long as possible. A backward facing child seat in the car's front passenger seat gives only 2 out of a possible 67 points. A good ranking does however show that a car manufacturer has put a lot of work into child safety. Child safety can be awarded up to a five star ranking.

Whiplash

Every year in Sweden about 20,000 people incur whiplash, which accounts for 70% of injuries incurred in cars. Every tenth whiplash casualty suffers chronic pain and approximately 150 casualties are forced to take early retirement as a result of their injuries. By far and away the most common cause of whiplash occurs when a car is hit from behind; Injuries can however occur during head-on collisions, single vehicle accidents, and sometimes even outside the road traffic environment. Since 2003 the Swedish Transport Administration and Folksam (an insurance company) have conducted collision tests to ascertain the level of whiplash protection offered by different car seats. The tests highlighted huge differences; a car with effective protection halves the risk for chronic pain.

Sweden is in the forefront of research on whiplash and when it comes to testing protection against injuries. The ambition for the future is that tests of whiplash protection systems will be included in the Euro NCAP tests.

Batteries

Nowadays batteries come in various sizes and materials. Electric and hybrid vehicles have large battery packs that weigh a lot, but that is covered in a separate chapter.

Today many cars have more than one battery, primarily because newer cars carry so much safety equipment which requires a lot of power, therefore the need for an extra battery. It isn't possible to see externally if a car has more than one battery because such information isn't marked anywhere. Noting the amount of safety equipment in a car can however give you an idea about the number of batteries in the car.

Mercedes Benz A-Class. The battery is located in the floor in front of the front passenger seat under a cover and possibly a mat.



Chrysler Cruiser. The battery is located on the left-hand side of the engine compartment under part of an air intake.



Cutting power

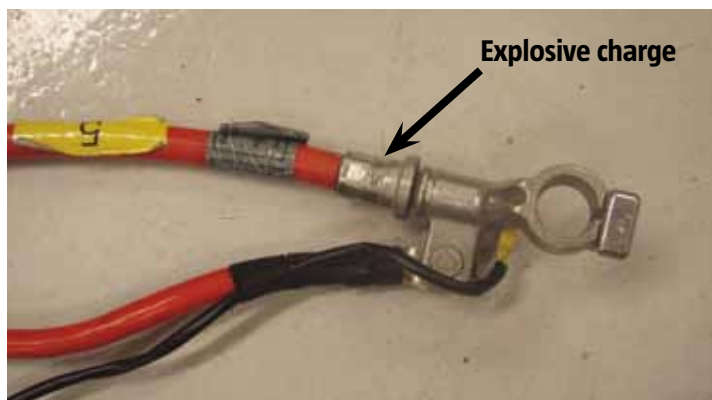
To be able to execute as good an emergency response as possible the emergency services must be conversant with how a vehicle's safety systems work and how they are activated.

When it comes to road traffic accidents (RTAs) it is important that the power from the battery is cut as soon as possible as this will reduce both the risk of fire and of any safety system being triggered because of a short circuit. If the power can't be cut off at the battery end then the ignition has to be disconnected. However, don't do this by cutting the cables just disconnect them from their terminals. This is because you might later need power to lower the windows or move an electrically adjustable seat to make extrication of injured passengers easier. In which case, it is good to be able to easily reconnect power again. Always start with the negative cable; if you start with the positive cable you can cause a short circuit if tools touches the metal bodywork of the car, and then there is a great risk of sparks. That risk is eliminated if you disconnect the negative cable first.

In some cases it will be difficult to cut power due to the position of the car or the location of the battery. In which case, don't spend too much time on that, just turn the power off with the key or stop button instead, and work safely based on your knowledge of those conditions.

Automatic battery disconnection

Some cars have a function that loosens battery cables from the battery in the event of an accident. This is done by a small explosive charge being detonated. Some of the power remains however to allow for certain safety equipment to carry on working.



Automatic battery disconnecter.

Belt pretensioners

To eliminate slack in seat belts, modern cars have pretensioners, which mean that the belts tighten around the vehicle occupants in the event of a collision. There are mechanical pretensioners that work with a powerful spring and pyrotechnic ones that tighten the belt around the occupant in the event of a collision. Pyrotechnic pretensioners are the most common type today. Older pretensioners may mean that the seatbelt is tightly secured around the casualty after a crash.

More recent models release the pressure on the casualty after activation. If the pretensioner has not been activated it is important not to cause any damage to it, to avoid activating it accidentally.

Airbags

Many vehicles on the road, particularly models dating from 1990 or later, are fitted with airbags. There are airbags for the driver's seat, passenger seats, side impact protection curtains and side airbags. The latter may be in the side of the seat, but also at other locations in the car. Common volumes are 60 litres on the driver's side and 150 litres on the passenger's side. The volume of side airbags and side impact protection curtains is around 12 litres. Other airbag applications are under development. In addition, nowadays there are airbags in other places in a car, for example, at the knees, by the pedals and by the seatbelt.

As well as cars and small and large vans, recent models of large goods vehicles are also usually fitted with airbags.

Examples of driver, passenger and side airbags in a Saab.



How an airbag works

Sensors located in the interior of the car, at the front or side, send an electric signal in response to a sufficiently powerful force (for example a head-on collision with a barrier at a speed of at least 15 kph) to a main sensor which in turn sends a signal to the safety equipment to be activated. The sensors sense the deceleration but do not have a "memory". This means that the system returns to its neutral position after a sharp braking manoeuvre or similar episode when the bag has come close to being deployed.

In almost all older vehicles (1997 year model and earlier), the sensors send an impulse to a gas generator, in which a rapid chemical reaction generates nitrogen gas. Various substances are used for this reaction and some by-products may be highly corrosive and cause irritation to both passengers and fire brigade personnel. Some substances can have an adverse effect on the healing of wounds. If they get into open wounds, it will take longer for the wounds to heal. One such substance is sodium hydroxide (caustic soda). According to the manufacturer no more than one gram of soda should emerge. But if it is known that caustic soda may have entered a casualty's open wound, the accident and emergency department of the hospital should be given this information.

A kind of talc is also used on older airbags to reduce friction. This talc could irritate the eyes and in some cases cause a stinging pain in wounds.

More recent systems have a pressure container that fills the bag and is free of the toxic substances produced by the chemical reaction.

Nitrogen has also been to some extent replaced by argon and helium. In addition, there are hybrid systems where the steering-wheel bag is inflated by a chemical reaction and the other airbags by pressure containers.

The airbag is filled with gas in a few hundredths of a second and is fully inflated before anyone hits it.

It is then discharged relatively quickly through holes that face away from the occupants. The bag expands quickly, and the speed of movement in the direction of the occupants can amount to a few hundred kph in a head-on collision. Heat is produced in the reaction in the gas generator, and the steering column may become quite hot. The sound level is also high. The sound level may be up to 170 dB.⁴ Some driver airbags are deployed in two stages, depending on vehicle speed and driver weight.

The fire brigade must be familiar with and be able to deal with the various safety systems encountered in different cars.

Fire

The former Swedish Rescue Services Agency carried out trials with Volvo and Saab in which cars are set on fire to see how the safety systems and gas containers and pyrotechnic deployment devices in particular respond at high temperature. Gas containers can ignite at temperatures in excess of 200°C. This means that an airbag might be deployed at high heat levels, for example in a vehicle fire. At a temperature above 200°C there will be a fully developed fire in the passenger compartment.

Volvo S80 airbag system

The airbag system of the Volvo S80 is a hybrid system. The driver's airbag is filled with nitrogen gas, formed in a chemical process in a gas generator. The passenger airbag, side airbags and side impact protection curtains (which come from the roof as protection inside the side windows) are filled with argon gas. This gas is in pressure containers that are opened by a pyrotechnic igniter con-

Break away the trim and look for where gas containers are located.



On certain convertible models the pressure containers are located in the front doors.



trolled by an electric signal from the central sensor. The pressure containers for the curtains may be in the A-, B-, C- or D pillars. Some pressure containers are located at the edge of the roof behind the passenger handles. The pressure vessel of the passenger airbag is in the dashboard. In cars with side airbags there is a pressure vessel in the backrest of the front seats which inflates them.

Regardless of the make of car, most gas generators include a pressurized container holding some form of gas. The pressure in the container is usually high, between 200 and 500 bars; so avoid cutting into them. Break away the interior and find out where the container is, then make the cut from the side on.

The airbags can have the following volumes:

- Driver airbag approx. 60 l
- Passenger-side airbag approx. 150 l
- Side airbags approx. 12 l
- Inflatable curtains approx. 12 l

Identifying a vehicle with an airbag

An airbag installation has to be identified in some way, but the clarity of the identification varies. The marking may be on a window, the dashboard or the steering wheel. Older forms of identification may be S.I.R., P.R.S. or Airbag. In some cases it may be very difficult to see whether the vehicle has side airbags, for example. Agreement has now been reached in the car industry to use the designation SRS (Supplementary Restraining System) for the system with airbag and pretensioner. The hub of the steering wheel may look "bulky" in a car with an airbag.



Side impact protection curtain in Volvo.

Side impact protection curtain for BMW.



An airbag installation has to be identified, for example on a window, the dashboard or the steering wheel. The picture shows Volvo's identification of an airbag.



Volvo V50 with identification of airbags on interior trim.



Medical effects of airbags

A person who has crashed in a car fitted with an airbag has probably been protected by the airbag, particularly if he or she has also been wearing a seat belt. According to the Folksam survey How safe are cars in 2005, using a three-point seat belt reduces the risk of fatal or serious injuries by more than 50%. A three-point belt together with an airbag reduces the risk of fatal or serious injuries by over 60%, according to Folksam.

The force required to inflate an airbag may, however, injure people who are very close to or in direct contact with the bag when it deploys. In the first few milliseconds of inflation the force can seriously injure a person who is hit by the expanding airbag. Anyone who is in contact with, or very close to, the airbag when it starts to expand is in the danger zone. It is important to understand that whether severe injuries are caused by airbags usually depends on the person's position when the airbag starts to expand - not the person's size or age. Most deaths involving airbags involve people who do not wear their seat belt, wear their seat belt incorrectly or do not sit correctly. People not wearing a seat belt, particularly vehicle occupants on the passenger side, are in danger as they will probably be thrown forward during the sharp braking manoeuvres or abrupt turns that often precede a collision. They may then come too close to their airbags and be injured. Drivers who lean forward or sit less than 25 centimetres away from the steering wheel are also in the danger zone.

Babies should never travel in rearward-facing child car seats in the front passenger seat if the car is fitted with an airbag on that side and the airbag is not disconnected,

As mentioned earlier, the occupant may get corrosive (alkaline) substances or substances that cause mechanical irritation in his or her eyes and wounds if an airbag deploys. If the substances get into open wounds, it may take longer for these wounds to heal.

It is mostly airbags in older vehicles (1997 and earlier models) that release these substances.

Gases and particles can induce asthma attacks in asthma sufferers in a few cases. The sound level when the airbag deploys (up to 170 dB) may cause temporary hearing impairment and dizziness.

In Sweden only a small number of injuries are known to have been caused by airbags. There are more detailed statistics in the United States. More than 87 million (43.6 %) of the 200 million cars and light trucks on the road in the United States are fitted with airbags on the driver's side (Insurance Institute for Highway Safety).



In Volvo cars there is a sticker showing what airbags etc. are fitted in the vehicle. There is also an ambition to include the number of batteries in the car on this sticker.

American figures indicate that many people have been killed or injured as a result of an airbag. The reason may be that many car drivers see the airbag as a substitute for a seat belt, and not as a complement to it. The car industry has therefore developed stronger airbags that can withstand the force of an adult who is not wearing a seat belt. This leads to increased risks for anyone who sits incorrectly.

Airbags and the fire brigade

The Insurance Institute for Highway Safety does not know of a single case in which fire brigade personnel have been seriously injured by an airbag during a rescue operation. However, two firefighters in the United States were slightly injured by an airbag that deployed when they were working to extricate a casualty from a car. The incident was described as follows in the magazine Rescue:

A car had left the road and collided with a tree. The left side of the car was severely damaged. The driver and a rear-seat passenger were trapped and had sustained serious injuries. Both were conscious. The crew attempted to open the bonnet and disconnect the battery, but the movements this produced in the car caused the trapped occupants severe pain and the attempt was abandoned. The firefighters then fire-proofed the car, but the circumstances caused them to forget that the battery had not been disconnected.

The driver was removed on a rescue board through the front right-side door. The passenger, an adult man, was trapped with his feet under the front seat, and it was very difficult to extricate him. A firefighter inserted a spreader between the seat sub-frame and a metal box located on the tunnel between the front seats. He was assisted by another firefighter who lay across the steering wheel. This first attempt to free the casualty failed, and another attempt was made. It was then that the airbags deployed. Both firefighters were violently thrown from the car.

The firefighter who had been lying across the steering wheel himself thinks that he lost consciousness for a while.

After the accident both firefighters suffered stomach and chest pain and temporary hearing impairment.

Fortunately it turned out that neither of them had sustained any fractures. Both were back on duty soon after the accident.

What happened was that one blade of the spreader peeled off the plastic cover on a positive cable (+). The other blade created a hole in the metal box which contained equipment for deployment of the airbags.

The spreader then conducted the current to the deployment equipment, and that was enough for the accident to occur.

(Extract from the magazine Rescue, July/August 1996)

A conclusion that can be drawn from the incident is that fire brigade personnel should follow these recommendations:

Remember!

- Always disconnect the battery. If this cannot be done, switch off the ignition.
- Bear in mind that cars may have two batteries.
- Avoid working in the risk zone of the airbag if the airbag has not deployed.
- Bear in mind that the car may have more than one airbag.
- Avoid placing the spreader guide against "unknown" parts of the car.

Note that there are some situations in which particular caution must be exercised:

Most vehicles have airbags with a certain deactivation time, so that they can also work in a protracted crash sequence in which the battery has been disconnected. The deactivation time in modern cars is normally less than one minute, usually a matter of seconds. But there are cars with a deactivation time of up to half an hour. For example, some Saab models from 1994 and earlier have a deactivation time of 20 minutes.

This means that an airbag that has not deployed in the crash may deploy unexpectedly during the rescue operation, even if the battery has been disconnected. This can happen, for example, if the leads are cut. It is therefore advisable not to be in the airbag risk zone (i.e. less than 25 cm from the steering-wheel hub) during a rescue operation work or to hold an object between a trapped occupant and a non-deployed airbag. Nor should work be done on the steering-wheel column or hub, as this can cause airbag deployment.

Remember! A car may have more than one airbag!

There have been reports of airbags having been triggered by radio communication equipment located in cars. Leads from sensor to gas generator could conceivably act as aerials and in so doing contribute to accidental airbag deployment. The instruction manuals of many modern cars contain a warning against using a mobile phone without an external aerial in the car, as the phone can "interfere with the car's electronic systems", which include the safety system.

Frequently asked questions and answers about airbags

How can one tell if a car is equipped with an airbag?

Cars equipped with airbags have to be marked accordingly. This marking may be located on a window, the dashboard and/or the steering wheel. Older terms used are S.I.R., P.R.S. or Airbag. The car industry has now reached agreement on the designation SRS (Supplementary Restraining System). The steering wheel hub often looks bulkier on a car that has an airbag. If you are uncertain, you should always treat the car as having an airbag.

Can toxic substances emerge from a deployed airbag?

Yes, very small quantities of toxic substances may emerge from a deployed airbag. Many airbags are inflated with nitrogen, which is formed by a chemical reaction in a gas generator. Residues are also formed in the process, including some corrosive substances, such as sodium hydroxide (caustic soda). On older airbags there is also a kind of talc that may cause irritation in the eyes and in some cases a stinging sensation in wounds.

According to the manufacturer no more than one gram will escape into the passenger compartment. In more recent cars with pressure containers, no toxic substances can leak out at all as different types of gases are used (e.g. argon and helium).

Can it be expected that all the airbags will have deployed if the car has been involved in a head-on collision?

No, normally not all the airbags will deploy in a head-on collision. The side-impact protection system will not have deployed in a head-on collision. If a car has been hit from the side, only the side-impact protection system will deploy.

Is it dangerous to approach a crashed car when the airbags have not deployed? Could airbags be close to deploying?

No, non-deployed airbags in a crashed car are not close to deploying. There is therefore no risk of the airbags deploying as a result of you taking hold of the vehicle, bouncing it etc. The sensors that sense the deceleration do not have any memory and always return to their neutral position after an abrupt manoeuvre. If this was not the case, the airbags might for example be triggered by a series of hard braking manoeuvres in succession.

Can airbags deploy accidentally?

An airbag normally does not deploy if the power supply is broken by disconnecting the battery.

- You should therefore always disconnect the battery and not cut the cables to the airbag!
- Also avoid cutting the steering wheel hub and steering wheel column.
- Turn off the ignition if it is not possible to disconnect the battery.
- Do not cut into a gas container.

Other safety systems

Most car manufacturers try to develop different assistance systems that improve safety and make driving easier.

Whiplash protection

Many car makers try to find solutions to the problem of whiplash injuries. Volvo and Saab have anti-whiplash protection fitted into their seats. Mercedes has protection built into the seat's head restraint.

This photo shows whiplash protection fitted into the seat's head restraint.



This photo shows one of Volvo's whiplash protection systems fitted into a seat.





Activated safety system for Saab 9-3 convertible. It is important to exercise caution if working close to a non-deployed roll-over protection system.

Roll-over protection systems

Convertibles have special safety systems to provide protection in the event of roll-over. These are known as roll-over protection systems. To protect the driver and passengers if the car rolls over, arches are deployed at the head restraint. If these arches have not been activated in a road traffic accident, they can pose a risk to fire brigade personnel. As the system may be activated during the rescue operation, it is important not to lean across the arches.

Safety glass

It is becoming increasingly common for cars to be fitted with safety glass (laminated glass). This is identified on all cars by a symbol on the window or by text stating that it is safety glass.

Protective systems

Here we describe some safety systems that Volvo has developed and that can be found in various current Volvo models.

WHIPS (Whiplash Protection System)

Whiplash injuries are Sweden's most common road traffic injury, usually due to vehicles being hit from behind at low speed. Volvo's Whiplash Protection System (WHIPS) is integrated into the front seats and is activated in the event of a powerful rear-end collision; it restrains passengers and thus reduces the risk of whiplash injuries. Independent tests by, for example, Folksam (an insurance company) and the Swedish Transport Administration have shown that WHIPS is one of the most effective whiplash protection systems in the world and that it can more than halve the risk for long term invalidity.



Volvo's symbol for safety glass.

Seatbelts with pre-tensioners and load limiters

Seatbelts are a car's most important safety feature. All seatbelts have pre-tensioners that activate within thousandths of a second when a car crashes or rolls over, which tighten the belt to provide optimal protection. The front seatbelts release after a while so that the driver and front seat passenger are restrained by the airbags in a controlled manner.

Side body-airbags

Side body-airbags reduce the risk of serious injuries to the chest and hip area in the event of a side impact. The airbags are inflated within thousandths of a second. They are fitted in the side of the front seats to provide protection in all seat positions.

IC (Inflatable Curtain)

The inflatable curtain (IC) deploys in the event of a side impact or the vehicle rolling over in order to help protect the heads of passengers by the doors, both front and back. It remains inflated to provide continued protection during complex collisions and helps to keep the passengers in the vehicle. In addition, the IC works in conjunction with the two-stage integrated belt-cushions to help protect children in the back seats.

Low front cross-member

On cars with low front bumpers a cross-member positioned low down is integrated into the front structure. In the event of a collision the cross-member can activate the car's other crumple zones and other safety systems to reduce the risk of injuries.

Pedestrian protection

To reduce the risk of injury to unprotected people in the street e.g. pedestrians, the car's front section is softly rounded, the headlamps are integrated into the bodywork, and the bonnet functions as an energy absorbing zone.

Two stage airbags

In the event of a frontal collision protection is provided by the driver and passenger airbags to the head, face and chest. To provide as good a level of protection as possible the force of the impact determines how far inflated the airbags should be. If the force of the impact is so low that the airbags aren't required then

only the seatbelt pre-tensioners will activate. The driver's airbag also works in conjunction with steering column deformation to minimize injury to the driver.

Pre-prepared restraints

Seatbelts and airbags in a Volvo are designed to provide maximum protection with a minimum of injury to the vehicle's occupants. The Volvo XC 60 has, in addition, the new fitted as standard laser based system, "Pre-prepared Restraints" (PRS), with a sensor in the windscreen that continually reads objects in front of the car at all speeds. This makes it possible to prepare and adapt seatbelts and airbags to the expected force of impact and thereby improve protection during a light or severe frontal collision.

Preventive systems

This section includes some of the systems that are intended to prevent accidents.

DAC (Driver Alert Control)

On motorways and A roads at speeds over 65 kph DAC can help to alert a tired driver or a driver who isn't concentrating. With the help of a digital camera and data about steering wheel movement the DAC compares the direction of the road with the direction of the car. If the DAC detects that the driving style has deviated from the normal and expected (e.g. the driver is becoming distracted or falling asleep) it emits an audible warning signal at the same time as a message on the data screen on the instrument panel suggests a break from driving.

LDW (Lane Departure Warning)

At speeds over 65 kph the LDW can help to prevent one-vehicle accidents and other accidents that are caused by temporary lacks of concentration.

A digital camera monitors the road markings and the car's position on the road. If the driver unintentionally crosses the lane markings the LDW emits an audible warning signal. The system doesn't activate however when a vehicle intentionally crosses a lane with its blinkers on.

ACC (Adaptive Cruise Control)

The ACC should make driving over 30 kph smoother. The driver only has to select the desired speed and distance to vehicles in front. When the radar detects that the vehicle in front is slowing down the ACC automatically reduces the car's speed so as to maintain the selected distance.

Collision warning with autobraking

The collision warning system is was constructed primarily for high speeds. Using radar and a digital camera the collision warning system can determine the distance to the vehicle in front to a range of 150 metres. If the vehicle In front suddenly slows down and the system assesses that there is a risk of collision it emits an audible signal and projects a warning symbol on to the windscreen. Simultaneously the car's braking system adopts readiness mode to reduce reaction time and to provide maximum braking effect at exactly the moment the driver's foot hits the brake pedal. If the driver doesn't react to the warnings and a collision is unavoidable the brakes will activate automatically.

RSC (Roll Stability Control)

Sometimes a driver takes such an extreme evasive manoeuvre that there is a risk of the car rolling over, but the RSC (Roll Stability Control) system can prevent this. The car's tilt angle and roll over risk are registered by a gyro sensor. If it is needed the RSC activates by immediately reducing the engine torque or by braking on one or more of the wheels, just as much as is needed to reduce the centrifugal force and to help the driver stay in control.

Volvo On Call

The Volvo On Call Roadside Assistance system works at the press of a button In the car. When pressed the driver is then in direct contact with an operator who can see the car's exact geographical position and quickly arrange for assistance. Additionally, the operator is alerted automatically in the event of an accident resulting in the deployment of airbags.

DSTC (Dynamic Stability and Traction Control)

Stability improving technology such as the DSTC system can prevent skidding, wheel spins, and roll overs, and some feel that the system is a very important innovation in safety. There are sensors in the car that detect the direction of the car and its tilt angle, this data is then compared to steering wheel movement and

wheel rotation. In this way the system identifies the beginning of a skid and can prevent it by reducing engine power or by braking on one or more of the wheels.

BLIS (Blind Spot Information System)

BLIS keeps an eye on traffic on both sides of the car using a rearward facing digital cameras in the wing mirrors. As soon as a vehicle is on its way into the blind spot a light blinks on the relevant forward door post. In conjunction with the wing mirrors BLIS makes it easier and quicker to assess if it is okay to change lane or not. The system is active from 10 kph and reacts to most types of moving vehicle, from motorbikes upwards. BLIS works both in daylight and at night time.

Rear view camera

The rear view camera shows what is behind the car when the driver is reversing, using a screen in the car and a digital camera about the rear number plate.



Hybrid car "Prius".



Electric car "Think".



Electric car charging.

2. Different fuels

This chapter describes Electric and hybrid cars, gas powered cars and cars powered by E85. These types of vehicle are becoming increasingly common on Swedish roads, but there is still no great experience from accidents involving them. It is therefore important to try to find out what new risks can arise in connection with collisions and fires involving such vehicles.

Electric and hybrid cars

There are several different versions of hybrid cars, but all hybrid vehicles have dual drive systems. There is often an electric motor combined with an internal-combustion engine. There are two different technologies that manufacturers make use of: parallel hybrid and series hybrid.

A parallel hybrid is a hybrid vehicle in which the electric motor and internal-combustion engine are used simultaneously. When the car is driven below a certain speed the internal-combustion engine is disconnected and the vehicle only uses the electric motor. At higher speeds the internal-combustion engine is used, but the electric motor can help out if there is a heavy load on the engine, for example on a steep slope. This technology is used, for example, in the Toyota Prius.

A series hybrid is a hybrid vehicle in which the internal combustion engine's only task is to drive the generator and electric motor, which in turn propels the vehicle. Series hybrids are often used in urban buses as the internal-combustion engine can be switched off when driving in urban areas. A problem is, however, that the vehicle has to start the internal-combustion engine at regular intervals to recharge.

Voltage and high energy content

Voltages of up to 500 Volts can occur in hybrid vehicles, in cars, buses and trucks. The high-tension cables are coloured orange and are usually contained in safe structures in vehicle bodies. All hybrid vehicles have their own safety systems which, turn off the main switches in the event of a collision or similar situation. This does not, however, mean that the battery is safe, as the high voltage and high energy content are still present even though they are isolated from the battery pack.

Cross-section of battery pack.



Engine compartment in a hybrid car. Orange = high voltage.





Cross-section of hybrid car.



Many battery cells are coupled together to form a battery pack in the Prius

These cars often have a service switch that mechanically disconnects the voltage in the middle of the battery, and in so doing halves it. The voltage should be disconnected in this way during rescue work. On the Toyota Prius the switch is orange and is located in the luggage compartment, but it is not entirely easy to find.

The car's safety system may be destroyed before there is time to trip the main switches. In the event of a heavy collision, it is thus possible that the main switches have not been turned off and that high-tension cables outside the battery pack are damaged and come into contact with the car's chassis. The Swedish Civil Contingencies Agency has tried to find out how the great the risk of such a scenario is, but manufacturers of cars and batteries reply that while it is theoretically possible it is highly unlikely. Fire brigade personnel should be aware of this risk and take the precaution of wearing full PPE (personal protective equipment).

Service switch Ford.



Service switch GM.



Service switch Toyota.



Boot of hybrid car. NOTE service switch and battery pack



Battery technologies

Lead-acid batteries

Proven old technology with limited output. As well as being used as starter batteries in cars, these batteries are used in fork-lift trucks, various types of implements and less energy-demanding products. All 12-Volt starter batteries are lead batteries, each cell generating about 2 Volts.

Two main types of starter batteries are distinguished, open and closed. The oldest starter batteries are open ones, in which the state of charge can be measured and topping-up with water is possible.

With regard to closed starter batteries, there are two types, “optically closed” ones whose plugs cannot be opened and valve-regulated batteries.

Valve-regulated lead-acid batteries are of the gel or AGM types and have a closed lid construction where gases that are generated are largely recombined. The gases that are regenerated are released through safety valves controlled by the gas pressure inside the battery. Gel batteries are basically designed in the same way as a traditional lead-acid battery but with the electrolyte in gel form, while the AGM technology is newer. AGM stands for absorbent glass mat and means that the electrolyte is bound in a fibreglass mat.

Valve-regulated batteries are also used to a limited extent in some electric cars. The battery packs of these cars are made up of many batteries connected in series. The reason why this type of battery is used in electric cars is a cost/benefit analysis.

However, the output of lead-acid batteries is limited and large battery packs are required to enable them to be used to power hybrid or electric vehicles. Lead batteries are also very heavy, which increases the weight of the vehicle.

The electrolyte is an acid that can be dangerous in contact with the skin and is to some extent environmentally hazardous.

No special account needs to be taken of this in connection with fires and collisions.

Nickel-metal hybrid batteries

Rechargeable nickel-metal hybrid batteries have existed since the mid-1970s and are the type of battery principally used in the hybrid cars of today. The advantage is that the design is relatively safe and that the batteries produce far better energy density than lead batteries (that is to say, they are smaller and lighter yet provide more energy).



Closed lead-acid battery.



Valve-regulated lead-acid battery.

Nor do these batteries contain any heavy metals posing an environmental hazard. The drawback is that the batteries have high self-discharge when not in use and that they generate so much heat during charging that cooling and monitoring are required, as there some risk of fire.

Each cell generates 1.2 Volts. To obtain 400 Volts, 320 cells need to be connected in series, and all the cells must be intact if the capacity of the whole battery is not to fall. The cathode is made of nickel and the anode is made of a metal hydride. The electrolyte is a corrosive alkaline solution which principally consists of potassium hydroxide and sodium hydroxide. The electrolyte is enclosed, and only small amounts can escape when a collision occurs.

Two different battery cell types.



The protective covering removed from a metal hybrid battery pack. The battery is made up of many interconnected battery cells.



Lithium-ion batteries

There are many hundreds of different types of lithium-ion batteries. The medium in the battery may be solid, semi-solid or liquid, and there is often both fuel and oxygen in the medium,

This type of battery is the object of intensive research. A major problem is that a chemical reaction can occur in a cell causing it to become overheated. This can spread to other cells, in what is known as “runaway”, and in rare cases batteries have exploded. Battery temperatures above 80°C signify danger, and above 120°C there is a risk of bursting, gas emissions, fire and explosion. There are no entirely safe lithium-ion batteries on the market today, and the more efficient lithium-ion batteries become the greater the risk of a “runaway” situation. Lithium-ion batteries are made up of many battery cells.

After a collision or a short-circuit, a battery of this type may give off powerful fumes. The gases may be either white or black and may also contain flammable organic solvents.

Supercapacitors

Supercapacitors are far better than batteries at collecting and returning braking energy, and this is particularly apparent in stop-and-go traffic. A supercapacitor can store relatively little energy compared with a battery, but it can receive and release high power in a short time. To date these capacitors are only present in hybrid trucks and buses, and in terms of appearance it is difficult to distinguish between a supercapacitor and a battery pack.

Chemical risks in connection with the handling of batteries in electric and hybrid vehicles

Batteries that have been damaged in some way so that the electrolyte fluid has escaped from the battery can pose a danger to people.

Leakage from the battery may occur through mechanical damage to the protective casing of the battery, but also through heating. A hot battery can lead to thermal runaway. This means a heat-generating thermal reaction that continues to heat the battery until it explodes and probably starts to burn. In both cases electrolyte and/or gases can leak and/or spray out.

The gases from a high-voltage battery may be lighter or heavier than air. You should therefore avoid standing close to hot battery remnants or inhaling fumes.

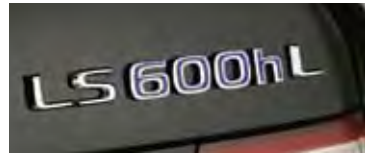
Always wear protective gloves and safety goggles when handling battery remnants. Batteries and battery remnants must not come into contact with any kind of acid. Battery remnants must be treated as hazardous waste.

Identification

There is no standard or industry agreement on how electric and hybrid cars should be marked, and each make of car has its own markings. It is therefore sometimes difficult to identify an electric or hybrid car. In some cases it is necessary to look for the chassis number which is under the bonnet or in the door frame on the driver's side. If the number begins with JTDKB2, the car is a Prius hybrid. Fire and rescue services must always be aware that a car may have a battery pack, and if there is any uncertainty the driver or a passenger should be asked.



Toyota Prius Hybrid.



Lexus hybrid.



Honda hybrid.



Honda hybrid.



Hybrid car GMC.

Fire in a battery pack

Water is the best cooling and extinguishing agent for a fire in a battery pack, despite the fact that the extinguishing operation may initially have some negative effects.

A great problem is that the battery pack may be in different locations in different types of car, and they are sometimes difficult to reach. If possible, the battery pack should be exposed to obtain better cooling and extinguishing effect, but the person who does this obviously has to wear full PPE (personal protective equipment) and BA (breathing apparatus). The battery pack enclosure, however, must never be broken open or removed as there is a great risk of severe or life-threatening electric burns or electric shocks. The possibility of an explosion or of fire spreading inside a battery packs can be prevented by drenching the battery pack with large amounts of water.



Battery packs have different designs.



A battery pack in a hybrid car. Many battery cells are coupled together to form a battery pack.

Recommendations during an emergency response

At present we have very limited experience of accidents involving electric and hybrid cars. Listed below are points that should be borne in mind after a collision in which an electric or hybrid car may have been involved, or in the event of a fire in such a car. The information may need to be supplemented as we gain new knowledge and new experience in this area. Any new facts that become known will be reported on the MSB's website: www.msb.se

Collisions

In the event of a collision you must:

- identify whether it is an electric or hybrid car
- never assume that the drive system has been disconnected just because it is silent, and instead disconnect the system or alternatively secure the vehicle with blocks or chocks
- turn off the service switch if there is one
- never touch, cut or open an orange high-tension cable or high-tension component.

Fire extinguishing

You must bear in mind the following when extinguishing a fire:

- If a battery pack is not burning, the fire in the car must be extinguished in the traditional way. As far as possible, avoid getting water into a battery that is not burning.
- A battery pack fire must be cooled and extinguished with large amounts of water.
- The battery pack enclosure must not be broken open or removed.
- If it is not possible to extinguish a battery pack, let it burn out under cooling and monitoring.

Gas vehicles

Almost all the gas vehicles on Swedish roads today are powered by methane gas. Altogether there are around 23 000 vehicles, of which around 1 400 are buses and other heavy vehicles (figures for 2009).⁵ It is expected that the number will rise. Liquid petroleum gas (LPG) vehicles may also occur, but there are only 750 registered LPG vehicles in Sweden, and 404 of those are off the road.⁵ DME and hydrogen are other gaseous fuels which to date only occur in small projects. In addition there is LNG (Liquefied Natural Gas), condensed methane which has been cooled down to approximately -160 °C. This gas is used for heavy vehicles such as buses and trucks, and is on the way to being introduced in Sweden.

Vehicle gas (methane)

In Sweden methane as a vehicle fuel is known as vehicle gas, or sometimes as biogas or natural gas. Internationally the name CNG (Compressed Natural Gas) is often used.

Biogas is methane produced by digesting crops, slaughter waste or other organic matter, but the gas is also formed as a by-product at sewage treatment plants. This gas is “upgraded”, i.e. purified, from approximately 50-60 percent to approximately 97 percent methane content. The remainder is principally carbon dioxide. The product is known as biogas and is used to fill vehicles powered by methane gas.

Natural gas is methane that has been pumped out of the ground or at sea, like oil. It is a fossil fuel and is not considered to be as environmentally friendly as biogas. The methane content is around 90 per cent. The other 10 per cent consists of other hydrocarbons (for example ethane, propane and butane) which give natural gas a higher energy content than biogas.



Filler nozzle for vehicle gas.

LPG (Liquefied Petroleum Gas)

There are only around ten filling stations for LPG in Sweden⁷, so the number of LPG vehicles on Swedish roads is small and is not expected to increase. On the other hand, such vehicles are common in countries such as Germany, Poland and the Netherlands.

DME

DME (dimethyl ether) is a fuel intended for heavy vehicles, principally trucks. For now it only exists in small projects, but in the future DME may partly replace diesel as a fuel for heavy vehicles. It has very similar characteristics to LPG, but produces lower emissions.

Hydrogen

Hydrogen as a vehicle fuel is so far only at the test stage, but it may become a significant fuel for the future. Several projects of varying size have been carried out and are under way around the world, and the EU has put large sums of money into hydrogen projects. Hydrogen is regarded as the fuel that produces the cleanest exhaust gases. It can be used in a traditional internal-combustion engine or in fuel cells that generate electricity for an electric motor.

Gas systems in methane-powered vehicles

Substance	Explosion limits ⁶	Relative density (air = 1) ⁶	Storage in vehicle tank
Methane	5–16 %	0,6	Compressed, 230 bar
LPG	2-10 %	1,5	Liquified (liquid/gas), approx. 10 bar
DME	2-27 %	1,6	Liquified (liquid/gas), approx. 10 bar
Hydrogen	4-75 %	0,1	Compressed, 350 or 700 bar

Table 1 Characteristics of fuels.



Gas tanks.

Today all methane-powered vehicles have an alternative fuel, usually petrol, which means that the vehicles have one or more gas tanks but also have a tank for a conventional fuel. The gas systems are more or less identical in all methane-powered car models. At the filler connection there is a check valve that prevents the gas from flowing out. The gas is then conveyed to the vehicle's gas tank or tanks. Such a tank generally holds around 30-40 litres (geometric volume), and they are sturdily built as they have to withstand being filled to a pressure of 230 bar.

Safety equipment

Directly on the gas tank there is a thermal fuse, a flow restrictor, a solenoid valve and a manual shut-off valve. The solenoid valve may, however, not be present on older vehicles. The requirements for safety equipment are contained in the former Swedish National Road Administration's Regulations on Cars and Trailers Towed by Cars, VVFS 2003:22. Checks that these requirements are met are performed by an accredited inspection body.

The thermal fuse trips at approximately 110 °C. On some models the gas is then discharged via an evacuation pipe out under the car, while on others it goes straight from the cylinder. The thermal fuse use is directly connected to the tank, separately from the fuel system.

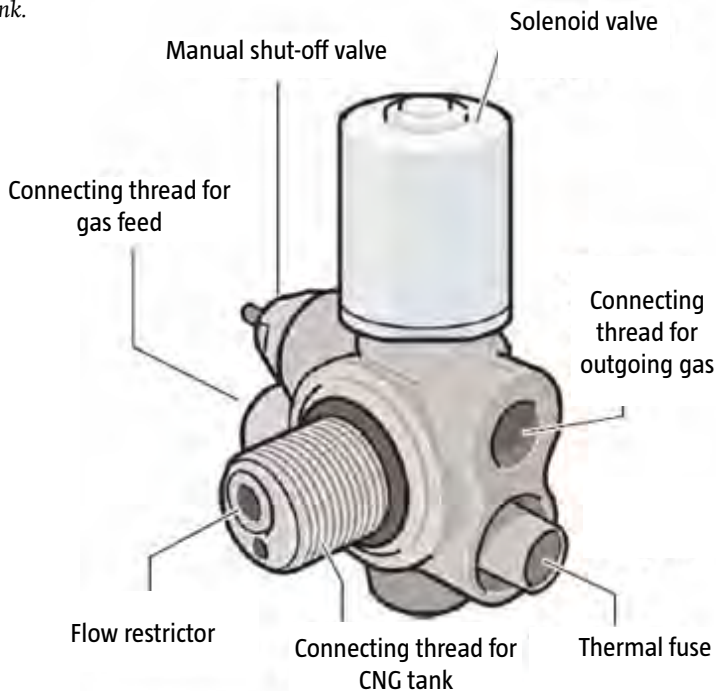
The flow is therefore not obstructed by other valves, and it is not possible to stop it if the fuse has tripped. If the gas tank is more than 1.65 metres long it has a fuse at each end.

The flow restrictor is located next to the gas tank. It closes if the pressure in the line running from the gas cylinder falls rapidly, for example if the pipe breaks.

The solenoid valve is normally closed, and opens when the tank is being filled up or when the key is turned in the car. An electromagnet opens the valve when current is passed through it. On some models this valve is connected to what is known as an inertia switch, which interrupts the electricity supply in the event of an impact, causing the solenoid valve to close. It can also be controlled by the speed of the engine, and is closed if the engine speed becomes sufficiently low. The manual shut-off valve may be difficult to access, and in some models special tools are required to close it.

If a fire in a gas vehicle reaches a gas tank, the thermal fuse should open so that the gas is released. This will probably result in a jet flame, either directly from the cylinder and thus inside the car, or directed obliquely downwards and outwards from underneath the vehicle. The gas then leaks out until the cylinder is empty, regardless of whether the fire is extinguished or not. It is

*Safety functions on
a gas tank.*



unlikely that a tank would crack because of the fire.

In the event of an impact, the solenoid valve on some car models is closed so that each gas tank is isolated from the other parts of the gas system. If it does not close and a pipe comes off, the pipe-break valve closes instead to prevent outflow.

Gas systems in LPG-powered vehicles

LPG cylinders also have a flow restrictor, solenoid valve and manual shut-off valve, but they do not have a thermal fuse. The tank instead has a safety valve that trips when the pressure becomes too high (approx. 27 bar).⁷ This may mean that the safety valve opens and closes repeatedly, as the pressure decreases when it opens and then increases again when it closes.

Accidents have happened when people have tried to fill vehicles intended for LPG with vehicle gas, using an adapter. However, vehicle gas is filled up to 230 bar, and the LPG tank exploded because it could not withstand the high pressure. Using an adapter in this way poses a danger to life, and it is also prohibited to do so.

Is the vehicle gas-powered?

Gas-powered vehicles do not have any special marking, apart from the car manufacturers' own designations. The names of methane gas-powered vehicles, which are usually found at the rear of the vehicle, are listed below, but they may be very similar to the designations found on ethanol-powered vehicles. It can otherwise be decided whether it is a gas-powered car by opening the fuel filler cap, because there are filling devices there for both gas and a conventional fuel, usually petrol (see picture). It is also possible to find out a vehicle's fuel type on the Swedish Transport Agency website by searching on the registration number.



The use of adaptors is extremely dangerous.

Manufacturers and designations - methane-powered vehicles



Fiat - Natural Power.



Opel - CNG ecoFLEX.



Iveco - CNG.



Mercedes - NGT.



Volvo - Bi Fuel (1998-2007).



Volvo - AFV (2010-).



Volkswagen - Eco Fuel.

Filling point for petrol

Filling point for methane



Recommendations during an emergency response

At present we have limited experience of emergency responses to accidents involving gas-powered vehicles, but a list is presented below of points to think about in the event of a collision or fire in a gas-powered vehicle. The information may need to be supplemented as we acquire new knowledge and more experience in this area. Any new facts that become known will be reported on the MSB's website: www.msb.se

Collisions

Remember the following if a collision has occurred:

- Identify whether it is a gas-powered vehicle.
- Switch off the engine if it is running. The solenoid valves that obstruct the flow of gas from the tanks will then also close.
- A high-frequency whining sound may indicate leaking gas. This occurs as a result of the high pressure in the gas tank.
- If a gas leak has been identified, evacuate casualties as quickly as possible and let the gas escape until the tank is empty.
- The gas pipes are usually routed in the car's underbody, and the doors or roof can therefore be cut apart without any risk of damaging the pipes. However, avoid cutting into the underbody (for example beneath the doors).

Fire

Remember the following if a fire has occurred:

- Extinguish the fire in the traditional way if there is no fire in or next to the car's luggage compartment (where the gas cylinders are kept).
- A fire in the luggage compartment may mean that a fuse has tripped, or that there is a risk of it tripping. If there is a jet flame, it is likely that a fuse has tripped, and the tank will then empty.
- The gas will continue to escape even if a flame from a tripped fuse is successfully extinguished, and there is a great risk of explosion if the gas cloud is ignited. It is therefore better to let the gas burn out if possible.
- Even if the gas has burnt out, the pipes may still contain gas under high pressure.
- Most gas vehicles also have a petrol tank.
- According to the Vehicles Act, the outlet of the thermal fuse must not be directed towards a pressure vessel. It is therefore unlikely that a jet flame in a luggage compartment would affect a gas tank so that it loses its pressure-bearing capacity. If this nevertheless happens, the gas may explode when the tank cracks. You should therefore try to set up a cordon 50 metres around a burning gas vehicle.



This photo shows a fire in an CNG-powered bus. The jet flame from the roof of the bus was caused by the thermal fuse . The flame is estimated to be around 4 metres long.



Filling up with E85.

E85

The risks associated with the ecofuel ethanol, E85, are not as great as previously feared. Despite the fact that E85 may contain up to 86 per cent ethanol, it behaves more like petrol than ethanol, which is considerably more flammable.

Risks during fire-extinguishing

SP Technical Research Institute of Sweden has studied the pattern followed by the fire in spillage fires under a fuel tank containing E85. The experiments showed that such as a spillage fire under certain circumstances may lead to the fuel in the tank being ignited and to brief flames and some splashes of burning fuel occurring. The same also applies to petrol. This may pose some risk for example to fire-brigade personnel who are very close to the vehicle, but it probably does not affect the total risk scenario with regard to a car fire.

In operations to deal with car fuels, fire-brigade personnel must wear full gear and have adequate personal protective equipment with a call-out suit, compressed-air apparatus with breathing protection and safe extinguishing water. Someone who is dressed and equipped in this way runs a minimal risk of being injured in incidents where an E85 vehicle is burning.

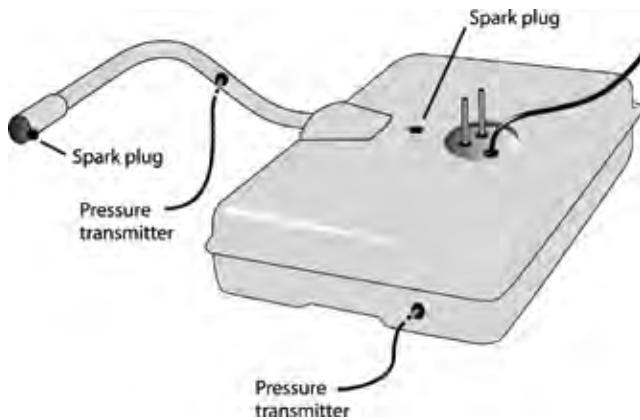


Diagram of a tank for ignition tests. During the tests when ignition was in the tank, the spark plug was located close to the tank's electric-plug on top of the tank.



Ignition test in a mounted tank.

How much more awkward is it to extinguish fires involving E85?

The ethanol admixture in the fuel makes that the breakdown of foam is greater than with pure petrol, as the ethanol is soluble in water and therefore breaks down foam bubbles. This applies in particular if the foam "dives" down into the fuel when applied.

When the ethanol content is lower, gel formation from the foam does not appear to be adequate to protect the remaining foam. The diluting effect instead appears to be most important, i.e. the water from the broken-down foam diluting the ethanol in the petrol so that the aggressiveness of the fuel is gradually reduced. This effect is particularly clear with regard to extinguishing smaller spillage fires and car fires and making spillage surfaces safe etc.



Soft application is vital for successful extinguishing.



From the point of view of efficiency, use of detergent foam liquids does not pose any problem for many fire scenarios. Most fire engines have one or two medium-foam hoses with a flow rate of around 200 l/min each, which signifies substantial overcapacity for example in the case of a car fire.

Even if the petrol in the vehicle contains 5-10 per cent ethanol or MTBE, this will not pose a major problem in view of the limited amount of fuel in a car.

In the event of a larger outflow of pure ethanol, for example from an ethanol-powered bus, detergent foam is not as effective as the extinguishing will largely depend on the fuel being diluted.

With regard to the environmental aspects of using foam, consideration should always be given to what causes the least total harm in each individual case.

To summarise, we present three tips for making fire-extinguishing as effective as possible when the petrol is blended with up to around 10 per cent ethanol:

- Use a 3 per cent foam admixture, but anticipate needing to increase the application rate, particularly if it is not possible to bring about a soft application (for the basic equipment with a given flow capacity this means that a smaller area can be extinguished).
- Use foam equipment that provides a good foam index and a stable foam (avoid foam equipment that is “non-aspirating”, such as fog-fighters).
- Use soft foam application (reducing the need for increased application rate).



3. Road environment

Every year, a number of people die in frontal-impact accidents on Swedish roads, and half of these accidents occur on around 7 per cent of the road network. Some roads are therefore particularly prone to accidents, and a good way of reducing these accidents is to centre-divide these stretches of road. There are various ways of centre-dividing a road, but the most common way is using a wire-rope barrier or a steel rail barrier. Another way of reducing road-traffic fatalities is to replace the present-day hard posts along roads with collapsible posts that give way when struck.

2+1 roads

A road on which the carriageway is divided in some way is known as a 2+1 road, the most common form being a wire-rope barrier.

Dividing the carriageway with a wire-rope barrier

There are many different types of wire-rope system today, but they are usually dismantled the same way.

Some of the most common wire-rope systems are shown below.

*Wire-rope barrier
Gunnebo.*



*Wire-rope barrier
Allmaco.*



*Wire-rope barrier
Blue System.*



*Wire-rope barrier
Briefen.*



Dismantling wire-rope barriers

An advantage of wire-rope barriers is that they can be easily dismantled, for example to enable vehicles to be moved from one carriageway to the other or to divert traffic. Here is the Swedish Transport Administration's recommendation on how to dismantle a wire-rope barrier.

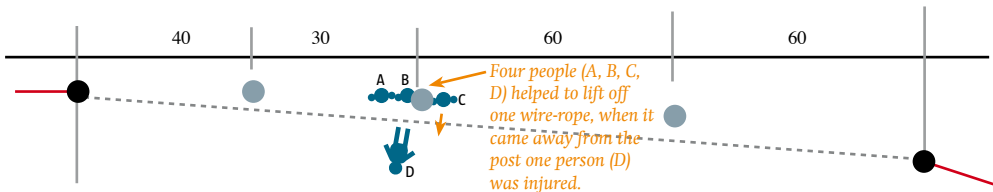


The wire-rope should be lifted out from one direction until it rests on the ground. If it is on a bend in the road, no one must stand on the side of the wire-rope that is the inside of the bend during dismantling.



Accident on 2+1 road

In August 2009 a serious accident occurred on Riksväg 26 (main road) near Skövde, when the centre wire-rope barrier had to be lowered in order to divert traffic during maintenance surfacing. Dismantling was done from two different directions so that around 190 metres of wire-rope was hanging on a post on the bend. Four people (A, B, C, D) & helped to lift the wire-rope, three on the outside and one on the inside.



4 people lifted off the 2 top wire-ropes. Approx.

190 m wire-rope came away from the post.

When the wire-rope came away from the post, the person on the inside of the bend was struck just above knee-height, and was thrown about 2-2.5 metres with the wire-rope against his body. The road worker's helmet fell off and his head struck the asphalt with such force that he was rendered unconscious.

Conclusion and recommendations:

- The accident was caused by the barrier being dismantled from two directions on a bend which has a radius of around 3,500 metres, until around 190 metres of wire-rope was hanging on a post. When two top ropes were removed from the last post there was a person standing on the inside of the bend.
- The wire-rope must be lowered from one direction only.
- If the wire-rope is to be laid down on a bend, no one must stand on the inside of the bend while work is progress.

Cutting of wire-rope

Wire-rope rarely has to be cut because it is so easy to lift it away, but if it nevertheless proves necessary to do so, move some distance away from the scene of the accident before cutting it. This is usually not a dangerous operation, but you should make sure that there is nothing heavy resting against the wire-rope, such as a truck, as the increased pressure on the rope can cause it to jump when it is cut.



Barriers

Wire-rope barriers are often damaged, resulting in many repairs. This is expensive, and those carry out the repairs are exposed to great risks as the work has to be carried out in the midst of traffic. Trials are therefore now in progress with other types of central dividers.

Experience from accidents that have occurred shows that wire-rope barriers can rip fuel tanks apart on heavier vehicles. To prevent damage to water sources or sensitive areas of nature, different safety measures should be considered or a different type of barrier should be considered along such sensitive sections of road.

The pictures below show some examples of alternative barriers. All barriers must be approved in tests conducted by bodies such as the Swedish Road and Transport Research Institute (VTI). Steel-rail barriers are most common. They are often simple to dismantle, and sections can be removed from the barrier, for example to divert traffic and switch vehicles from one carriageway to the other.

Various types of steel-rail barriers.





*There are also central
dividing barriers made
of concrete.*



4. Equipment

When working to extricate casualties, fire brigade personnel must have access to hydraulic tools and equipment to make the accident site safe.

- In addition, the following are needed, for example:
- a tarpaulin (used as tool point)
- stabilisation material
- crowbar
- a tool bag
- protective plastic sheets for personnel and casualties (bubble-wrap plastic)
- safety goggles, also for casualties
- ear defenders, also for casualties
- blanket and cap for casualties
- a glass saw
- hard plastic disc as protection for casualties when cutting
- protection against sharp edges
- support plates for the cylinders
- a marker pen to mark the cutting point.

This chapter describes the hydraulic tools used during the rescue operation and how to handle and look after them. If the rescue operation on the scene is to work smoothly, we need to be familiar with the tools we have at our disposal and to look after them after use.

The three most common hydraulic tools used in road traffic accidents are cutters, spreaders and rams (also known as pistons). There are also some other tools, for example a combi-tool (cutter and spreader combined into one tool), a pedal cutter, which is a smaller cutter used to cut pedals, steering wheel rims, head restraints etc., and manual tools operated by hand, so that they can be transported to and used in inaccessible places.

The cutting force of the cutter is 20-95 tonnes. But the force is not what we are concerned with here. To achieve good results when cutting different types of steel, the blade must be suitably shaped. It is also important to cut as close to the centre of the cutter as possible, because that is where it is strongest.

It is important to look after tools

Cutter.



Ram.



Spreader.



The spreading force of a spreader is around 5-30 tonnes and the compressive force of a hydraulic ram is 10-25 tonnes, depending on model.

A hydraulic pump is needed to operate these tools. The maximum operating pressure on the most commonly used pumps is 600-800 bar. The high operating pressure of the hydraulic oil means that there is a risk of injury if care is not taken. Do not use hydraulic hoses that are more than 10 years old. This ten-year limit also applies to the shorter pieces of hose built into the tools.

Check the hydraulic hoses at regular intervals. Do not pull on a hose if there are kinks or knots in it. Doing so would make the hose more brittle and prone to damage, resulting in reduced power (pressure losses).

All tools should be left with their jaws/spreader arms/pistons slightly apart so that the tool pressure is relieved. If the tool is left closed up, there continues to be pressure in it, increasing the risk of an accident.

Checklist - daily inspection

- Check the condition of hydraulic hoses.
- Inspect the blades and tips of cutting and spreading tools visually. Replace blades and tips if metal chips have become detached or if there is a lot of deformation on the cutting edge/tip.
- Visually inspect quick-release connectors. Clean away dirt.
- If there is a level gauge for the quantity of hydraulic oil in the pump, it should be checked at regular intervals.
- Check the level of fuel in fuel-driven pumps and electric cables on electric pumps.
- Test the system.

Checklist - regular inspection

- Test tool and pump to detect any leaks. Open and close the tools so that the pump builds up full hydraulic pressure (check using pressure gauge).
- Check the “dead man’s handle”. The handle must return easily to the neutral position.
- Dismantle, clean and grease all joints (pins) on the cutting tool, including the blades. Make sure that there is no play in the blades and that they are not damaged.
- Check hoses to make sure there is no damage and no kinks. Bear in mind that the operating pressure is 600-800 bar. Avoid pulling on the hydraulic hose if there are knots in it.
- Check the level of hydraulic oil.
- Check the torque on the centre bolt. If the centre bolt is not properly tightened, there is a risk of the blades separating and coming apart during cutting.

Portable hydraulic pumps

In recent years the Swedish fire service has successfully used portable hydraulic pumps in road traffic accidents, and most hydraulic pumps installed in newly produced emergency vehicles today are portable.

Portable hydraulic pump.



The benefit offered by portable pumps is that they have their own internal-combustion engine which has greater output than an electric hydraulic pump as found in most emergency vehicles. Flow to the tools is faster, without any impact on maximum pressure. It is also easier to move the equipment to a reserve vehicle if necessary.

The road network and the infrastructure have changed in recent years so that there are now more motorways and more roads with a centre divide. This makes it more difficult for the emergency services to reach the scene of an accident due to tailbacks and long stretches of road with a centre divide. The portable pumps have been effective in these cases, and they can also be easily taken off road into fields and woods etc.

The designation portable equipment is governed by European standard EN13204 and the equivalent Swedish standard, which state that portable equipment must not weigh more than 20 kg if it is to be carried by one person. The latest models of portable hydraulic pumps are, in addition, quiet and can power two tools simultaneously.

Hydraulic hoses and hydraulic couplings

Most manufacturers of hydraulic equipment have systems that provide maximum working pressure of 700-800 bars. This makes great demands on the hydraulic hoses and hydraulic couplings, and all the hydraulic hoses therefore have to cope with a pressure that is four times as great as the maximum working pressure. The bursting pressure on the hydraulic hoses is therefore around 2,800-3,200 bars. With regard to the hose system, it is also particularly important to check service life (max. 10 years), wear, and damage. The hydraulic couplings most used today are designed to make it easier to change tools while work is in progress. When the tool is not being used and there is only circulating pressure in the system, the tool can be disconnected from the hose without unloading the system. With the old systems it was necessary to go to the pump to unload the system before tools could be changed. The new hydraulic couplings that make this possible exist in two variants with two entirely separate hose systems.

The single-hose system has a hose of coaxial construction, where the pressure hose is protected in the middle and has the return hose around it.

Poor hydraulic hose.



The diameter of the return hose is greater than the old traditional hydraulic hoses, which means that the return pressure in the system is lower. The hose consists of Kevlar on the pressure side and reinforced PVC plastic on the return side, with the result that it weighs 40 per cent less than a steel-reinforced hose.

The two-hose system is used by most manufacturers, and the hydraulic hoses here have steel reinforcement. The pressure hose and return hose are separated from each other, and the diameter of the hoses on the pressure and return sides in principle is the same. The return pressure in this system is somewhat higher than in the single-hose system.

Two-hose coupling.



Left: single-hose system.
Right: single-hose coupling.



The hydraulic coupling here as well is generally a universal single-hose system which can be used for several different makes, but with different colour combinations to avoid confusion between different hydraulic systems.

Design of cutters

The cars of today have reinforced bodies, particularly in the B-pillars. Hydraulic cutters therefore now have to have better performance and cutting capacity, and the manufacturers have accomplished this task by making the cutters larger and heavier in order to increase their cutting capacity.

Manufacturers calculate the cutting force in hydraulic tools in different ways, and they indicate everything from theoretical cutting force to the cutting force possible in practice. European Standard 13204 is therefore based on tests to cut different types of materials in different dimensions, but for the cutting force to be assessed correctly, the standard states that it is desirable for a testing institute similar to SP Technical Research Institute of Sweden to also test and issue statements on performance.

With regard to cutting with hydraulic cutters, it is important that the blades are in good condition as a poor blade may adversely affect both cutting capacity and safety. The blades should therefore be checked often to make sure they are not worn and do not have any weaknesses.

There are two types of cutter blade today, which operate in slightly different ways. With what are known as parrot-beak cutters, the object to be cut is pulled in towards the cutting centre where the cutting force is greatest.



Parrot-beak cutters.

Straight cutters.



There are also straight cutters, where the cutting force comes from the cutting centre and goes outwards. These cutters generally grip over a slightly larger surface.

The fire service uses both these types, depending on the make of hydraulic tool.

There are also two different systems for locking the blades in the cutters. Whatever system is used, the tightening torque must always be checked to make sure the cutter blades do not start to work loose and pose a safety risk.

Personal protective equipment (PPE)

Fire brigade personnel must wear RB 90 or a similar type of PPE, supplemented by a warning vest in accordance with the former Swedish National Road Administration's "Recommendations for warning vests at the scene of an accident". Personnel must wear a helmet with reflectors and reflectors on the sleeves and at the bottom of the legs. The existing reflectors on call-out gear or loose reflectors attached for example by Velcro should be used for this purpose.

N.B. The existing reflectors usually have poorer reflective capability as they are exposed to smoke, heat and wear. If necessary, they can be supplemented by loose reflectors attached with Velcro.

Fire-brigade personnel should also have the following equipment:

- Safety goggles protect the eyes against glass fragments and blood splashes with possible blood contamination (the casualties must also wear safety goggles). The visor does not provide complete protection.
- Reflective jackets are worn by all personnel working on the road. They must be cleaned so that they are visible from a long distance.
- Latex gloves should be worn under the working gloves as protection against blood infection.
- Working gloves may be a thinner variant but have to protect against cuts. Avoid touching injured people with dirty working gloves. The safety officer must also wear fire gloves. Make sure that the working gloves do not hang so that glass fragments can land in them.
- A filter mask must be worn when sawing glass to provide protection against glass dust and fragments. Such masks must be worn by everyone who may come into contact with glass dust, including the casualties.
- Hearing protectors protect against noise damage. The casualties must also be given hearing protectors if necessary.



Personal protective equipment



Crash Recovery System

Crash Recovery System (CRS) is a system that has been developed in cooperation by the Dutch fire service and Moditech Rescue Solutions B.V. but has also existed in a Swedish version for a few years. This system gives incident personnel rapid access to information about a vehicle's safety system, equipment and construction. In CRS the incident personnel can find out for example where the batteries are located, where various pressure containers are to be found, at what points the vehicle has reinforcements and what safety equipment is contained in the vehicle.

The system has been developed with a clear focus on the user, and the aim is for the software to be easy to use and accessible for everyone. More than 8 000 car models have been stored in the mobile database which contains all information about the safety system that may be relevant to the incident personnel. The software is installed in a laptop or a tablet PC controlled by a touch screen. The tablet computer is obviously also taken out to the scene of the accident.

At the scene of the accident, the incident commander can enter the vehicle's registration number into the mobile terminal. The number is sent to a central server at Moditech which quickly sends back all relevant information concerning the vehicle concerned, such as year, model, make, type etc. The information is presented both as text and as drawings of the vehicle.

Red markings on the drawings show all parts of the vehicle where caution should be exercised in taking action or where no action at all should be taken. If a component is highlighted in

red on the screen, the system displays important information on the selected component and also what problems may arise. The drawing also shows what reinforcements are built into the chassis and where they are.





Orderliness on scene allows rescue work to flow better.

5. Organisation on scene

In this chapter we provide suggestions for how to work on scene and what needs to be considered to ensure that rescue work proceeds safely and efficiently. A standard routine is generally followed to make sure that work on scene is more efficient. This means that each member of the fire brigade crew has particular tasks that he/she performs automatically without waiting for orders. It is also important that everyone knows what everyone else is doing.

Making the accident site safe

To make the accident site safe, the section of road concerned is usually closed. The police are responsible for closing the section of road and controlling traffic, but before the police have arrived on scene the task has to be fulfilled by whoever is first on scene, which is generally a member of the fire-brigade personnel.

There are no uniform rules or recommendations today for how fire and rescue personnel should cordon off the accident site so that it is made as safe as possible. Road users become less accepting of road cordons, and the experience of fire brigade personnel is therefore that work at accident sites has also become more dangerous.

Cordoning off a road

The level of ambition for cordoning off can vary between emergency services depending on how important safety measures are considered to be.

Some simple advice that should be taken into account follows, however:

- If your safety or the safety of others is jeopardised at the accident site, the road should be closed completely. Traffic can otherwise pass at low speed.
- Arrange clear demarcation of the accident site zone.
- Create a good structure for how the vehicles are to be parked. The vehicles should also be clearly and uniformly marked.
- Use marker boards. They should have alternately red flashing warning lights.
- Set up a clear warning ahead of the accident site with amber flashing warning lights.
- Take the cordoning off equipment with you to the accident site so that it is available on arrival.
- Always inform the Swedish Road Administration's traffic control centre about the accident.

The purpose of cordoning off is to improve safety for personnel and casualties.

There are various methods for cordoning off a road, and several emergency services have developed their own procedures. It is hoped that in future the Swedish emergency services will be able to agree on a common method accepted by all the authorities affected.

Road cordon



The MSB has chosen to highlight the "Falköping model" as a clear and structured example of how to cordon off a road. The procedure is based on having to close a county road or a motorway. Examples of ways of cordoning off various types of roads are given in the Falköping model.

The Falköping model

The Falköping model is a method developed in cooperation by the former Swedish National Road Administration, the MSB, the Skaraborg ambulance service, and the fire and rescue services of Falköping and Tidaholm.

The method is available as a manual on the Falköping Municipality website, and has the following aims:

- Fire brigade personnel are to be given a safer working environment, while preventing new accidents and improving patient safety.
- Personnel gain a standardised working method and fundamental incident plans to support them in their work.
- The working method is to be easy to apply in reality.
- The working method is to be legally tenable as the fire and rescue service closes off sections of road.
- The ambulance service, the fire and rescue service and the police are to achieve better cooperation.
- All fire-brigade personnel are to receive fundamental training in safety thinking on the road and be able to identify risks in their work.
- Information from the Traffic Control Centre of the Swedish Transport Administration is to be emphasised for motorists in order to divert traffic and improve safety.

The most important features of the method are presented below, with brief suggestions:

- If your safety or the safety of others is jeopardised at the accident site, the road can be closed completely. Traffic can otherwise pass at low speed.
- Arrange clear demarcation of the accident site zone.
- Create a structure for the parking of vehicles. To improve visibility they should be face in the direction of travel.
- Develop clear and uniform marking of the vehicles so that they are easily visible in the traffic environment, with the aid of reflectors, alarms and warning lights.

Basic equipment for cordoning off a road in accordance with the Falköping model

According to the Falköping method, the fire and rescue service needs the following equipment to be able to cordon off roads in a clear and safe way.



Marker boards

6 foldable/collapsible marker boards with yellow high-reflective reflectors (S2) and red high-reflective reflectors (S2). They must be at least 90 cm in height. Horizontal warning lamps with alternately flashing red light



Marker boards

4 foldable/collapsible marker boards with yellow high-reflective reflectors (S2) and red high-reflective reflectors (S2). They must be at least 90 cm in height.



Road sign holder

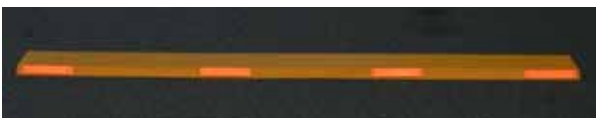
4 road sign holders bearing the word "Accident".

A flashing warning lamp with amber light.



Road sign

2 road signs 1.1.10 with high-reflective reflectors (S2). The additional sign "Speed limiter" is placed on the existing marker board.



Speed limiter

2 speed limiters with reflectors. The design must follow Swedish Transport Administration recommendations.

Equipment in position:

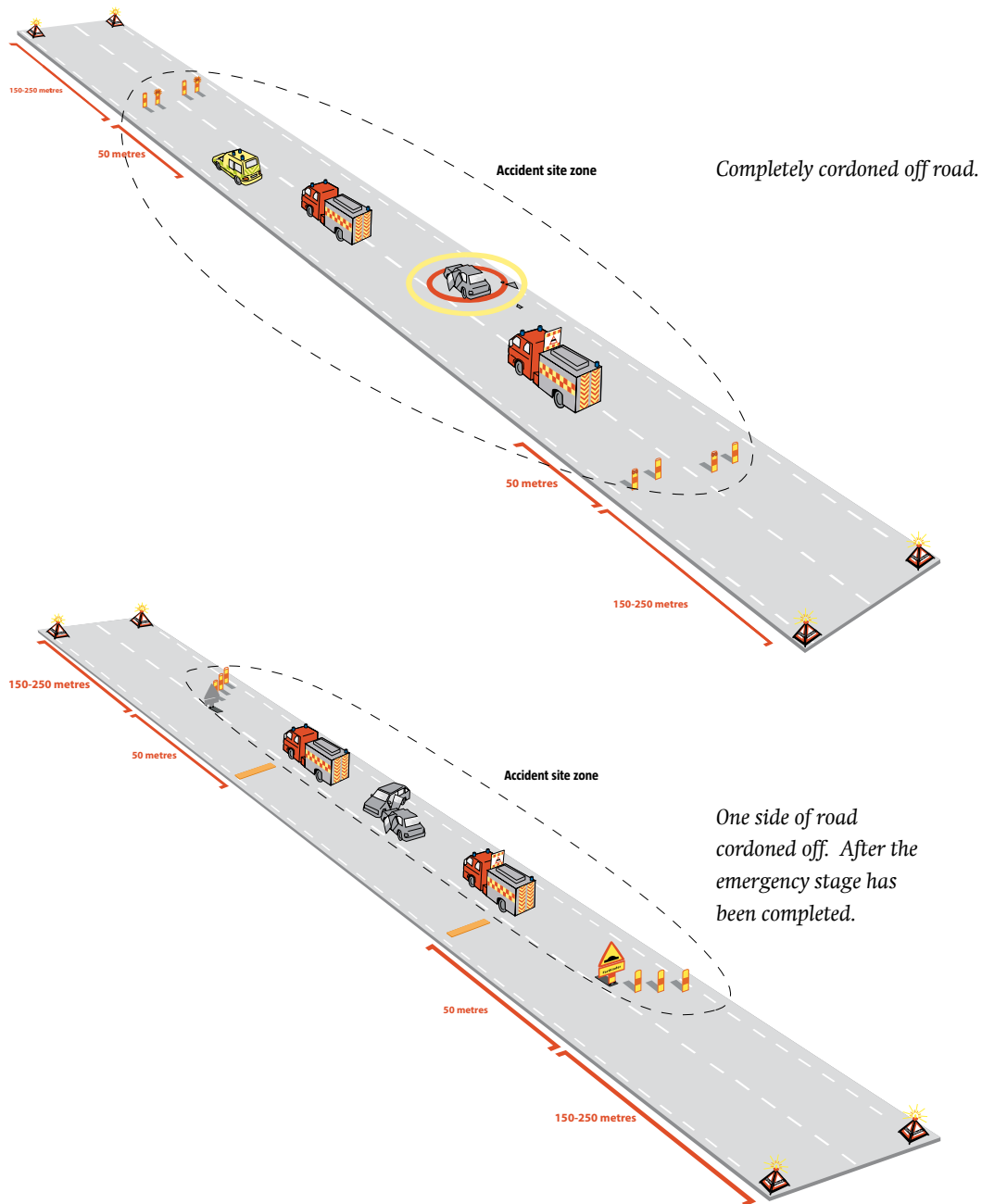
Completely cordoned off road

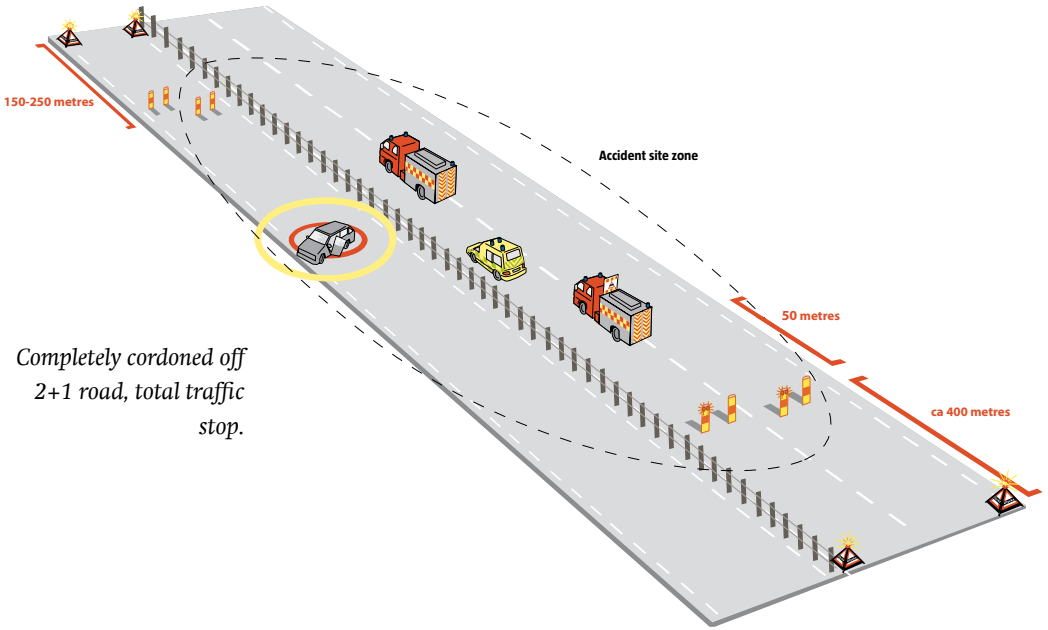


Partially cordoned off road.

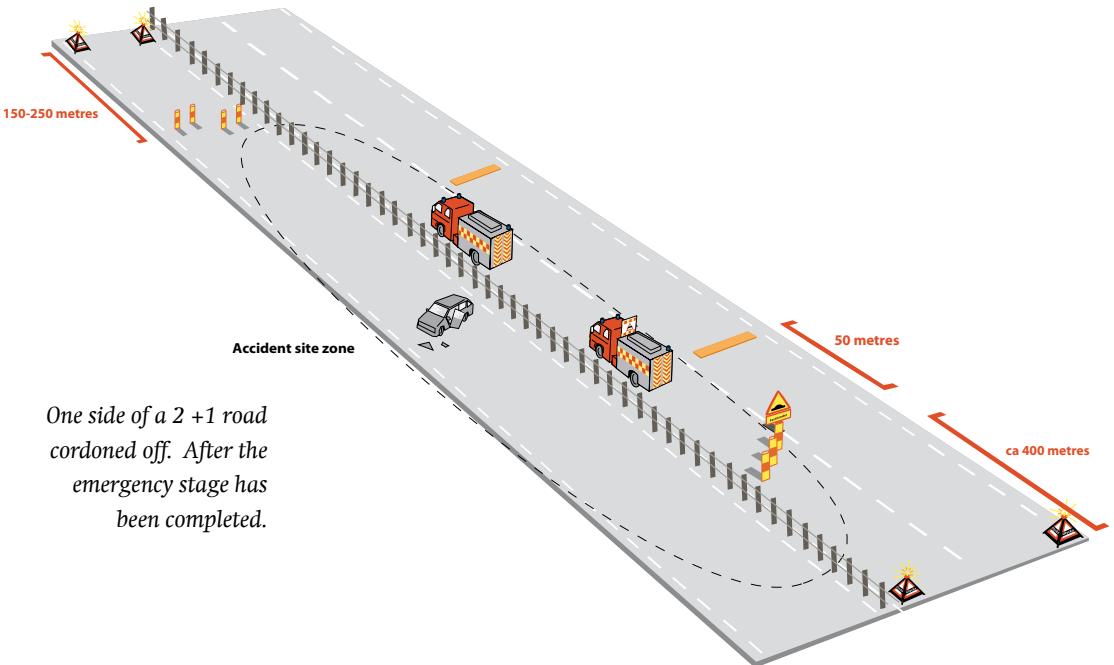


Examples from the handbook of cordoning off roads using the Falköping model

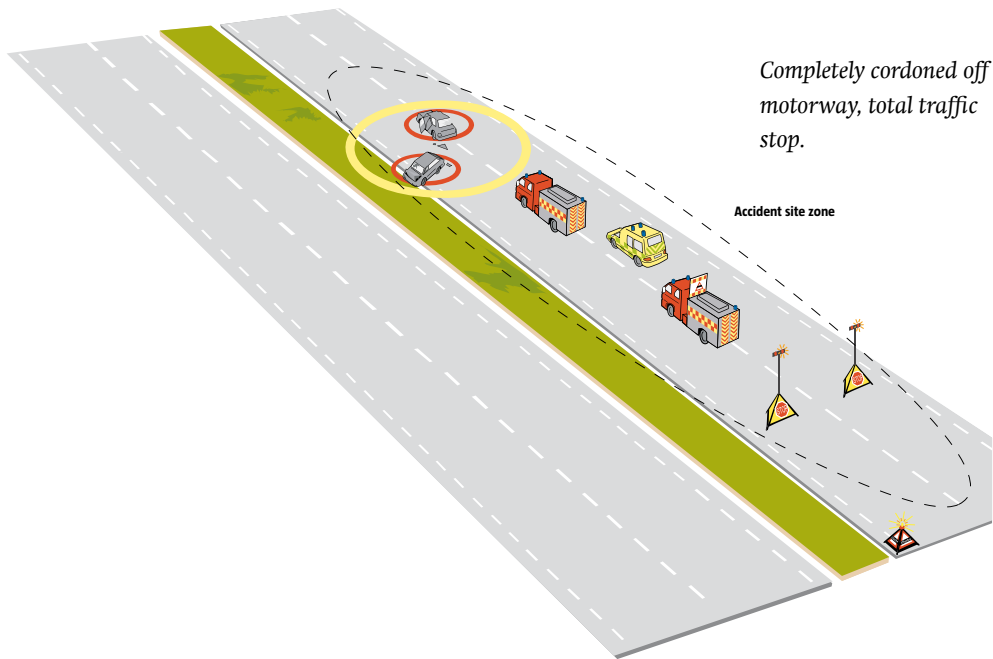




Completely cordoned off
2+1 road, total traffic
stop.

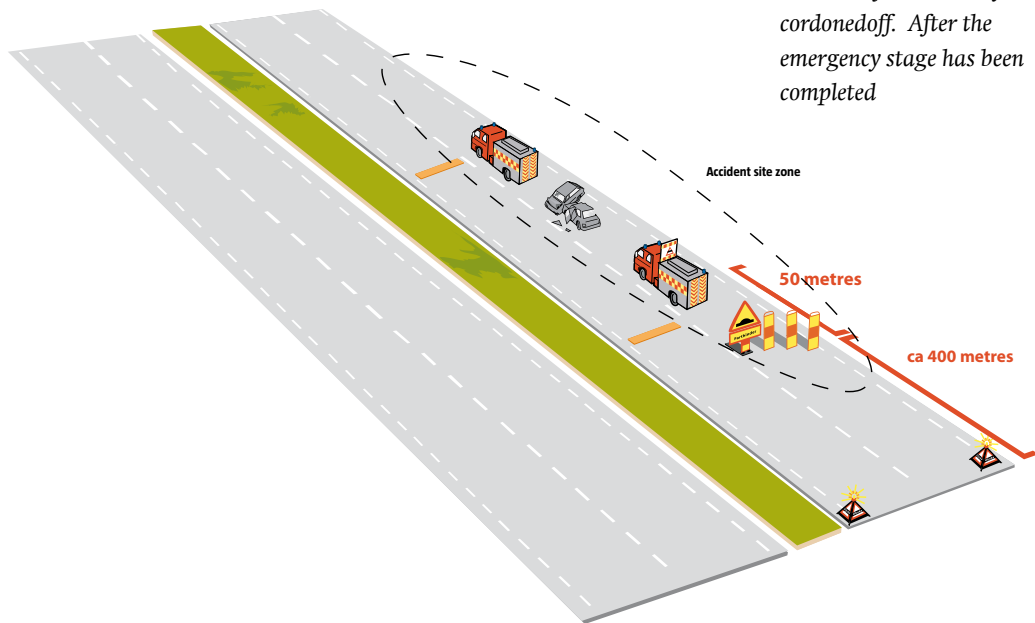


One side of a 2 +1 road
cordoned off. After the
emergency stage has
been completed.



Completely cordoned off motorway, total traffic stop.

Accident site zone



One side of a motorway cordoned off. After the emergency stage has been completed

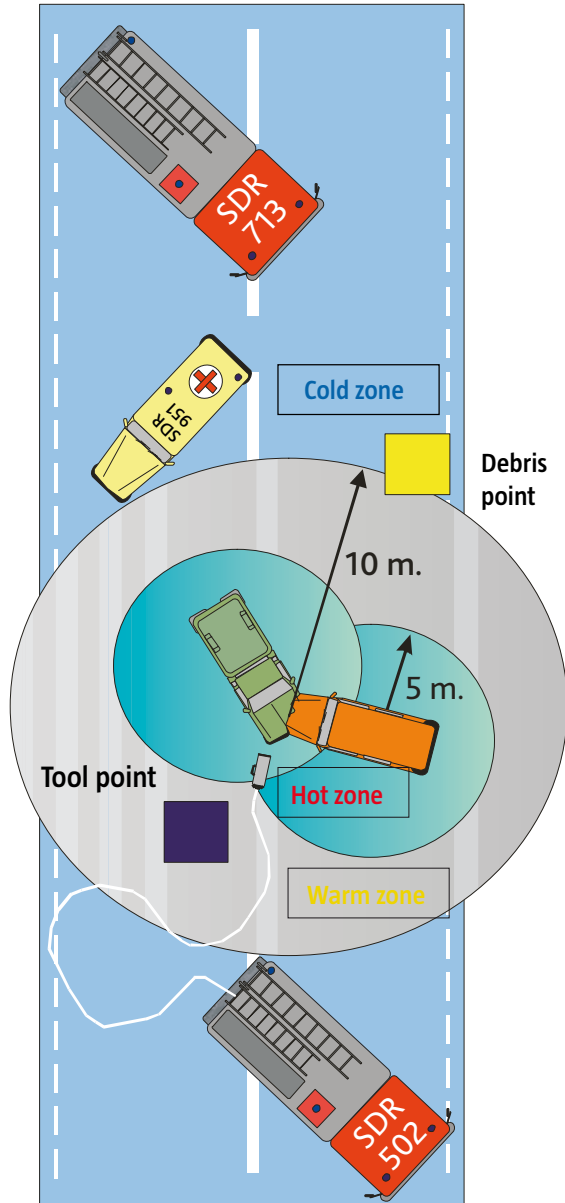
Accident site zone

50 metres

ca 400 metres

Accident site

The accident site is divided into three zones: a hot zone with a radius of 5 metres (inner zone) and a warm zone with a radius of 10 metres (outer zone) and a cold zone.



Emergency services vehicles are parked in the cold zone (the third zone), so that they protect the accident site. Only people who have a specific task to perform with the casualties and the extrication stay in the hot zone. All personnel working in the hot zone have to wear safety goggles and latex gloves under their ordinary gloves, in addition to their personal protective equipment. The ground must be kept clear in the hot zone. There should be no reason for anyone to tread on or trip over anything. Medical equipment is placed on or in the vehicle. Car parts and similar cut free are placed at the debris point in the warm zone.

The warm zone contains personnel, tools and equipment that aren't needed at the time.

Positioning of vehicles

The vehicles at the accident site can be positioned straight along the road and yet provide adequate protection. The warning lights are then more readily visible and the vehicles can be easily used if the personnel have to use the pulling method.

Remember to leave the vehicles with only their parking lights on so that no is dazzled by dipped headlights. All vehicles must also be provided with good and clean reflectors, and all warning lights must be intact.



Correctly marked vehicle

Standard routines

Standard routines are intended to make the work more efficient and ensure that no important tasks are forgotten. Standard routines are based on everyone in the group having the same tasks to perform, particularly in the initial stage. An example of a standard routine for road traffic accidents is presented below.

The incident commander's tasks

The incident commander briefs, assesses, decides and issues commands. The incident commander carries out continuous risk assessment, coordinates with the emergency medical services and police and if necessary requests salvage assistance.

The incident commander

- requests supplementary information from the emergency services switchboard concerning people who are injured/trapped
- issues preparatory orders to fire brigade personnel and is responsible for making the accident site safe (stabilising vehicles if necessary)
- assesses access routes/separated lanes of traffic
- decides whether to cordon off the road on arrival and provides the emergency services switchboard with a through-the-windscreen report.
- documents the incident, if appropriate by taking photographs, sound recordings, notes
- makes sure that the vehicle is positioned so that it provides protection
- looks out for specific risks, for example hazardous materials
- orders more ambulances and if necessary an emergency medical services team and other resources needed on scene.

In addition, the incident commander assesses environmental hazards and whether a clean-up operation is required.

Traffic control officer/medic/extricator

The traffic control officer/medic/extricator (right rear) initially cordons off the road completely or partially on either side of the accident. He/she then goes accident site and puts on his/her tool belt to work as a medic/extricator.

In some cases cordoning off the road may need to be given lower priority, for example if a fire or other high-priority task arises or the police are already on scene.

Safety officer

The safety officer (left rear) initially wears breathing apparatus and a mask, and ensures that no fire breaks out by deploying a pressurised foam extinguisher or powder extinguisher.

Always think first of all about the safety of both fire brigade personnel and casualties!

Injured fire brigade personnel are of little benefit at the accident site and use up resources if they need to be treated.

The safety officer

- makes sure that the vehicle is stabilised
- makes sure that the car battery is disconnected and then judges the safety of the casualties and fire brigade personnel on the scene by taking a few steps back to obtain an overview
- makes sure that personal protective equipment is used (safety goggles, gloves, helmet etc.)
- is responsible for there being a clear area to work in around the damaged vehicle (hot zone)
- has to be prepared to step forward to help when necessary and then step back to reduce the risk of tunnel vision.

Do not take off breathing apparatus until the scene is safe and the command to do so has been given!

Medic/extricator

The medic/extricator (centre rear) takes medical fluids and cervical collars to the scene of the accident and itemises and prioritises together with the commander.

The medic/extricator is responsible for medical attention until ambulance personnel arrive.

When ambulance personnel are on the scene, he/she changes role to that of extricator.

Medic/extricator

- starts giving medical attention on the basis of L-ABCDE principle. If fire brigade personnel enter the damaged vehicle before it has been stabilised, great caution must be exercised so that the condition of the casualties is not made worse.

Think about the safety of fire brigade personnel and casualties!

- keeps the casualties' airways open
- stabilises the casualties' necks using cervical collars
- creates access for medical treatment. If the car doors cannot be opened, the windows are used. Windows that may break with the result that the casualties are hit by glass fragments must be removed.

Driver/tool officer

The driver parks the emergency service vehicle so that the scene of the accident is protected as much as possible, leaves the blue flashing light on and turns on the hazard flashers. The emergency service vehicle must not dazzle other traffic with dipped headlights and should instead have its parking lights switched on.

The driver also makes sure that the accident is documented by taking photographs early on.

Driver

- connects and lays out a foam line
- then acts as tool officer
- takes out stabilising material and assists with stabilising if necessary.

Tool officer

- Builds up a tool point in the warm zone by laying out the following equipment:
 - tarpaulin
 - stabilising equipment
 - tool bag
 - blanket
 - crowbar
 - protective plastic sheet for the casualties (to guard against glass fragments)
 - hydraulic tools
 - glass saw
 - hard plastic disc (cutting protection)
 - protective equipment for sharp edges etc.

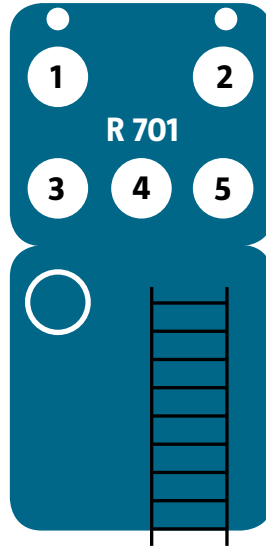
The tool officer serves fire brigade personnel with equipment and is prepared to help for a short time in the hot zone if necessary.

A Arrival:

Immediate action: Taking stock, Life-supporting measures and establishment of a "safe workplace"

B Extrication:

Continued measures: First Aid, Creating space/extrication



	A	B
1. Driver	Takes out extinguishing equipment. Foam.	Tool officer. That the right tool is always available. Assists with lifting.
2. Commander	Vehicle location, first assessment, decision.	Orders. Leads the work at the scene of the accident. Status reports.
3. Safety officer	Protect and safeguard against fire. Disconnects car battery and has a foam extinguisher or powder in readiness. Respiratory equipment to be used until commander orders otherwise.	Continuously checks on safety, e.g. glass fragments, sharp edges, petrol leaks, cut-off parts, personal protection, stability of vehicle, protection of casualty/ casualties. Assist with lifting.
4. First aid	Accompanies commander on "first round", takes medical equipment. Life-supporting measures/ life-threatening situation. Attends to casualties until ambulance personnel take over.	Works with tools. Creates space for medical personnel.
5. Traffic safety	Warns, cordons off road. Attends to casualties until ambulance personnel take over.	Works with tools. Creates space for medical personnel.

*Incident Commander,
AIO and MIO*



Medical services organisation

When the first emergency medical services (EMS) personnel (usually ambulance personnel) arrive on scene at an accident, a dedicated medical incident control point is immediately established with an Ambulance Incident Officer (AIO) and a Medical Incident Officer (MIO). The names for those two roles must always be used at the scene of an accident.

Ambulance Incident Officer

The AIO leads the medical work on scene; and with particular focus on safety, communication and logistics.

The AIO is responsible for the following:

- Liaison at the control point with the Incident Commander (always fire brigade in Sweden), the Police Incident Officer and any other bodies involved
- Making a safety assessment for EMS personnel
- Setting up communications for EMS internally and externally
- Reporting in accordance with established procedure
- Monitoring available medical resources and requesting extra resources as and when necessary; planning for a drawn-out operation



- Jointly with the MIO taking decisions on the aims of the medical work on scene.
- Information (own organisation, collaborating authorities, and the media)
- Documenting times and decisions

Medical Incident Officer

The MIO has the overall medical responsibility for the medical work on scene, and has as his/her main task management of the medical care on scene.

The MIO is responsible for the following:

- Monitoring medical needs on scene
- Priorities
- Care of casualties
- Jointly with the AIO taking medical aim decisions
- Organising transport so that casualties are transported in a safe way to the correct destination
- Documenting times of medical decisions, and ensuring that observations, assessments, and treatment are documented in accordance with established procedure.

Staff

Those who are assigned to assist the AIO or MIO are called the staff. The AIO might, for example, need a person that deals with all communication or logistics for the resources that arrive on scene. The MIO might need a person to deal with the logistics of hospital transport for casualties. This person is then called the hospital transport officer.





The police

The police incident officer directs the police on scene, allocates work among them and cooperates with fire brigade and medical personnel.

The areas of responsibility of the police are:

- traffic control
- cordoning off
- evacuation
- monitoring
- searching
- registration and identification
- collection of and dealing with goods
- notification of family
- information to the public
- information to the media
- investigation of the cause of the accident together with the Swedish Transport Administration.

Traffic information, traffic control and handling of disruption

The Swedish Transport Administration has traffic control centres (TLC) which are to inform the rest of society about a road traffic accident, for example on radio, television and the Internet and through navigational equipment in cars, The operation becomes more efficient and safer as informed road users

- can choose a different route, which reduces the traffic at the accident site and enables the fire brigade to work more effectively
- more readily accept being in a queue of traffic, which reduces the risk of follow-on accidents
- pass the accident site with greater caution, which improves safety for personnel on scene.

The Swedish Transport Administration's traffic control centre is an important cooperating partner for fire-brigade personnel. The incident commander (who is in contact with the SOS Alarm emergency centre) has to assess the extent and duration of the accident together with the police on scene, which the traffic control centre can quickly and effectively inform the public about. The traffic control centre can also make sure that the right contractor is sent out to the accident site to sign a diversion or to restore the road after the accident.





6. Extrication

It is important that rescue service personnel can read accidents so that they can set the right priorities. The first visual impression of the scene of the accident often gives a pointer to what awaits. Move casualties who are in positions that pose a danger to life, make sure that the casualties' breathing, circulation and heart activity are functioning, prevent shock, stop bleeding, avoid hypothermia etc.

The fire brigade personnel's knowledge and understanding of the forces that cause physical injury, how quickly they can detect suspected various injuries and their skill in assessing the situation are a crucial factor for the casualties' outcome.

Read the accident!

Reading an accident means obtaining an understanding of the situation purely from what can be seen at the scene of an accident, regarding what has happened, the sequence of events, and what measures need to be taken. One forms an understanding of how and where injuries may have been sustained: Have loose objects been thrown around in the car? Did the passengers have their seat belts on? Is there, for example, a 'bull's eye' in the windscreen? If so, neck and head injuries can be suspected for the driver or passenger. It may also mean that there has been a collision with someone or something.

The more you know about emergency medical care, extrication etc., the more you can read from the situation you see in front of you and the greater your readiness for action.

Reading the accident also means studying the accident site:
What is the speed limit for the section of road concerned?
What are the road conditions like? What has the car collided with? Fire hazard?

Life threatening situation? And so on.

One way of learning how to read accidents is to look at photographs from the scenes of previous accidents along with colleagues and thinking about what might have happened.

Read the accident

One way of reading an accident is to ask yourself a number of questions about what you see.

Accident site:

- Attempt to create an overall picture of the accident, what does it look like?
- What does the accident site look like?
- How many vehicles are involved?
- Establish the type and extent of damage to each vehicle.
- What was the legal speed limit on that section of road?
- Road conditions?
- Is it a high-energy or low-energy impact?

Situation:

- What has actually happened? Why?
- What has collided with what and at what speed?
- How many vehicles are involved?
- How many people are involved?
- How old are the people involved?
- How has the body moved?
- Was the surface hard or soft?
- Important details?
- Was the seat belt being used?
- If yes, was it correctly positioned?
- Were airbags or side impact protection curtains deployed?
- Is the windscreen intact? If it is damaged, has the damage been caused by impact from inside or outside?

- Could the casualty's head have struck the steering wheel or the windscreen?
- Is there blood in the car?
- How has a person who has been flung from the vehicle landed?
- Where are the occupants of the vehicle positioned outside it?
- What was the location of the casualties at the start?
- Is there anything under the vehicle? A child who has been hit can easily end up under the vehicle.
- How many people are in each vehicle?
- Is anyone trapped?
- How much is the vehicle compressed from the impact?
- Are there any brake or skid marks on the road?
- Where on the vehicle did the impact occur?
- Are there any signs that the vehicle has rolled over?
- Are there any marks inside the vehicle indicating that any part of the body has struck anything?
- Must the vehicle be moved to enable extrication?
- Is there a risk of the vehicle toppling over, sliding down a slope etc.?

Questions can also be put to the casualties. The replies you receive generally give an indication of the condition of casualties, how severe the injuries are and where they are. The information obtained also makes it easier to commence with the right treatment.

It is useful to start with a question that demands more than a yes or no, for example,

What happened? Where does it hurt? By asking questions of this kind you can gain an idea of the casualty's breathing, circulation and general condition.



Documentation

It is useful if someone can take one or more early photographs, perhaps before exiting the fire brigade vehicle. The rest of the operation should be documented with more photographs afterwards. The incident commander should also record his or her first impressions and all decisions that are taken, either by writing notes or by speaking onto tape.

Assessing the condition of casualties

The medic decides if the casualty is regarded as critically injured or non-critically injured. A person who is critically injured should be extricated within 5 minutes (“rapid extrication”) to enable him or her to be driven to a hospital to within 10 minutes. For critically injured casualties survival is reduced by 10 per cent for every 10 minutes of delay before the person receives hospital care.

Critically injured

- A critically injured person has
- a blocked or threatened airway
- impaired ventilation with an abnormally fast or slow breathing rate (slow – fewer than 10 breaths per minute, abnormally fast = 30 breaths or more per minute)
- shock: significant external bleeding or suspected internal bleeding with a pulse of 120 beats per minute or more.
- lowered consciousness, i.e. only responds to pain according to AVPU (the grades “Alert”, “Voice responsive”, “Pain responsive” and “Unresponsive”) and/or is convulsing

- penetrating trauma to the head, neck or chest
- any trauma combined with an environment posing danger to life, serious diseases (e.g. cardiovascular disease, obstructive pulmonary disease and haemophilia), hypothermia, burns and pregnancy.

Spinal injuries, i.e. injuries to the spine, are not always life-threatening if the other values are good.

Such injuries include

- pain in the neck or back
- pain on palpation of the back or neck
- deformity in the neck or back
- visible injuries to the back or neck
- muscle cramps in the neck or back
- paralysis, weakness, numbness or pins and needles in the arms or legs.

Examination and measures according to L-ABCDE

L = Life-threatening situation. Consider moving or dealing with what constitutes the danger.

A = Make sure that the Airway is free. Stabilise the cervical spine manually. Put a neck collar on the casualty and continue stabilising the cervical spine manually.

B = If the person is Breathing. Measure the breathing rate, depth of breaths and breathing pattern. Decide whether rapid extrication and rapid transportation to hospital are necessary. Fast breathing means problems with oxygenation in the body, so meet the need for oxygen by giving plenty of oxygen at an early stage. Make frequent checks on breathing.

C = Failing Circulation is life-threatening. A sign of this is that the pulse rises. The skin is pale and clammy as capillary re-filling is delayed, due to reduced blood flow in the skin. Place the casualty with the feet raised and maintain a free airway.

If necessary, place the person in the three-quarters prone position (recovery position) to secure the airway, and with the knees drawn up to relieve the strain on the abdominal muscles. Stop visible bleeding and check pulse at close intervals. If the blood pressure drops it is a late sign. Satisfy the need for oxygen and consider whether the casualty needs a drip.

D = Level of consciousness falls as the bleeding causes oxygen Deficiency. An agitated and aggressive person at the scene of an accident is to be assessed as having oxygen deficiency until the opposite is proven. An unconscious person should be placed in a stable lateral position with the feet raised. Feeling and mobility should be examined if there is time, for example while waiting for an ambulance to arrive and if the person's condition allows.

E = Carry out a whole-body Examination to discover further injuries and protect from the environment. Prevent the casualty from becoming cold by using blankets and, if necessary, a cap. Decide whether the injuries need to be fixed, bandaged or similar. Make continued checks and arrange continuous monitoring.

A person showing signs of abdominal injury must be given high priority in care and transportation as abdominal injuries are the second most common cause of trauma mortality. The most reliable sign of bleeding in the abdomen is shock. Deal with oxygen deficiency at an early stage, and suspect internal injuries. Arrange rapid transportation for surgery or care.

Choice of extrication method

The extrication follows an action plan. When the incident commander, medic and safety officer (with a foam or powder extinguisher) arrive, they walk around the vehicle to obtain a picture of the injuries and the damage to vehicles and of the risks posed by the vehicle or vehicles. At this stage decisions must be taken on whether the vehicle needs to be moved to allow access.

The medic/extricator takes the medical equipment, makes sure that the emergency medical services have access so that the casualties' airways can be kept open and tries to open the doors.



Initially, the safety officer guards against the danger of fire by using a foam or powder extinguisher.

The tool officer unreels the hose and foam tube for foam spreading and lays out the tools.

He or she starts with blocking equipment, protective plastic sheet, rigid plastic and crowbar, which are normally used first.

During this time the traffic control officer/extricator has been placing cordons on either side of the accident. Everyone wears safety goggles, safety vests and flexible working gloves. Latex gloves are worn under the working gloves to prevent blood contamination.

A general description is first given below of what fire brigade personnel must watch out for and do in view of the fact that there may be non-deployed airbags and side impact protection curtains in the vehicle. A brief description is then given of what is known as quick removal, followed by more detailed flow charts for extrication and removal when the condition of the casualties is judged to be stable and there are no external hazards that make quick removal essential.

The descriptions are intended to provide readers with as broad and structured a picture of extrication as possible.

At the scene of a real accident many people will naturally be working at the same time, and actions will be performed in parallel wherever possible. It is important to have the casualties under supervision the whole time, which is not repeated for every operation in the account given below.

Non-deployed airbag

Identify whether the car is fitted with an airbag, or with more than one airbag! This is marked on a window, the dashboard or the steering wheel. The car industry has now reached agreement on the designation SRS (Supplementary Restraining System). This marking also means that the car is fitted with belt pretensioners. Older markings may be S.I.R., P.R.S. or Airbag. The steering-wheel hub is slightly bulky in a car fitted with an airbag. If you are unsure, treat the car as though it has airbags.

Do not hold any tools or other objects between the casualty and a suspected non-deployed airbag.

Disconnect the battery, detaching the negative terminal first. The airbag sensors may be located at the front of the vehicle, in the passenger compartment or on the side depending on what airbags there are in the car. Do not work on the steering-wheel column. Doing so could cause tool damage. Also avoid exerting force on the steering wheel hub as doing so may trigger a non-deployed airbag. Do not cut the leads attached to the safety system. The leads are generally brightly coloured: orange, yellow or neon-green.

Check where the gas containers are located and make sure you do not cut into them.



Turn off the ignition and disconnect the battery to deactivate the system. Avoid cutting into pressurized containers. If a cut is made in a pressure vessel, it might conceivably fly off due to the high pressure in the container (300 bars). Containers today are not just located on the C or D pillars, in some cases they can also be found on A-pillars or on the edge of the roof. We recommend breaking away the inside of all the pillars and looking to see where the pressure containers are before cutting. It is a good idea to mark on the outside where it is appropriate to make the cut. Also take account of the width of the pillar so that you cut at the narrowest point possible not at its widest point.

Summary

- Always disconnect the battery before commencing extrication.
- Note that some car models may have two batteries.
- If possible do not work in the airbag's risk zone if the bag has not deployed.
- Remember that the car may have more than one air-bag.
- Do not place the spreader guide against "unknown" parts of the car.
- Do not cut into the "brightly coloured" cables as there is a risk of accidental deployment.
- Prise off the panel and look to see where gas containers are located before cutting.

Action plan for dealing with an RTA (road traffic accident)

It is always the condition of the casualty that dictates the focus of the operation. The assessment should be made by personnel who can decide how critically injured the person is, what trauma he or she has suffered to and how urgent hospital care is. Another decisive factor is whether the casualty is trapped or not, as this can prolong the extrication work.

These factors have to be considered in deciding what tactics and method to use, but the tactics and method should also be adapted to the situation to be effective as possible.

Criteria for how to assess the condition of a casualty

To assess the condition of a casualty, it is necessary to have suitable training as this assessment can very often decide whether the casualty survives. Personnel must be able to read what trauma the casualty has suffered and know what injuries it can lead to, and as a result the casualty can quickly receive the right care.

What is usually most crucial in deciding the extent of injuries is the speed of the vehicles at the moment of collision and how the vehicles decelerated. If the vehicle was being driven at high speed (above 80 kph), and depending on the vehicle's design and whether it has collided with a solid object that does not yield, it is likely that the people in the vehicle are severely injured and perhaps trapped. But even if the people in the vehicle do not have any visible injuries and are not trapped, their bodies have suffered significant trauma which may mean that they are in a critical condition. They may have sustained severe internal injuries with tearing of vital organs and blood vessels, and consequently major internal bleeding. If the vehicle collided at high speed (above 80 kph) it should always be suspected that the people travelling in it have critical injuries. In these situations it is important to study the location of the cars and what has collided with what to be able to decide the level of trauma. It is generally only possible to save the casualty if they reach hospital quickly for surgery.

In some cases the speed is slowed down at the moment of collision if the car, for example, collides with something that yields or if it has large crumple zones. The trauma may then be somewhat less and the injuries a little less serious.

If the vehicle was being driven at lower speed (below 80 kph) it is most likely that the casualty will have neck and back injuries, but their condition will probably otherwise be relatively good. In these cases caution should be exercised in dealing with the casualty and the focus should instead be on stabilising or fixing the back and neck. This is important, because lifting at an angle or someone losing their grip may result in the casualty spending the rest of his or her life in a wheelchair. However, there is always a risk of the casualty's condition deteriorating, and the casualty should be watched over the whole time.

To facilitate attending to the casualty and to make it easier to choose the method of extrication, casualties can be divided into various grades of injuries. These groups could be:

- A. uninjured or slightly injured, no signs of back or neck injury
- B. suspected back or neck injury, other signs good, casualty not trapped.
- C. suspected back or neck injury, casualty trapped
- D. critically injured, casualty not trapped
- E. critically injured, casualty trapped
- F. dead person

Extrication methods

On the following pages are described some of the extrication methods that can be used in attending to casualties in RTAs. The condition of the casualties as defined for groups A-F determines the choice of method.

A. Uninjured or slightly injured, no signs of back or neck injury

These persons have generally already exited the vehicle before the fire brigade has arrived on the scene, but they should still be assessed by someone with medical knowledge. If the casualties are still in the car, someone with medical knowledge should assess their condition before they are allowed to leave the car.

These people should be gathered together at a designated place so that a watch can be kept on them in case their condition worsens. They may also have important information about the accident.

B. Suspected back or neck injury, other signs good, casualty not trapped

It is assumed here that the vehicle has collided at a lower speed, less than 80 kph, and that the condition of the casualties is stable, even if injuries to the back or neck may be suspected. In these cases it is recommended that the casualties are dealt with as gently as possible. The operation should focus on attending to the casualties calmly and safely, where an attempt is made the whole time to stabilise or fix the back and neck. The roof of the car should be removed to make this easier.

It then becomes easier to apply the stabilisation equipment, and those who are going to lift the casualty out have plenty of space in which to do so safely.

Some SUVs (such as the Volvo XC90) have a very heavy roof that also contains reinforcements in the steel structure that are difficult to cut into. An attempt can nevertheless be made to lift the casualties safely out of these cars as space permits doing so.

Action plan for attending to casualties

An action plan follows showing how casualties could be attended to when their condition is assessed as stable and there are no external hazards. Rescue personnel are given a little more time here than in rapid extrication.

1. Stabilise the vehicle

First stabilise the vehicle at four different places: behind each of the front wheels and in front of the rear wheels. Place blocks/wedges/steps under the door sills and remove the wheel valves. The vehicle will then settle on the blocks and become stable.

2. Disconnect the power supply

Turn off the ignition, gain access to the battery and disconnect the negative cable first.

N.B. First unlock the doors if the vehicle has central locking. There are vehicles today on which the central locking locks automatically at speeds above 20 kph. Electric windows may need to be lowered in the door. This should be done if possible before the battery is disconnected.

Otherwise the necessary actions can be done first and then the battery can be reconnected.

Stabilise the vehicle.





Remove the wheel valves.



Disconnect the cables from the battery, negative cable first.

It is partly for this reason that the power supply has to be disconnected by detaching the cable terminals and not by cutting off the cables.

3. Attend to the casualty

Normal seats have a number of manual adjustments that can be used to relieve the pressure on the casualty.

Alter the position of the steering wheel to reduce the pressure on the casualty if there is steering wheel adjustment.

If the car has been hit from the side and there is pressure on the casualty, use the hydraulic ram to force the bodywork apart so that the pressure on the casualty is eased.

Prevent cooling by putting a blanket and cap on the casualty.

Cover the casualty and medic with transparent bubble-wrap plastic and put safety goggles and a cap on the casualty if necessary.

Attend to the casualty.



4. Remove side and rear windows

Wind or run down the windows and crush them in the door (if possible). The glass fragment will then be left in the door. If you leave the windows intact it is possible that they will disintegrate in an uncontrolled manner later in the operation, leading to an increased risk of injury. Another option is to place sticky film on the windows to avoid problems with glass fragments when they are broken.

There are cars that have unbreakable laminated glass or safety glass in the side windows. Windows of this kind must be run down into the door or sawn away. The usual practice is to saw them away as the battery has been disconnected previously.

Work on the rear window in the same way if it is made of laminated glass.

Bear in mind that sabre saws and glass saws generate high sound levels that may be very distressing for the casualty.

It is therefore advisable to put some form of hearing protection on the casualty and the medic.

Finely divided glass dust is also formed in the sawing operation, and has a tendency to whirl around in the car.

So make sure that the protective plastic sheets provide a proper cover. Everyone who comes into contact with glass dust must wear a protective mask.



Crush or saw side windows and rear window.



Cut off the seat belt.

5. Cut off the seatbelt

Cut off the seatbelts where necessary to ease the pressure on the casualty.

6. Cut the pillars

Break away a little of the trim lining the pillars and look for gas containers so that you do not cut into them.

Break away the trim and look for where any gas containers are located.

Use a sharp object or a special pen to mark a line on the outside to indicate a suitable point at which to cut. (See photo on next page.)

Start cutting the A-pillar furthest away from the casualty and saw from the hole at an angle across the windscreen.

Continue by cutting the B-, C-, (D-, D-,) C-, B-, A-pillars.



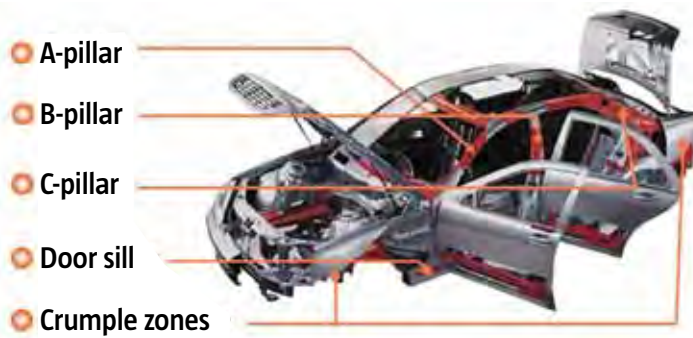
Exposed gas container.



Break away the trim and look for where gas containers are located.

Marking of cutting point.





The pillars are named from the front: A-pillar, then B-pillar and at the rear the C-pillar. If the car is an estate or an SUV there is also a D-pillar. Note the car's crumple zones and the door sill.



Cut off the A-pillar.

7. Saw the windscreen

Saw the windscreen with a glass saw or battery-operated saw. Wear a dust mask. Start sawing from the cut made in the A-pillar just above the windscreen. Saw to the intended cutting point on the other A-pillar.



Saw the windscreen.

8. Lift off the roof

Bear in mind that the roof becomes unstable when the pillars are cut on one side. Secure by asking someone to hold up the roof on the cut side. The car roofs of today are often heavy, so make sure that there are sufficient people to carry out a safe lift.

9. Cover sharp edges with edge protectors

Use edge protectors. This prevents personnel and casualties from cutting themselves on sharp edges.

Lift off the roof.



Cover sharp edges with edge protectors.



10. Lift the casualty out

When the casualty is ready to be lifted out, lower the rescue board/spine board down behind his or her back.

Hold the stretcher/board still, lower the backrest, pull the casualty and board backwards, slide the body up onto the board, lift out in the lengthways direction and place on, for example, a vacuum mattress and ambulance stretcher.

In most cases these measures are sufficient for it to be possible to perform a controlled and safe extrication. However, it might also be necessary to cut the back of the seat to allow for a safe extrication.



Lift the casualty out.



Summary - extrication from upright car

- Stabilise the vehicle
- Disconnect the power supply
- Attend to the casualty
- Remove side and rear windows
- Cut off the seatbelt
- Cut the pillars
- Saw the windscreen
- Lift off the roof
- Cover sharp edges with edge protectors
- Lift the casualty out

C. Suspected back or neck injury, casualty trapped

With the strongly-built cars of today a relatively high speed (above 80 kph) is usually required for anyone to be trapped, and the condition of anyone who is trapped should be considered critical. This means that their values may deteriorate quickly, and it can suddenly become urgent to extricate them. The aim should nevertheless be to stabilise the back if this does not delay extrication too much. If the casualty's values deteriorate, it is often time that decides whether he or she survives or not. In these cases the roof is not cut but the casualties are nevertheless extricated, either with a traditional cylinder technique by the pulling method, "dash lift" or some other method that has been practised in exercises (these methods are described under E, "critically injured, casualty trapped"). Lifting-out then takes place quickly, primarily through the hatchback or rear window, in the longitudinal direction of the body. If this is not possible, the casualty should be lifted out according to the PHTLS concept through a side door (see D "critically injured, casualty not trapped").

*Falkenberg Fire & Rescue
Brigade lifting a casualty out.*



D. Critically injured, casualty not trapped

Those who are critically injured but not trapped should be taken to hospital quickly for medical attention, and lifting-out should therefore be done quickly. This should be done rearwards in the longitudinal direction of the body through the rear hatch or rear window, but if this is not possible the casualty can be gently lifted out through the side-door opening according to the PHTLS concept. If anyone has been thrown out of the vehicle, it should always be suspected that such a person is severely injured, until the opposite is proven.

Action plan for rapid extrication

A rapid extrication can be initiated due to the condition of the casualty or an external hazard, for example, fire, dangerous goods and so on, that make it crucial to get the casualty out quickly. The basic principle is that the casualty is removed lengthwise through the rear window on a rescue board, spineboard or similar. That way twisting of the casualty's neck and back can be avoided, which otherwise could lead to further injury.

If the rear window opening is tight it can be made larger using a spreader or ram.





Action plan for rapid extrication.

- 1. Open the door(s)**
- 2. Hold the head, might need to put on a neckbrace**
- 3. Open the hatchback or break the rear window**
- 4. Lower the backrest**
- 5. Insert the board and pull out the casualty**

Rapid extrication can also be achieved by cutting away the B-pillar to obtain a larger opening on one side. Then fold the seat or cut the backrest to make safer lifting possible. When the backrest is being cut there must be protection between the casualty and the backrest. The backrest should also be cut open to see what you are cutting into.

Then lift the casualty out through the side-opening according to the PHTLS concept.



Left: Cut the backrest to make safer lifting possible, ensure there is protection between the casualty and the backrest.

Right: Perform a careful lifting-out .





Lifting the roof.

In some situations other solutions must be found to make controlled and safe lifting-out possible. The personnel should practice in different situations so that they are prepared and have a number of solutions. It may sometimes be necessary to bend and force up the roof in various ways.

E. Critically injured, casualty trapped

All critically injured casualties must receive hospital care as quickly as possible, so choose the quickest method of extrication for the situation. This may either be the traditional cylinder technique, the pulling method (the Oslo Model), a “dash lift” or some other method practised in exercises. Examples are given below of different techniques that can be used in these situations.

The cylinder technique

This is the most common and most practised technique used by the emergency services in Sweden. A description of how the method should be carried out follows. Do not compromise on safety, even if it is urgent.

The points we have touched on earlier with regard to stabilisation, fire safety, disconnecting the power supply, attending to the casualty as soon as possible, removing windows, cutting off belts and checking where gas containers are located also apply here. Likewise PPE (personal protective equipment).

Remove the door

If the door is wedged shut, it must be forced off. Start on the hinged side between the A-pillar and the window frame.

Force the gap open with a crowbar. Continue with the spreader. Make the opening wider and work downwards.

Hold the spreader at an angle of around 45 degrees from above. This eliminates the risk of a smashed door being bent inwards.

Work in small movements towards the hinge.

There is a large amount of metal to be gripped when opening the hinge.

It may occur that the inner panel of the door bends inwards. Use the spreader to clamp the panels together and bend the door outwards.

Continue down towards the lower hinge until both hinges have been released.

When this has been done, try to get the door back to its starting position. Press the door handle in and lift the door away.

If that doesn't work, bend the door backwards and then forwards. A crack will then appear, making it easier to break the lock away.

When the front door has been removed, it will be possible on some models to unscrew the hinges on the rear door. Bear in mind that the rear door may be needed as a counter hold.

Press the dashboard forwards

If the dashboard needs to be pressed forward, place a hydraulic ram horizontally in the door space. Press with the ram.

(If necessary make a cut in the bottom edge of the A-pillar.)

Remove the door.



If the roof is still in place, both A-pillars must be cut off high up. Make sure you position the hydraulic ram before cutting, as the vehicle may collapse and increase the pressure on the casualties.

Press the dashboard forwards with the ram and follow-up by placing blocks. The rear door must be left in position to serve as a counter hold.

The door ram can be advantageously combined with a lengthened ram which is positioned from the rear seat between the front seats and towards the dashboard. Remember to protect those who are in the car, as pieces will be loosened from the dashboard, which may hit someone.

When this has been done the two rams can be run in parallel. Bear in mind that some form of support may be needed in the rear seat, as there will be a lot of pressure on it.

Check the stabilisation as you press, as the car body changes and



Press the dashboard forwards.



Cut the backrest if necessary.

Support plate against back seat



The steering-wheel rim can also be cut with a pedal cutter.

Move the pedals aside with the spreader. The photo shows the spreader being used on the A-pillar and seatbelt.

the undercarriage tends to rise a little.

It may also be necessary to cut the backrest of the seat to be able to lift the casualty out safely.

Cut pedals and rim of steering wheel if necessary

It is very difficult to cut pedals with pedal cutters if someone's feet are trapped by them.

Either the pedal moves or the cutter does, and this can exacerbate the injury to the foot.

One option is to tie a safety harness around the pedal, for example, and connect it to the spreader.

Then use the spreader to put weight on the outside of the A-pillar in the door opening and pull in the direction in which the pedal is to be pulled. Another option is to cut the rim of the steering wheel off with the pedal cutter.





Falkenberg Fire & Rescue Brigade lifting a casualty out through the rear window.

Lift the casualty out

When the casualty is ready to be lifted out, lower the rescue board/spine board down behind his or her back.

Hold still. Lower the backrest and pull the casualty and board backwards. Slide the body up onto the board, lift out and place on a vacuum mattress or ambulance stretcher, for example.

The pulling method

The pulling method should primarily be used in extricating critically injured people who are trapped in severely deformed vehicles, but it can sometimes be used to supplement the more common methods of extrication. The fire and rescue service in Greater Gothenburg has successfully used the method in incidents involving small trucks where the cylinder technique did not work.

The method must, however, be performed correctly, with the right equipment, and by personnel who during their training have practised the method on severely deformed cars. All this is important to create a safe working environment at the scene of an accident. The method should also only be used when cars are upright on their wheels. There may otherwise be certain medical risks to those casualties who require further assessment.

A description of how the pulling method should be carried out follows.



Lift the casualty out.

Arrival at the scene of the accident

The fire brigade should consider from the outset that the pulling method may need to be used, and therefore that it is important vehicles are positioned correctly. The vehicles should be parked straight along the road, with one in front of and one behind the vehicles involved in the accident. The scene of the accident is usually divided into hot, warm and cold zones, and no vehicles may be positioned in the hot zone. The pulling vehicle and the counter hold vehicle may be positioned at the outer margin of the warm zone, while the other vehicles must be in the cold zone.

Cordon off the scene of the accident to obtain a safe scene, and start work according to the standard routines. The safety officer must be dressed for the possibility of fire on arrival and focus on safety at the scene of the accident. The other personnel must focus on giving medical attention and reaching the casualties. The crew commander must quickly establish what extrication method is to be used.

If the pulling method is chosen, coupling must be done according to the established and practised routines. It is important to have a good standard routine for how coupling is to proceed and who is to do what.

A suggestion follows of the form such a standard routine can take with regard to the pulling method. The suggestion is based on a crew of 1 + 4 people.

Position of fire engines when using the pulling method.





Keep the casualty under permanent supervision.

The crew commander's decision is governed by the assessment of the casualty's condition.

It is usually the ambulance personnel at the scene of the accident who assess the casualty's condition, but fire brigade personnel may also need to make their own assessments. The focus throughout the operation must be on the casualty, and the aim should be to get a medic into the accident vehicle as quickly as possible.

- The crew commander controls the work with practised signals; and checks safety around the casualty and in the protection zones.
- The driver couples the winch, lays out the equipment needed and attends to the winching in accordance with the crew commander's instructions.
- The safety officer checks safety, tries to disconnect the power supply in the car, and helps out where needed.
- Extricator 1 creates access to the casualty, makes sure that the vehicle is stabilised and connects a chain to the front of the vehicle. The extricator is also responsible for cutting and spreading on one side of the accident vehicle.
- Extricator 2 couples the counter hold and is responsible for cutting and spreading on the other side of the accident vehicle.

Equipment

The equipment to be used should be kept in a ready-made kit to save time. The kit consists in particular of chains and straps which should be in the same place and be clearly marked to avoid misunderstanding.

There are ready-made kits containing chains already cut to correct lengths and marked in a clear way. There are different types of chain, including a type that eats its way into the sheet metal by tightening itself the more pulling is performed, which means that it is only necessary to wind it one turn around the pillars. It is useful but somewhat more expensive than an ordinary chain. There is also an ordinary chain that can be ordered in ready-made kits and in correct lengths, but such chains have to be wound two turns around the pillars.

Connection

Start coupling with both the pulling side and the counter hold simultaneously. The chains on the pulling side consist of two chains joined together made in ready-made lengths and marked so that it is apparent where they are to go. One chain should be attached around the steering wheel and the other around the A-pillar on the driver's side. The chain around the steering column has to be around 5 cm shorter than the one in the A-pillar for the wheel to be pulled away from the casualty's body before the other pulling begins.

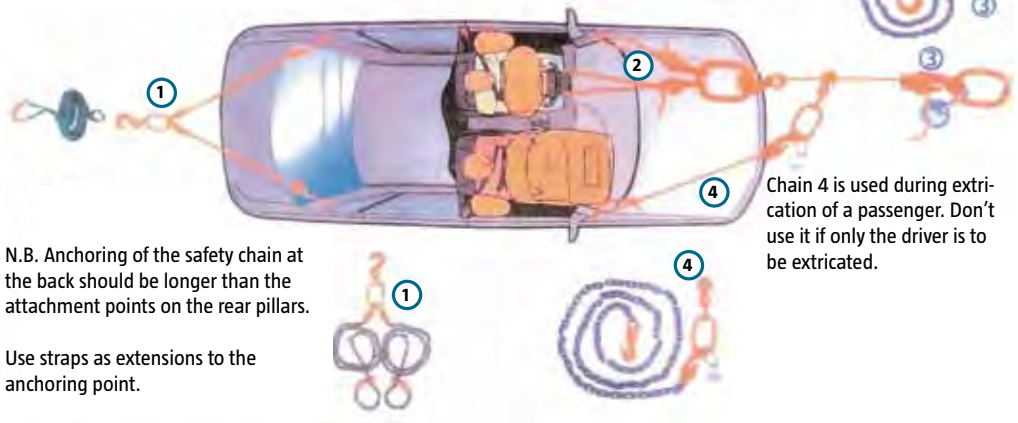
N.B. When the pulling method is used on trucks, the chain is not wound around the steering column as the design of the steering column means that it can cause further injury to the casualty.

If there are more severely injured people in the car, a chain must also be attached to the A-pillar on the passenger side (this chain is also included in the kit and in the picture is shown as chain 4).

The chains are then attached to the winch, and it is important to use a block and double the cable. Remember always to mark out the cable so that it is visible, e.g. with cordon tape. Also hang a blanket on the cable to muffle the recoil in it if something untoward should happen. The counter hold must be placed high on the C- or D-pillars on the accident vehicle (the rearmost pillars) so that the counter hold presses the accident vehicle down on pulling and as a result makes it steadier.

Chain 2 is wound twice round the A-pillar. Around the other pillars and the steering column the chain is wound once.

N.B. The chain round the steering column should be shortened 5 cm more than the A-pillar, so that the steering column is pulled first.



N.B. Anchoring of the safety chain at the back should be longer than the attachment points on the rear pillars.

Use straps as extensions to the anchoring point.

Chain 4 is used during extrication of a passenger. Don't use it if only the driver is to be extricated.

Key to the chains in the picture.

Chain 1 = Chain kit connected as counter hold,

Chain 2 = Chain kit connected on the pulling side.

Chain 3 = Chain between the pulling chain kit and the winch block.

Chain 4 = Chain connected if there is anyone in the passenger side of the accident vehicle.

Pulling

Before pulling begins, ambulance personnel must be inside the car to monitor the casualty. Everyone in the car must be covered with a protective plastic sheet. Check also that no one is in the protection zones.

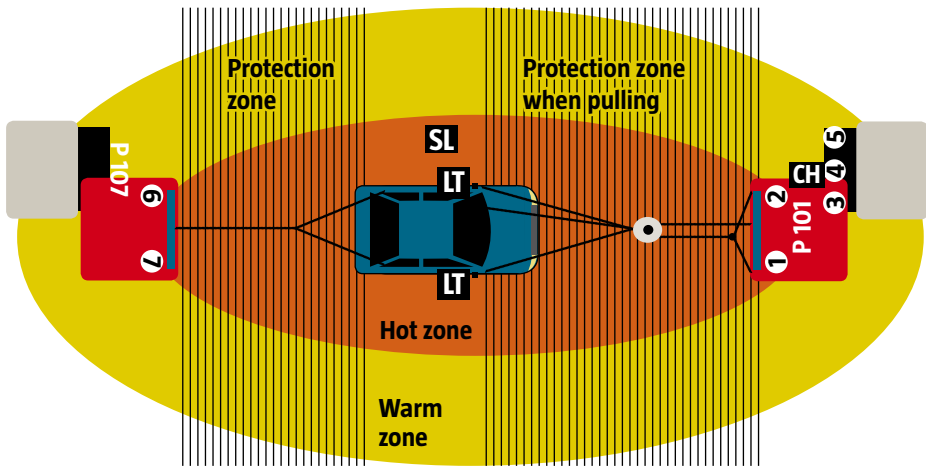
The crew commander stands at the side of the car where the casualty is seated, but not in the protection zone. From this position he or she can control and monitor pulling.

No people or other vehicles may be within the protection zones during the pulling operation.

SL = crew commander. He or she is well positioned to be able to monitor pulling, but is not in the protection zones.

LT = extricator. There must be one on each side to work with the hydraulic tools.

CH = driver. He or she must be protected in winching, either standing behind the door or sitting in the car.



Connect the cable doubled and with a block between. Mark it with cordon tape. Also put a blanket on the cable. Make sure that no one is in the protection zone.

Before the actual pulling begins, it is useful to mark the positions of the accident vehicle(s) in a simple way and to take a photograph of the scene of the accident. This makes reporting and subsequent accident investigations easier.

One extricator stands by each front door of the accident vehicle.

Then tension the chains using the winch. Pull until the A-pillar on the driver's side is almost in its normal position, and then stop pulling but maintain the tension. The extricators must now open the doors, either manually or using hydraulic tools. It is important that the doors are opened so that the weakening cuts that are needed can be done, but also because they act as a counter hold in pulling and when they are then released there is powerful jerk in the vehicle.



Pull the vehicle to its normal shape before cutting starts.

It is also useful to get the doors open early to gain a better overview of the casualty.

Make sure never to make any cuts or spread any door until the car is in tensed condition, because the car could otherwise collapse further towards the trapped person.

When the doors are open, cut the A-pillars off high up (do not forget to check what is in the pillars). If it is a fairly new car, also make a weakening cut at the bottom of the A-pillar to assist pulling and to prevent the sill from rising up too much. When this has been done, do the same on the opposite side.

The crew commander then orders the car to be pulled further apart until the casualty can be gently eased out.

*Pull under supervision
until the casualty is
released.*



**Remember to do as
gentle and good a
lift as possible even
when in a hurry.**





Before the casualty is lifted out, the driver can slacken the pull a little under the direction of the crew commander to reduce the tension. The car will not appreciably collapse, and it will be possible to work as you wish around the vehicle, including in the protection zone.

Dash lift

The “dash lift” is a method used in Germany and the United States. It is based on lifting the dashboard using the spreader in order to release the trapped person.



The door is first removed and a deep notch (a “slice of cake”) is then cut far down on the A-pillar on the side where the trapped person is sitting. Bear in mind that the car may collapse a little when you are making the cut and that the pressure may then increase on the trapped person.

Cut out so much that the A-pillar comes off completely and the tips of the spreader enter the notch.



It is a good idea to place a support under the sill, to avoid the sill being pressed down.





Lift carefully with the spreader.



Demonstration of a dash lift at Rescue Days in Germany.

If it is difficult to lift the dashboard, the A-pillars can be cut higher up, half-way up the windscreen. It may also be necessary to weaken certain other members around the area for lifting to be sufficient.

These methods are examples of methods that fire-brigade personnel can use. Personnel must, however, have good training and experience in the method, and use the right equipment. If these methods are carried out incorrectly, both the casualties and the personnel may be exposed to danger.

Other methods are required if the accident vehicle is not upright on its wheels.

Some examples that can be used in these situations are described below.

Car on its side

If the vehicle is on its side and the casualty has to be lifted out a special action plan is followed.

Only the extrication is described here.

See the earlier section, Choice of Extrication Method, for assessment and fireproofing.

1. Attend to the casualty

The casualty may be caught in the seat belt or lying on the door (not secured by a seat belt).

Try to keep the airway open.

2. Stabilise the vehicle

Stabilise the vehicle, if possible underneath, for example with scaling ladders against each axle and then secure the fire engine's winch cables or equivalent (e.g. straps) at a suitable point on the car underbody to obtain purchase against the ladders.

If this method is applied, there is no stabilisation on the other side to obstruct extrication. This makes it easier to work.

It is also possible to use various types of supports positioned so that the car becomes stable. It is advantageous to position the supports on either side of the car and try to position them directly opposite each other.

3. Take care of the casualty

Make sure that the casualty does not become cold. Use a blanket or similar and a cap.



A good way of stabilising a car on its side is to use ladders, as shown in the picture, or supports.

Crawl into the car and attend to the casualty as soon as the vehicle is considered to be stable. If possible send someone in to relieve the strain on the casualty if he or she is still held in the seat belt.



Stabilise the casualty as quickly as possible.



Cover the casualty and medic with transparent plastic.

4. Disconnect the battery

Turn off the ignition, gain access to the battery and disconnect the negative cable first. (See point 2 in the section on an upright vehicle.)

5. Remove side windows and rear window

Cover the casualty and medic with a protective plastic sheet.

Remove the windows. Remove the lower windows first, so that they do not break later, for example if someone stands on them. One way of reducing the risk of glass fragments when the window is removed above the casualty's head is to stick adhesive film or tape on it before using the centre-punch.

Reduce the risk of glass fragments by using tape or adhesive film when centre-punching and removing the window.



6. Cut the pillars

Break away the trim and see what is underneath.

Cut off A, B, C, and where applicable D-pillars that are facing upwards. Cut the pillars high up at the edge of the roof.

The casualty will be left caught in the seat belt.



Break away the trim and check where any possible gas containers are located before cutting.



Cut above the seatbelt attachments.

7. Saw the windscreen

Saw the windscreen. The more you saw out, the more space there will be for lifting out. If possible, saw so that a spine board can be inserted to relieve the strain on the casualty.

8. Make notches in the edge of the roof to weaken it

Make notches in the lower edge of the roof to weaken it at the A and C-pillars, or the D-pillar where there is one, so that it is easier to bend the roof down.

Saw away as much as possible of the wind/ screen.



Make notches where you want the roof to bend, or cut away the whole roof.



9. Bend the roof down

Bend the roof down. Take care to cover sharp edges while working. The whole roof can be cut away if necessary.

10. Cut away the steering-wheel rim

The rim of the steering wheel often needs to be cut away to make extrication easier.



Bend the roof down.



Cut the steering-wheel rim away if necessary.

Lift the casualty out as gently as possible.



11. Lift the casualty out

Make sure the casualty's feet are not trapped in the pedals.

If the casualty is caught in the seat belt, insert the rescue board/spine board underneath him or her.

Support yourself against the transmission tunnel, hand brake or the other seat.

Lift the casualty up and relieve the strain on him or her.

Cut off the belt.

Take hold of suitable points on the casualty's body and pull him or her out.

Guide the casualty's legs.

If the casualty is lying on the door, insert the rescue board between him or her and the door.

Lift out.

Summary - extrication from a car on its side

- Attend to the casualty
- Stabilise the vehicle
- Take care of the casualty
- Disconnect the battery
- Remove side windows and rear window
- Cut the pillars
- Saw the windscreen
- Make notches in the edge of the roof to weaken it
- Bend the roof down
- Cut away the steering-wheel rim
- Lift the casualty out



Attempt to establish access to the casualty by opening a door.

Car on its roof

If the vehicle is on its roof, the casualty may be caught in the belt or be lying against the roof.

Only the actual extrication is described here.

See the earlier section, Choice of Extrication Method, for assessment and fireproofing.

1. Attend to the casualty

Try to open the door where the casualty is located.

2. Stabilise the vehicle

Stabilise the vehicle with wedges under the A and C-pillars and supports.

Always take care to stabilise the car.



It may be difficult to obtain a good counter-hold with the supports as there may not be much to secure them against. Try to place supports on both sides of the car.

3. Disconnect the battery

Switch off the ignition. Try to disconnect the battery. It can sometimes be reached from underneath.

4. Remove the side windows and rear window

Cover the casualty and medic, if present, with a plastic sheet and remove the windows (if there are any left).

5. Prise the door away

Prise away the door where the casualty is seated. Start on the hinge side and continue with the lock side. On vehicles with four doors the rear door can often be screwed off. This may be sufficient to get the casualty out.

6. Lift out

It is best if the casualty can be removed without making any cuts, as every cut makes the car more unstable. Try to pull the casualty onto a stretcher or rescue board straight back and out through the rear hatch or rear window. If it is tight, the opening can be made larger using a hydraulic ram or spreader.



If a ram is being used, it can be removed when the opening is sufficiently large, without the opening changing. However, this only applies if some cuts have been made in some load-bearing parts of the vehicle.

A large amount of space can be created by adjusting the backrest, making it easier to work.

Relieve the strain on the casualty (either by one of the rescue personnel taking the strain or by using a rescue board).

Cut off the seat belt. Insert the rescue board if it is not already in position, and lift the casualty out.



Relieve the strain on the casualty if he or she is caught in the seat belt.

Lift out gently, using
a rescue board for
example.



If this does not prove sufficient, proceed as follows:

Alternative A: Open the car from the side

7A. Create space

Position the hydraulic ram between the edge of the roof and the door sill or floor. Apply pressure to the ram.

8A. Cut the pillars

Cut off the B and C-pillars or the A, B and C-pillars on one side of the car depending on how much space is needed. Cut above the seat belt attachment if the casualty is caught in the belt. Note that the other side must not be moved as it is needed for stabilisation.

It is also possible to cut off and remove the whole B-pillar if the casualty is caught in it when the front door has been removed.

9A. Widen the opening between the roof and floor

Apply pressure to the ram and separate the vehicle from its roof.

Then support with blocks so that stability is maintained.

10A. Lift the casualty out

Lower the backrest of the seat.

Cut the backrest off if it is electrically operated and the power supply has been disconnected. N.B. Cut the upholstery where the seat is going to be cut and check that there is no hardened steel or side airbags at that particular point.

Insert the rescue board under the casualty. Relieve the strain. If necessary, the steering-wheel rim can be cut off to gain easier access to the casualty's legs.



Make sure that the car is stable and safe the whole time.

Cut off the belt.

Lift the casualty out straight back through the rear window, diagonally through the rear door, or firstly into the rear seat so that the feet come free in the front door space and then out.

Create space if the casualty is lying against the roof.

Alternative B: Open the car from the rear

Make sure that the car is stabilised on both sides.

7B. Create space

Position hydraulic rams in the edge of the roof and up into the floor.

8B. Cut the pillars

Cut the pillars from the rear, but never cut either of the A-pillars, as doing so would make the car extremely unstable.

9B. Widen the opening between the roof and floor

Apply pressure to the ram and separate the vehicle from its roof.

Then support with blocks so that stability is maintained.

10B. Lift the casualty out

Lower the backrest of the seat.

Cut the backrest off if it is electrically operated and the power supply has been disconnected. N.B. Cut the upholstery where the seat is going to be cut and check that there is no hardened steel or side airbags at that particular point.

Insert the rescue board under the casualty. Relieve the strain. If

necessary, the steering-wheel rim can be cut off to gain easier access to the casualty's legs.

Cut off the belt.

Lift the casualty out straight back through the rear window, diagonally through the rear door, or firstly into the rear seat so that the feet come free in the front door space and then out.

Create space if the casualty is lying against the roof.

Always cover sharp edges.



Summary - extrication from a car on its roof

- Attend to the casualty
- Stabilise the vehicle
- Disconnect the battery
- Remove side windows and rear window
- Prise away the door
- Lift the casualty out

Alternative A: open the car from the side

- Create space
- Cut the pillars
- Widen the opening between the roof and floor
- Lift the casualty out

Alternative B: open the car from the rear

- Create space
- Cut the pillars
- Widen the opening between the roof and floor
- Lift the casualty out

F. Fatality

People who have died in a road traffic accident also have the right to be treated with dignity. It has happened that family members have reacted negatively to the way in which a person who has died was treated. One problem may be that the person almost always has to be declared dead by a doctor, and until this has been done fire brigade personnel have to work according to the principle of saving lives. It may also take a long time to obtain a declaration of death if it is not possible get a doctor out to the scene of the accident quickly.

If it is not possible to properly extricate a person who has died for further transportation to hospital, the accident vehicle should be cordoned off or moved to a more remote place. If so, choose a place where fire brigade personnel are not often present, for example, the back yard of a car showroom or a scrap yard. Avoid placing it at the fire station, as fire brigade personnel may then suffer constant negative memories.

Avoid allowing family members coming into contact with the person who has died until he or she has reached hospital.



7. Post-emergency work

Every firefighter is likely to have been taught at some time to bear salvage value in mind during various emergency response operations. For example, not to use more water than necessary when extinguishing fires, so as not to cause water damage to flats or houses, to remove smoke from an affected room, or to pressurise adjacent rooms before the smoke reaches them. It is also necessary to bear salvage value in mind following road traffic accidents. Even if a car has been involved in a road traffic accident and cannot be repaired, there is considerable salvage value to consider. If the car has been involved in a head-on collision, part of the vehicle interior, wheels, panels from the rear of the vehicle, lamp glass, rear axle etc. may be usable.

Instead of buying new parts, insurance companies and car dealers may, for example, use these parts to repair cars that have been hit from behind. We can help here, for example by not slitting the tyre with a knife when stabilising a vehicle, and instead pulling the valve. There is a price difference of around SEK 1500 per tyre.

Follow the recommendations below when starting to clear up at the scene. This is an easy way of helping to preserve salvage value. These recommendations have been produced by the Swedish Civil Contingencies Agency in conjunction with the motor vehicle industry and insurance companies.

What can we throw back into the vehicle?

- Metal parts. But make sure they do not damage the vehicle interior.
- Plastic parts
- Rubber

What must we not throw back into the vehicle?

- Glass fragments
- Road surface materials, gravel etc
- Cleaning materials
- Wet, sticky parts that spoil the vehicle interior
- General rubbish and debris

Make sure you have some kind of container with you, to collect that which cannot be thrown back into the vehicle.



Follow-up and evaluation

Under Chapter 3 Section 10 of the Civil Protection Act we are also obliged to document the accident:

When an emergency response operation has been completed, the municipality shall ensure that the accident is investigated in order to clarify to a reasonable extent the causes of the accident, the sequence of events in the accident and how the emergency response operation was conducted.

Whosoever carries out an investigation in accordance with the first paragraph of this section is also entitled to gain access to the scene of the accident. The police authority shall provide the assistance required.

Follow up the accident at the station using photographs taken on arrival and after the accident.

Discuss questions such as:

- What went well?
- What went less well?
- What do we need to do better next time?

Also follow up the accident together with others who were at the scene of the accident, for example the police, ambulance crew, emergency medical services etc.

- Did cooperation work well?

If not:

- Why didn't cooperation work?
- What do we need to do better next time?

Emergency response operation report

The following points should be considered and be included in the emergency response operation report:

The sequence of events in the accident and implementation of the emergency response operation

Course of the accident prior to arrival of the fire brigade, behaviour of the public, evacuation

Course of events after the fire brigade arrived, deficiencies in protection, implementation of the emergency response operation.

Evaluation

- Measures to prevent similar accidents occurring
- Measures to improve protection against similar accidents
- Measures to make similar emergency response operations more effective.

If it there is a fire brigade operation at the road traffic accident, include also:

Types of road traffic involved

- For example pedestrian, animal, car, bus, lorry, tram etc.

Fire brigade measures

- Extrication - simple tools, hydraulic tools, air bags for jacking up etc.
- Securing of the scene of the accident - spreading of foam, stabilisation, battery disconnection etc.
- Other aspects - traffic control, vehicle recovery, clearing of road surface etc.

In-depth studies

In Sweden we do not accept road traffic claiming human lives, and extensive work is therefore in progress to improve road safety. Part of this work consists of the in-depth studies conducted by the Swedish Transport Administration on all fatal road accidents, both through its own investigations and using information from the police, ambulance and fire services. These in-depth studies started in 1997, on the initiative of the then Swedish National Road Administration and have formed the basis for many improvements in road safety. An in-depth study is a systematic procedure for finding out what has caused the tragedy that a fatal accident represents. The accident is not forgotten about. It does not become merely a figure in the statistics.

Chain of events

The in-depth studies provide knowledge about what made the accident so serious that it led to someone losing their life. An important element in the in-depth studies is to analyse the events leading up to the fatal injuries and to see where the chain of events could have been broken.

Confidentiality

All information that can be linked to individuals is confidential. The results of the in-depth studies are therefore presented in such a way that individuals and vehicles cannot be identified.

Execution of an in-depth study

An in-depth study is like a jigsaw puzzle. Masses of information

are collated to obtain as complete a picture as possible of what happened before, during and after the accident. When a fatal accident has occurred the Swedish Transport Administration is notified, usually by the police. The Swedish Transport Administration investigator is kept constantly informed through the media and other information channels, for example the SOS Alarm emergency services switchboard. The in-depth studies are then conducted by personnel appointed by the Swedish Transport Administration.

Scene of the accident

Shortly after the accident has happened, the Swedish Transport Administration investigator initiates a close examination of the scene of the accident. For the continued investigation it is important to document various traces at the scene of the accident showing where the vehicles collided or what obstacles a vehicle crashed into on the side of the road. Brake marks and traces of wildlife may also be significant.

The road

The Swedish Transport Administration investigator also documents the road layout, any bends or inclines, road width, surface, traffic signs, road markings, speed restrictions, whether visibility is good and whether there are any trees, rocks or similar obstacles close to the road. In addition the scene of the accident and the direction of travel of the vehicle are photographed.

The vehicle

The vehicles involved are closely examined to obtain answers to the following questions: What was the year model of the vehicle? In what condition was it? Were the tyres of good quality? Were the passengers in the car wearing seat belts? Where there any airbags, and were they activated? Did the vehicle have ABS brakes? How was the vehicle deformed? How did the collision forces affect those who were travelling in the vehicle and any person or persons who were hit by it? What other safety equipment was the vehicle equipped with?

Other sources of information

The Swedish Transport Administration receives further information about the fatal accident and the fatalities by cooperating with the police, fire brigade, medical services and the vehicle recovery company, among others.

Examples of questions that are answered are: What was the chain of events? When did the accident happen and when was the fire

brigade alerted? Was anyone under the influence of alcohol or drugs?

It is also important to find out what happened after the crash. When was the SOS Alarm emergency services switchboard informed? When were the police, fire brigade and ambulance service on scene? How was the emergency response operation conducted?

Internally at the Swedish Transport Administration, information is also gathered on the weather and road conditions at the time of the accident and whether any accidents have happened previously at the location.

Analysis

All information about the chain of events before, during and after the crash is collated and analysed by experts at the Swedish Transport Administration who have expertise in vehicle engineering, road design, traffic engineering and behavioural science. The investigation work may also involve experts from the fire brigade, medical services, police and local authority.

The in-depth study is presented

All collations and analyses of in-depth studies are used as a basis for the Swedish Transport Administration's road safety measures, at both regional and central levels. The in-depth studies also provide information and knowledge from which other authorities and organisations benefit. Fatal accidents are presented to the region's management team. As a result, the responsible managers become aware and engaged, and this is crucial to ensure active road safety work.

Improvements

An in-depth study very often leads to immediate changes to the road environment, for example by installing safety railings on dangerous roadsides, thinning out forests along a stretch of road with poor visibility, removing rocks and trees close to the road, installing a centre divide, moving traffic signs that cause an obstruction or lowering speed at intersections. The in-depth studies are also part of the basis for long-term work on designing roads and developing vehicles, as well as guiding police traffic surveillance and other road safety work.

But the in-depth studies do not just bring about improvements to roads and streets, they have also led to the effect of alcohol and drugs on the drivers involved being recorded. It was previously suspected that many drivers were under the influence of alcohol or drugs, but with the in-depth studies it became entirely clear that around a quarter of drivers involved were under the influence. The proportion in single-vehicle accidents is nearly half. This has resulted in increased efforts to prevent drink-driving and to increase the use of alco-locks.

The in-depth studies have also increased knowledge of what protective effects seat belts and other safety equipment in vehicles have, and the local authorities have started making stricter demands on safety in the vehicles they purchase. Several local authorities now require seat belts to be fitted to all seats in school buses and coaches.

Extracts from in-depth studies are used as a basis for various information projects for schools, and this increases the pupils' understanding of what tragic consequences and accident can have. At the same time, it is possible to discuss young people's attitudes to road safety.

Finally the in-depth studies also form part of the basis for systematic cooperation between authorities, companies and organisations which can influence road safety. This work method means that everyone takes responsibility for making improvements. This way of working is called OLA, an abbreviation based on the Swedish words for objective facts (O), solutions (L) and intentions (A).

Further reading

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Every year about 70,000 road traffic accidents occur in Sweden. Many people are injured. Attending to the casualties of road traffic accidents is a responsible and demanding task. It is important to focus the whole time on those who need help and to base the emergency response operation on their condition.

In order to do so in a medically correct and gentle manner requires knowledge, practical skills, patience and common sense. The fire brigade, police, emergency medical services and others involved have to be able to cooperate so that a satisfactory result is achieved.

Joint exercises and dialogue are required so that the various parties involved can learn about and understand one another's methods of working and their approach to the work.

Extrication from Cars during Road Traffic Accidents highlights extrication as an important part of this work.

The book presents various safety systems first, then goes on to describe the effect of various fuel types on the emergency response operation, the road environment, equipment, the organisation of rescue operations and extrication in accordance with various action plans. The book concludes with a chapter on post-emergency work.

Extrication from Cars during Road Traffic Accidents supplements literature and training in other areas, such as, emergency medical treatment, and is intended to provide fire brigade personnel with a firm foundation for attending to the casualties of road traffic accidents.

Extrication from Cars during Road Traffic Accidents was first published in 2007. This is a new edition with two completely new chapters on various fuels and road environment. In addition, sections on Euro NCAP, crash recovery systems, secure accident sites, and in-depth studies have also been added.