

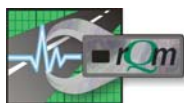
VEHICLE EXTRICATION

Extrication Strategy, Evolution Analysis & Management

Suitable for vehicle types:-



- 2/3 door car/hatchback
- 2 door car/coupe
- 2 door convertible/ragtop
- Sports car/roadster
- 4/5 door car/hatchback
- 4 door car
- 4 door estate car/station wagon
- MPV – people carriers
- 4x4 Jeep/SUV off-road
- 4x4 pick-up/SUV



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VEHICLE EXTRICATION

Extrication Strategy, Evolution Analysis & Management

Vehicle technology:

New designs, safety systems and steels and their implications:

In 1989 a sudden wind of change happened in the motor industry. The US federal requirement for a steering wheel airbag to be incorporated into all new vehicle designs was to influence the whole of the motor industry. The same initiative was introduced in Europe in 1993 along with a further addition, the seatbelt pretensioner. Although the initiative was intended for new vehicle design only, model upgrades also included frontal airbags and pretensioners.

By 1996 the emphasis was to change again when the crash worthiness of vehicles came under a more rationalised scrutiny. The 'Head-on' crash test was replaced by a 40% front off centre (Front $\frac{1}{4}$ oblique) impact test. The new independent EuroENCAP testing program was to expose the horrifying results of such tests at the mean speed of 40 MPH and side impact testing at 30 MPH. Additionally, low speed crashes saw the dash area of the car decimated by the reactive force of airbag deployment, where the cost of repair would have to be met by insurance companies.

Side impact strengthening and steel bars with high Rockwell hardness were introduced into door design and By 1998 new vehicle designs were beginning to incorporate a dash cross-member, meatier front door-posts and additional strengthening to the windscreen pillar.

In the light of occupant ejection and part ejection in roll-overs and side-on impacts, a further initiative was influenced by governments. The effort to reduce the road kill from such accident types would see the development of laminated glass and polycarbonate side glazing. To reduce occupant ejection and offer a much higher level of security to combat car crime, 2001 new vehicle designs would sport all-round laminated safety glass.



2003 new vehicle designs can incorporate:-

- Dash cross-member
- Multi generator steering wheel airbag
- Multi generator front passenger airbag
- Door airbags (Trim or window deploying)
- Seat airbag (Electronic or pyrotechnic)
- All position seatbelt pretensioners (Electronic or mechanical)
- Inflation curtains or head protection bolsters
- ROPS – roll-over protection system for convertibles and sports cars
- Boron steel bars and gussets for side protection
- Boron steel strengthening in windscreen pillars
- Boron steel seat brackets
- All steel front seat backs
- Strengthening cages to front footwells
- Fuel cells
- Dual fuel and bi-fuel systems
- Hybrid dual power
- 'Ready-Go'
- 'Keyless-go'
- 4 door pillar-less side construction (Centre posts built into doors with new locking system)
- Aluminum foam sandwich

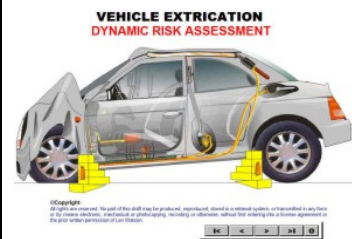
The number of new innovations such as glazing, motive systems and safety features incorporated within new motor vehicle designs, have created very real challenges for the rescue profession.

Working with live systems:

The necessity to be able to perform extrication evolutions with undeployed/live systems

Certain accident types will make it impossible for the rescuer to disconnect the battery and many extrications will have to be performed with live systems (i.e. under-rides, vehicle resting on its roof, battery located under trapped person etc).

Even where the battery is disconnected, capacitors for SRS, music centers and alarm systems can remain energized for some considerable time and will raise some concerns where certain extrication evolutions have to be performed.



When ramming or spreading modules can be crushed and some can detonate under pressure or from a sharp blow from a percussion tool or reciprocating saw.

A working logic

Vehicles can be realistically grouped so that in-built components and safety features will match their particular grouping. In most cases this will be fairly obvious. e.g. The 2 door as opposed to the 4 door car and the coupe as opposed to the sports car. However subtle differences in layout do exist between vehicle types and, for this reason, it is very necessary to adopt model type grouping that works for the purposes of risk assessment.

Vehicle types:-

- 2/3 door car/hatchback
- 2 door car/coupe
- 2 door convertible/ragtop
- Sports car/roadster
- 4/5 door car/hatchback
- 4 door car
- 4 door estate car/station wagon
- MPV – people carriers
- 4x4 Jeep - all terrain
- 4x4 pick-up/SUV
- Commercial vehicles

Crash types are also important, as the accident damage will directly relate to the methods employed to extricate the casualty.

Crash categorisation

- Head-on
- Front ¼ oblique
- Side-on
- Rear-shunt
- Vehicle on-its-side
- Vehicle on-its-roof

Extrication evolutions can alter the integrity of SRS, especially where the battery cannot be disconnected. It is essential to recognise how evolutions could possibly effect on-board systems and the likely implications they hold for rescuers. It is therefore necessary to be able to implement

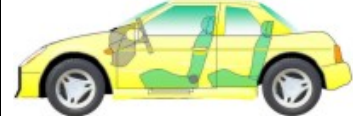
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Vehicle Types

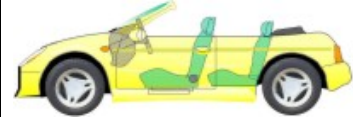
2/3 door hatchback



2 door car/coupe



2 door convertible



Sports car



4/5dr hatchback



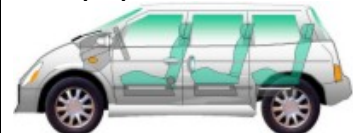
4 door car



4 door estate car



MPV – people carrier



4x4 Jeep/all terrain



suitable risk control measures for commonly practiced extrication evolutions.

Extrication evolutions

- Glass management
- Roof removal
 - Complete (IC/HPS)
 - Flap back (IC/HPS)
 - Side flat (IC/HPS)
 - Forward flap (IC/HPS)
- Door forcing
 - Forcing the doorlock (SIPS)
 - Forcing/removal from hinges (SIPS)
- Side removal
 - Centre post complete with rear door (SRS)
 - Centre post rip (SRS/SIPS)
 - 2 door: Side panel removal (SRS/SIPS)

Dash relocation

- Dash roll (SRS/SIPS)
- Dash Lift (SRS/SIPS)
- Steering wheel relocation (Dash cross-member)

Vehicle on-its-side

- Roof fold down (IC)
- Roof fold down (HPS)

Vehicle on its roof

- Inverted door forcing/removal
 - Inverted door forcing (SIPS/Fuel systems)
 - Inverted door removal (SIPS)
- Inverted side removal
 - Centre post complete with rear door (SIPS)
 - 2 door: side panel removal (SRS/SIPS)
 - Clam (Inverted ramming and cutting with IC)
 - Clam (Inverted ramming and cutting with HPS)

Generic risk assessment

The importance of 'Generic' risk assessment procedures must be stressed; as vehicles of the same model year may incorporate different components and batches e.g. SRS systems may be supplied by different manufacturers or upgraded to multi-generator modules. Customers' preferred options will always be an unknown quantity and cannot, by any stretch of the imagination be part of any planned precognition. This is the main reason why dynamic risk assessment is so significant. Not only does it offer a fail-safe, it allows for the situation whereby it is impossible to identify the exact model type or year of manufacture

Crash categories



Head-on



Front 1/4 oblique



Side-on impact



Rear impact (rear shunt)



Vehicle on-its-side



Vehicle on-its-roof

identify the exact model type or year of manufacture.

Solutions

Pry before you cut:

The policy of 'Pry before you cut': stripping the trim to pillars and posts to reveal the installation slots so that the exact position of SRS, SIPS and, where practical, sensors can be identified, is being universally adopted throughout the fire rescue service. When performing any extrication strategy it has now become mandatory to view and risk-assess prior to conducting any evolution that could possibly alter the integrity of any system that could cause injury.

Risk recognition is vital and Logic to address and manage risk requires a workable plan to identify, control and reduce all foreseeable risks.

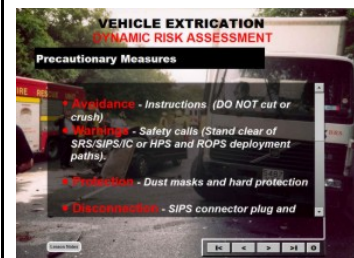
Where the battery cannot be disconnected, rescuers are going to have to work alongside live systems. As the motor industry as a whole has failed to address the issue of 'Rescue with compromised or live systems', rescuers have to make their own judgement calls and initiate suitable option measures – These measures include:-

Precautionary measures:

- **Avoidance** – *Instructions (DO NOT cut or crush)*
- **Warnings** – *Safety calls; stand clear SRS/SIPS/IC or HPS and ROPS deployment path (Safe distance rule - 500 /250 /150mm [20 /10 /6 inch]).*
- **Protection** – *Dust masks and hard protection*
- **Disconnection** – *SIPS connector plug and module disconnection*
- **Isolate/Cut**– *Use an *insulated wire cutter to cut SRS wiring or a strategic safety cut to isolate pyrotechnic lines. *See - [SRS smart systems LOGIC](#)*
- **Safety cuts** - *Cuts to air curtains and HP bolsters*
- **Extrication options** – *Various evolution strategies to reduce possible hazardous outcomes.*

Risk critical information

Under the circumstances discussed, recognising the importance of certain information, which can be considered 'risk critical', is an absolute necessity. Possible hazardous outcomes, especially as a result of rescuers' action must be a known quantity and, wherever possible, risk managed. It is therefore essential that all rescuers be made aware of all



risk critical information and their risk control measures.

For the control measures already mentioned to be initiated and adhered to, there must be a high degree of acceptance amongst rescuers that the perceived risk is real until proven otherwise.

Evolution options

When performing specific evolutions, the various extrication options and likely perceived risk/s must be quantifiable and, because of the varied nature of MVA rescue, the ultimate decision must remain with the Incident Commander.

Available 'Options' for respective evolutions, allow a degree of flexibility and can offer the solution to an otherwise high-risk situation, but be aware; there is a 'time' implication.

Evolution options amount to the performance of a technique or evolution using the 'Precautionary measures' outlined below. e.g. When removing a roof structure incorporating electronic inflation curtains we can employ several options to control, reduce or avoid perceived risk. After risk identification is performed and appropriate risk control measures implemented, conduct –

Option 1 – Perform roof removal taking the following precautionary measures -

- **Avoidance**
- **Warnings**
- **Protection**

***RISK - Liberation of window housing and sharp edges to roof pillars. Possible deployment of SIPS and pretensioner/s (Short-circuit). Liberation/Deployment of propellant through inadvertent cutting**

Option 2 - Perform roof removal taking the following precautionary measures in addition to Option 1 -

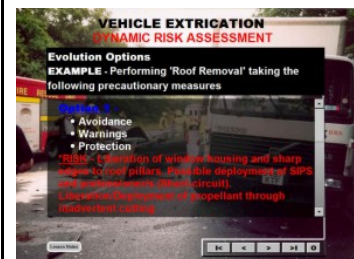
- **Disconnection**
- **Isolate/Cut.**

***RISK - Liberation of window housing and sharp edges to roof pillars. Possible deployment of SIPS and pretensioner/s (Static discharge). Liberation/Deployment of propellant through inadvertent cutting**

Option 3 - Perform roof removal taking the following precautionary measures in addition to Option 1 & 2 -

- **Safety cuts – Conduct safety cuts and conduct**
Option 1 or 2

RISK - In the event of deployment (PAD), subsequent hot gas release from strategic cut to side channel and IC.



Casualty v Risk

Within fire departments the enigma of casualty versus risk for MVA rescues has, for the most part, been left either unwritten or understated. The nearest we get to a real understanding is when the Paramedic or Doctor says, “We need the casualty out now”.

Where an ‘Immediate release’ or ‘Rapid extrication’ is called for, it has become accepted practice to either manoeuvre the casualty free or speed up the extrication by releasing any pinning or making the minimal space to lift the casualty from the wreckage.

Rescuers now find themselves with a new dilemma in the equation of ‘casualty v risk’. Not just the risk that the critical patient faces having lower limbs manipulated free or being manoeuvred through a restrictive opening, but the risks that can now be associated with certain space making, ‘rapid extrication’ techniques.

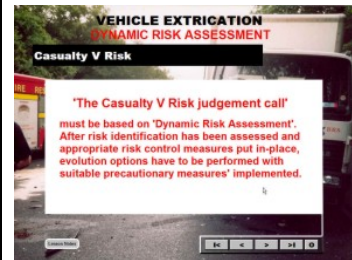
In terms of safety, ‘Rapid extrication’ techniques must be a known measure and have to be dynamically risk assessed; otherwise, by their very actions, Rescuers are admitting that they are working blind and are ignoring the hazards that may be present.

The Casualty V risk judgement call must be based on ‘dynamic risk assessment’. After risk identification has been assessed and appropriate risk control measures put in-place, evolution options have to be performed with suitable ‘precautionary measures’ implemented.

Dynamic Risk Assessment

When inspecting a late model vehicle, look for any telltale stickers, signs, marks and indicators, and identify and take note of the exact position of any likely hazard.

To realistically manage risk in today’s vehicles, vital information on relevant systems must be quickly identified and fully understood in terms of extrication strategy. This necessitates a functional logic for:-



- Battery Supply
- Fuel Systems
- SRS – Supplementary Restraint Systems
- Gas struts
- Locks
- Seating
- Doors

Initial vehicle assessment must look for these indicators:-

- **Ignition** – Key, ‘Ready-go’, ‘Keyless-go’
- **Motive power** - Petrol/Diesel/Gas/Electric/Hybrid
- **Fuel filler cap** - *Its position will assist you in locating the fuel tank. Also look for LPG/CNG filler and stickers.*
- **Fuel tank location** - *If the fuel tank is not underslung under the seat-squab/floorplan or luggage compartment, it is likely to be positioned on either side of the trunk/boot space.*
- **Engine configuration** - *Straight/in-line or side-on/Transverse*
- **Glass type** - *Toughened/Laminated/Plexiglass/Polycarbonate*
- **Airbag and pretensioner indicators** - *Look for anagrams and motifs/moldings- SRS, SIR Airbag, SIPS, IC, HPS and ROPS and convoluted rubber moldings to buckle pretensioners*
- **Gas struts** - *You can anticipate their inclusion in the tailgate*
- **Seat adjustments and other indicators** - *Electric, manual, active, seat mounted pretensioners and airbags*



Identifying these indicators will help considerably when assessing critical risk information and understanding ‘risk critical’ implications. When planning strategy and performing extrication evolutions, a methodical plan will greatly assist in identifying the risk posed by the vehicle's electric and fuel systems, SRS, SIPS and locking systems. Seat construction and adjustments, and in-built SRS/SIPS, door design incorporating airbags and strengthening bars etc., will all have a direct bearing on extrication strategy. Vehicles incorporating new design technology and safety systems require preplanned risk control measures and dynamically risk-assessed operating procedures essential to safe working practices.

If we accept the logic, that vehicle types differ in respect of the layout of their electrical and safety systems, and that

crash categories dictate extrication strategy to a large extent, we can then appreciate the growing scale of the problems now facing rescuers. It can then be appreciated that the solutions are not just a simple matter of common sense. On the contrary, the lack of solutions have led to the growing concern for the 'health and safety' of both rescuers and casualties alike, where the extrication has become an altogether more complex issue.

Vehicle extrication – dynamic risk assessment and management needs a support mechanism and workable solutions. Today rescuers cannot possibly carry all the necessary information around inside their heads and be expected to always make the correct judgment call whilst under severe pressure.

The rescuer needs help: not tomorrow but now! We live in the age of information technology and instant access to relevant and safe codes of practice to support internationally used extrication evolutions is essential, both to sustain and improve performance levels.

The understanding we hold also has a bearing on a fire department's preparedness training. Currently 'end of life vehicles' used for training purposes incorporate little or no supplementary safety systems. This will gradually change to where 'end of life' vehicles incorporate SRS. The question now arises, do we make it mandatory to remove such systems before we commence a training exercise and miss out on the positive advantage that training with such systems offer.

As it is not always possible to disconnect the battery at the scene of operations, many 'real time' extrications will have to be performed with live systems (i.e. Under-rides, vehicle resting on its roof, battery located under trapped person etc). It is possible and can be seen as essential to safely conduct 'real' training with live systems. If the risk factor is properly assessed and precautionary measures fully implemented, extraordinary training of this nature can be safely managed and undertaken as required.

Consider – The alternative will necessitate rescue crews meeting the challenges of 'real time' rescues without having

any first hand knowledge, or at best, classroom instruction to help guide them through the extrication process.

What can the passive car 'end of life' vehicle really offer the student in terms of extrication training? Also, to prepare an SRS equipped vehicle, as a 'passive car', is likely to prove cost prohibitive and would incur its own 'health and safety' implications in terms of module removal and disposal.

It can be argued that the passive car can be suitably prepared with purpose-designed stickers to replace the removed modules, but again there is the preparation and cost implication.

CBT – Computer based training, information technology and simulation

CBT has much to offer in the way of an information centre for - risk identification, control measures, risk critical information and extrication evolutions options that take account of vehicle types, new technology and crash categories. It is not enough to be able to identify the risks involved, the rescuer must be able to eliminate, reduce or mitigate risk in order to over-see and effectively manage the operation.

This also applies to training managers, perhaps even more-so, as they have the greater role to play, especially with students who may have little or no previous experience or familiarisation. In fact CBT may offer the only solution that can address all the issues involved and underwrite both operational and training needs. With the possibility for 24/7 workstation and fire-truck tablet availability, immediate access to an information centre for risk identification, assessment and extrication evolution management would appear to offer the ultimate solution to an otherwise seemingly insurmountable problem.



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