Submission No 29

MOTOR VEHICLE REPAIR INDUSTRY

Organisation: Delta-V Experts

Name: Dr Shane Richardson

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Delta-V Experts

The Committee Manager

Select Committee on the Motor Vehicle Repair Industry

Parliament House

Macquarie St

Sydney NSW 2000

Submission to the New South Wales Parliamentary Motor Vehicle Repair Industry Inquiry

To whom it may concern,

Delta-V Experts is an independent Forensic Engineering consultancy based in Melbourne, Victoria and has expertise nationally and internationally in:

1. Investigating and reconstructing collisions for civil proceedings and criminal proceedings (for both the Plaintiff and Defendant);
   a. Reconstructing collisions both for and against insurance companies, including: Transport Accident Commission (TAC), Motor Accident Insurance Board (MAIB), AIG, QBE, CGU, RACT, RAC, NRMA, Club Marine, Western Australia, RACV, Suncorp, GIO, AAMI, APIA, NTI, Zurich and others;
   b. Investigating insurance fraud (for and against insurance companies) QBE, CGU Zurich and others .
2. Determining liability for insurance purposes.
3. Investigating and documenting mining, workplace and industrial incidents both for and against insurance companies.

As a result of ongoing forensic engineering investigations Delta-V Experts have developed specific experience in relation to insurance related accidents and associated repairs. This arises from:

1. Regularly entering vehicle repair workshops to inspecting damaged vehicles, vehicles undergoing repairs or repaired vehicles across Australia and within NSW;
2. Conducting crash tests;
3. Evaluating the structural performance of crashed vehicles.

In the past 12 years Delta-V Experts have undertaken consulting projects for the following::

1. BHP Billiton (Iron Ore, Nickel West, BECSA, GEMCO and ICAMS);
2. Rio Tinto (Mobile phone usage and Traffic management plans);
3. Pacific National (Crash investigations and Black boxes);
4. Alinta Energy (Fire cause and failure investigations and evaluation of vehicles);
5. Parmalat (Chain of responsibility);
6. Visy (Chain of responsibility training, OH&S training, Truck law training and assessment of machine manning);
7. Australia Post (Vehicle selection assessments and Failure investigations);
8. Department of Foreign Affairs and Trade (Vehicle selection assessments and Failure investigations);
9. Department of Sustainability Victoria (Testing and evaluation of vehicles);
10. Department of Defence (Vehicle risk assessments, Vehicle handling and Crashworthiness analysis);
11. Hume City Council (Motorcycle road safety audits);
12. Patrick Logistics (System safety review);
13. Victorian Transport Association (Training);
14. Australian Centre for Agricultural Health & Safety (Testing Quad bikes);
15. Brisbane Water (Testing and evaluating vehicles);
16. Ergon Energy (Testing and evaluating vehicles);
17. Racing Victoria (Testing and evaluating running rail systems);
18. Roads & Traffic Authority NSW (Snow clearing vehicles);

19. SafeDrive International (Evaluating, designing, supervising manufacture and installation of vehicle safety systems in the Oil, Gas and Exploration sector internationally);
20. VicRoads (Motorcycle road safety audits, Pole protection systems and Rumble strip trials);
21. Yarra Trams (Collision investigations);
22. As well as other entities.

Delta-V Experts have also undertaken consulting projects work for; The National Motor Vehicle Theft Reduction Council, Suncorp Group, Capital SMART Repairs and QPlus Production, which is closely related to the Inquiry questions. These inspections and audits have enabled Delta-V Experts to:

1. Inspect damaged (crashed), repaired and undamaged vehicles;
2. Assess safety devices and features;
3. Assess repair processes from an engineering perspective.

Delta-V Experts, in this work estimates it would have audited, evaluated, reviewed or been within more than 200 repair facilities across Australia, with a many in NSW within the past 3 years. The inspections and audits of repair workshops have focused on process, documentation, equipment, training, and the safety and quality of the repairs and, therefore places Delta-V Experts in an excellent position to provide a submission to this Inquiry. Some of the findings for this work are outlined below.

National Motor Vehicle Theft Reduction Council

The National Motor Vehicle Theft Reduction Council contracted Delta-V Experts in January 2010 to research and revise the Statutory Write-Off Criteria in 2010, based on structural damage to vehicles. The work undertaken by Delta-V Experts resulted in the Statutory Write-Off Criteria being adopted either in full or part across Australia. (Refer to Appendix A; Society of Automotive Engineers Paper 2012-01-0576 '*The Development of the Current Australian Statutory Write-Off Criteria for Damaged Vehicle Repair*' presented at the 2012 Society of Automotive Engineers World Congress, Detroit, USA).

Suncorp Group

Delta-V Experts were contracted in July 2012 by Suncorp Group to conduct a number of independent assessments and audits of various 'heavy hit' vehicle repair shops around Australia, as identified by Suncorp. The audits were conducted from an engineering perspective, to ensure that a vehicle was repaired in such a way that it was returned to its pre-collision state and would be safe to drive.

Based on the inspections, Delta-V Experts assisted Suncorp in the development of a best practice guide which was further refined into the Vehicle Repairer Standard currently used by Suncorp Group with its recommend repairers. This standard sets out minimum requirements for repair shops in order to safely repair motor vehicles.

It should be noted that the Suncorp Vehicle Repairer Standard was recognised (Highly Commended) in the 2013 Society of Automotive Engineers – Australasia Engineering Excellence Awards.

Capital SMART Repairs

Delta-V Experts were engaged by Capital SMART in April 2013 to review the process undertaken in its facilities. A number of days were spent in the Capital SMART repair shops across Australia, and in NSW and Delta-V Experts concluded that:

1. Capital SMART **do not undertake** any repairs to safety related parts such as steering, brakes, suspension, chassis, restraint devices or any structural or integral components of vehicles;
2. Significant repairs (large, time consuming repairs) or repairs requiring chassis alignment or body straightening were **not undertaken**;
3. Capital SMART **do undertake** cosmetic repairs such as scratches, bumper replacements, dent removal and bolt on part and trim replacement/repair;
4. During the time spent at Capital SMART, a number of vehicles were rejected from the Capital SMART system on the basis that the repairs exceeded criteria of the Capital SMART process (i.e. may have involved a safety related or structural component).

It was identified that Capital SMART were able to repair large volumes of vehicles due to the setup of the shop (specifically the workflow) and a focus on a particular type of repair.

No issues were identified where shortcuts were taken by Capital SMART to finish a vehicle on time.

Delta-V Experts observed:

1. That the vehicles being repaired in the Capital SMART system were small repairs which could be completed quickly.
2. Multiple examples of vehicles being removed from the Capital SMART repair process, because vehicle damage was beyond the scope of Capital SMART. The damage beyond the scope of Capital SMART was identified either during the initial inspection at Capital SMART or during the repair process.

The repairs undertaken by Capital SMART did not impact on the safety devices or the structural safety systems of the vehicles.

Capital SMART has designed a workflow which works efficiently and is tailored to work with cosmetic and minor repairs. The initial inspection of the vehicle at Capital SMART is critical to the efficient and economic repair of the vehicle. Capital SMART did not repair vehicles with structural damage but focuses on cosmetic damage or minor damage to vehicles. As a result, Capital SMART has been able to streamline the processes to suit minor and cosmetic repair tasks. Hence Capital SMART is able to organise the flow of vehicles through the shop and optimise the workflow to repair vehicles in an efficient and timely manner.

QPlus Production

QPlus was audited against the Suncorp Vehicle Repairer Standard QPlus undertakes heavy hit repairs (non-driveable) where safety devices or structural components were being repaired.

Key elements of the QPlus repair process were that all vehicles repaired were repaired by following either the repair manuals or other acknowledged repair guides (such as Thatcham Methods) which were given to the repair technicians. No repair was undertaken without the use of a repair guide.

Over multiple visits a number of days were spent at QPlus where it was identified that repair technicians were following the provided repair guides when repairing the vehicles. The repair quality was high, with good quality welding and finishing identified on all vehicles.

The processes and procedures at QPlus were in compliance with the Suncorp Vehicle Repairer Standard with well documented and implemented methods. Various checks were undertaken following each step of the repair process. The repairs viewed and assessed were of high quality with no safety or quality issues identified. QPlus had an abundance of equipment available to the repair technicians which would enable them to correctly complete a repair.

QPlus was audited against the Suncorp Vehicle Repairer Standard and achieved a very high score, which is well above what other repairers that Delta-V Experts have visited would achieve.

QPlus have designed a workflow process which works within QPlus and is tailored to work with heavy hit (non-drivable) repairs. As a result, QPlus was able to streamline their processes to suit the repair tasks. This means that QPlus was able to organise the flow of vehicles through the shop and optimise the workflow process to repair vehicles in an efficient and timely manner.

RESPONSE TO INQUIRY TERMS OF REFERENCE

Based on Delta-V Experts experience and knowledge the following Inquiry Terms of Reference will be addressed within this submission:

1. "*Smash repair work and whether it is being carried out to adequate safety and quality standards;*"
2. "*The business practices of insurers and repairers, including vertical integration in the market, the transparency of those business practices and implications for consumers*;"

Smash repair work and whether it is being carried out to adequate safety and quality standards

It is Delta-V Experts' experience that the majority of smash repair work it is being carried out to adequate safety and quality standards. However, there remain no defined repair safety and quality standards consistently applied across the industry.

Rather, there are individual methods of operation which result in a variety of outcomes in terms of both safety and quality. Manufacturer methods appear to be the most common form of methodology applied, but these are inconsistently applied in practice. There is wide variation in understanding of the term 'industry standards'.

In general terms there are three levels of collision damage:

1. Cosmetic;
2. Non-structural;
3. Structural.

The typical practice within the repair industry is to provide repairs across each of the three levels of repair within one repair workshop, which then requires the repairer to hold the capabilities (workshop, tools, equipment, personnel, knowledge and experience) to undertake the three levels of repair. Some repairers have demonstrated the ability to do this and provide repairs that are both safe and to a high standard of quality the larger repair work does require a higher level of skills, equipment and training.

The issue of quality of the repair is applicable across all three levels, whereas the issue of safety is applicable predominantly to structural repairs (non-drivable). Vehicles which have sustained either cosmetic or non-structural damage by definition should not have damage to the structural safety systems.

<u>Recommendation</u>: The Suncorp Vehicle Repair Standard or a similar (well researched and engineering verified) methodology should form the basis of a NSW repair standard or authorised process for each repair.

<u>Recommendation</u>: Manufacturers should as part of their import licence be required to provide technical repair information to the independent repair sector as the best means to ensure processes are correctly and appropriately followed.

The business practices of insurers and repairers, including vertical integration in the market, the transparency of those business practices and implications for consumers.

Delta-V Experts has independently reviewed, evaluated or audited the Suncorp joint venture facilities of both Capital SMART and QPlus. We found that the quality of the repairs is comparable or better with other leading repairers. Capital SMART does not conduct structural repairs, whereas QPlus do structural repairs.

Both Capital SMART and QPlus have presented to Delta-V Experts that their optimised work process and their focus on specific types of repair, allows for a the fact that their overall cost per repair is lower than the traditional repair workshop, while maintaining high standards of quality and safety.

The implication for consumers is that the cost of repairs should be reduced, which should as we understand it, positively influence overall premium costs to consumers in the long run. However the economic detail will need to be presented independently by Capital SMART and QPlus.

<u>Observation</u>: From Delta-V Experts' perspective there are no safety or quality issues with either Capital SMART or QPlus.

CONCLUSION

Delta-V Experts welcomes this NSW Parliamentary Inquiry and its focus on safe, high quality repairs to ensure consumers are appropriately protected. It is Delta-V Experts' view that smash repair work is being carried out to a high standard in the majority of smash repair facilities, however, to drive consumer and regulatory confidence in the repair sector a defined repairer standard is needed nationally.

Delta-V Experts see no evidence that well equipped, well organised repair facilities set out to do a poor repair job. They appear in the most part to be doing the best they can with the information available to them. However, Delta-V Experts submit that the repair industry need some assistance to ensure that correct information, training and a regulated standard are available to assist them in improving repair outcomes.

Delta-V Experts see that insurer vertical integration programs appear, at this stage, be part of the industry's path to improvement. It is Delta-V Experts experience of the programs evaluated that they are producing high-quality repairs and repair oversight.

Delta-V Experts is happy to discuss its independent work in the automotive repair industry further should the Committee wish to obtain further clarification on any of the issues raised in this submission.

Dr Shane Richardson
Principal Forensic Engineer (Managing Director)
Delta-V Experts

About Delta-V Experts

Delta-V Experts have investigated a number of high profile incidents such as the Trawalla and Waterfall rail accidents, the Swanston St wall collapse, 2006 Bus rollover in Egypt, various mining injuries and fatalities throughout Australia and internationally and high profile criminal driving cases.

In addition to the Forensics, Delta-V Experts also:

1. *Conduct objective vehicle handling assessments for Victoria and NSW Police, evaluating all of the Police fleet vehicles.*
2. *Design, develop and test Roll Over Protective Structures (ROPS) for a range of Mining and Exploration vehicles. Delta-V Experts created a company in South Africa (Delta-V Experts SA) in 2009 after working with several companies in South Africa from 2005. Delta-V Experts has ROPS manufacturing arrangements with companies in Colombia, USA and the Netherlands.*
3. *Developed with Proof Engineers (based in Queensland), an objective methodology to collect and process daily road data to evaluate both road roughness and transients (potholes) for Mining and Road Authorities.*
4. *Is developing systems to instrument and analyse sporting equipment.*
5. *Provide engineering design and analysis services as required.*
6. *Sell in vehicle monitoring systems and crash analysis software.*
7. *Conduct maintenance audits of transport and mining organisations.*
8. *Published and presented both nationally and internationally on quad bike safety, yaw analysis, crush analysis, statutory write-off criteria, development of repair guidelines for heavy hit repair, cost of repair parts, truck suspensions, hail damage, pedestrian impact and other matters.*

Delta-V Experts staff have conducted, supervised and been involved in crash tests at Crashlab and Autoliv, as well as crash tests between vehicles and objects to demonstrate and illustrate the behaviour of vehicles and vehicle structures when involved in a collision(s). Delta-V Experts have conducted virtual crash tests and crash simulations. Delta-V Experts annually attend crash testing days held at DSD, Linz, Austria.

Appendix A – Statutory Write-Off Criteria

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The Development of the Current Australian Statutory Write-Off Criteria for Damaged Vehicle Repair

Shane Richardson
Delta-V Experts

Geoff Hughes
NMVTRC/CAR-SAFE

Tandy Wei Pei Pok, Nikola Josevski, Tia Orton and Chris Jones
Delta-V Experts

ABSTRACT

Within Australia there are seven States and two Territories, each with their own Government Authority which were until recently all using slightly different criteria to define the criteria between a Repairable Write-Off (RWO) and a Statutory Write-Off (SWO).

Under the national framework for the management of Written-Off Vehicle's (WOV's) developed by the National Motor Vehicle Theft Reduction Council (NMVTRC) any collision, fire, water or weather-event damaged vehicle declared by an insurer to be a total loss must be classified to be either a SWO or RWO. Under the current Australian regime a SWO may only be sold subject to a statutory restriction that it may only be used for parts or scrap metal. A RWO may be repaired and re-registered subject to the vehicle passing specific safety and identification inspections. A set of State and Territory based technical criteria determine when a WOV should be classified an SWO. A national workshop in June 2009 resolved that the pre-2010 criteria were in need of urgent updating to better reflect contemporary vehicle design and fabrication techniques and to make the system more impervious to manipulation by criminal networks. In late 2009 the NMVTRC engaged a group of vehicle engineers to work with stakeholders to develop new criteria to meet the current and future needs.

Draft criteria were circulated for comment in May 2010. Stakeholders were briefed on the draft criteria and during the comment period stakeholders made submissions. In general terms, the comments received indicated there was significant consensus about much of the proposed draft criteria and a high level of consistency in comments on those elements which required clarification or re-working.

Revised draft criteria were evaluated in the field by a group of experienced assessors to evaluate and gather empirical evidence as to the likely impact of the new criteria on the prevailing ratios of RWOs to SWOs. The trial found that:

- Application of the draft criteria could shift up to 30% of vehicles currently classified as RWO's to SWO's (i.e. parts or scrap only);
- With only slight modification the revised draft criteria could effectively remove all classes of damage considered to pose a structural repair risk from the RWO category;
- The principle of separately counting like areas of unconnected damage in determining whether a vehicle has the three areas of damage required to render it a SWO did not have any undue or disproportionate impacts on the vehicle classification process; and
- The draft criteria were generally clear, unambiguous and therefore relatively simple to apply once familiar with them.

Some refinements to the final criteria were, however, proposed to ensure their consistent application and have been included in the developed SWO criteria.

The developed SWO criteria which is being used in Australia to characterise vehicle damage is presented within this paper.

CITATION: Richardson, S., Hughes, G., Pok, T., Josevski, N. et al., "The Development of the Current Australian Statutory Write-Off Criteria for Damaged Vehicle Repair," *SAE Int. J. Passeng. Cars - Mech. Syst.* 5(1):2012, doi: 10.4271/2012-01-0576.

INTRODUCTION

The authors were engaged to review the existing SWO criteria from a vehicle safety perspective. The objective was to:

- Consult with affected parties;
- Re-evaluate the pre-2010 SWO criteria to take account of changes in design and repair techniques to ensure that vehicles which should not be repaired on safety grounds are classified appropriately; and
- Develop recommendations for a new set of SWO criteria that achieve that end.

The authors were assisted by an Expert Reference Group (ERG) of affected parties established especially for this purpose by the NMVTRC. The ERG comprises twenty-one stakeholder representatives drawn nationally from a cross-section of transport agencies, police, insurers, and the motor trades. Discussions were also held with a range of other select organisations with an interest in related issues.

Section 1 sets the basic considerations and environmental factors which influenced the development of the current criteria. This includes:

- A description of the pre-2010 criteria and classification process;
- A discussion of the relative design characteristics of 1980-1990s vehicles with their successors; and
- Alternative options considered in developing the proposed method of approach.

Section 2 discusses in detail why in key areas the pre-2010 criteria are adjudged to be deficient and outlines how they may be modified to better meet the system's needs.

Section 3 details the developed SWO criteria that has been introduced and is being adopted in six States and two Territories in Australia (New South Wales has not adopted the SWO criteria).

SECTION 1. BASIC CONSIDERATIONS

PRE-2010 CRITERIA

The pre-2010 SWO criteria was developed in the mid-1990s initially in New South Wales by the Roads and Traffic Authority and later adopted by the NMVTRC and the other jurisdictions as the 'national' criteria.

A vehicle declared by an insurer to be a total loss must be assessed against a set of technical criteria to determine its status as a RWO or SWO. A SWO may only be sold subject to a statutory restriction that it may only be used for parts. A RWO may be repaired and re-registered subject to the vehicle passing specific safety and identification inspections. The current assessment criteria cover impact, fire and water damage and the deliberate stripping of parts.

The existing criteria represent a good starting position and the fundamental basis for the criteria when first developed was sound. However, there are weaknesses with the existing system. They include:

- The structural damage criteria:
  - Which is open to interpretation, has resulted in vehicles that are suitable only for dismantling being classified as RWOs (Gribble [1]). Vehicle rollover crashes were identified by some members of the ERG as a crash type that does not explicitly get identified within the current criteria. Rollover crashes can result in damage to multiple pillars and the vehicle roof. An interpretation of the current criterion is that rollover damage to the roof and pillars can be collectively interpreted as meeting only one of the three required areas of damage for an SWO classification.
  - Rely heavily on the training, skill and experience of the assessors to appropriately interpret the pre-2010 criteria. In the discussions held with some representatives of the insurance industry and others during the ERG meetings, the lack of a recognised qualification for a vehicle 'assessor' was discussed. The larger insurers identified a preference for recruiting assessors with an automotive repair trade background and who in most cases, required supplemental training. It is also common for insurers to use outsourced service providers whose employees' skill sets are not within the insurer's direct control. (There are organisations and associations which provide assessors with on-going training and development. Greater co-ordination in curriculum development between these organisations and associations would assist to improve consistency.)
  - The area criteria of 300mm ×300mm has not maintained pace with advances in vehicle manufacturing techniques such as the use of boron steel, laser welding and/or composite construction. It is possible that a boron steel member could be catastrophically damaged, with a damage area less than the 300mm ×300mm requirement. The current vehicle roof, firewall and floor panels are structural elements in a modern vehicle. Bernquist [2] illustrated this in his presentation on the design of the Volvo XC90, at the '*Great Designs in Steel Seminar*' by autosteel in 2004. The presentation details that:
    - "*A rigid framework surrounding the occupants which creates a support for the interior safety equipment and provides a survival space for the vehicle occupants in case of a crash*".
    - Side Impact Protection System has existed since 1991 and minimises the intrusion by amongst others "*transverse floor/roof members*".
    - The front structure includes the "*cross member firewall*".

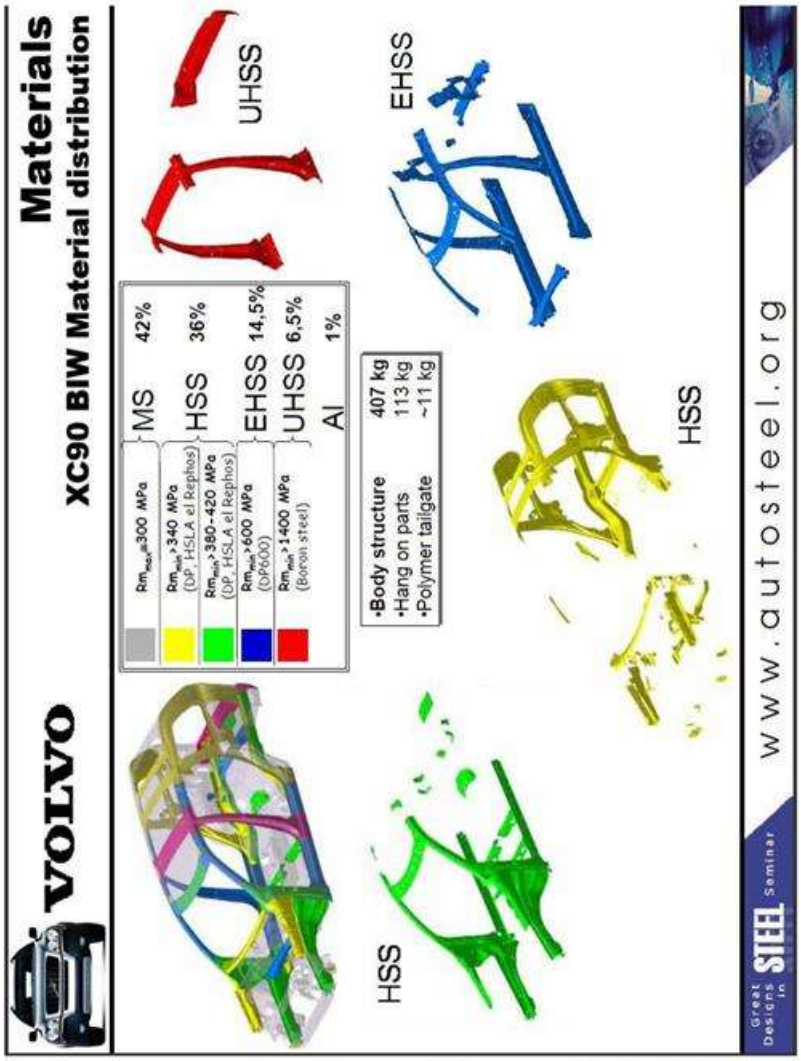

Figure 1. Extracted from Berquist presentation and illustrates the different structural steels used in the Volvo XC90. Note that the roof, firewall and floor pan are included as structural elements and that they're reinforced by higher strength steels.

- Figure 1 is extracted from Berquist [2] and illustrates the different structural steels used in the Volvo XC90. Note that the roof, firewall and floor pan are included as structural elements and that they are reinforced by higher strength steels.

  - Defines an area amount of damage to be sustained to the roof turret, floor pan and firewall, rather than defining an amount of damage which is unacceptable from a safety perspective per se.

  - Does not define damage to the structural rails/chassis of the vehicle or to the suspension attachment points.

- Does not utilise the deployment of airbags as an indicator of severe loading of the vehicle structure.

• There are no detailed criteria for the amount of acceptable fire damage.

• There is a difference in the current criteria between a vehicle immersed in salt water as opposed to fresh water. A vehicle immersed in salt water up to the door sills is a SWO, whereas a vehicle submersed in fresh water up to the dash for less than 48 hours can be a RWO. When the current criteria were developed the positioning of key electrical and electronic system were limited to the under dash area. However, in current vehicles such systems are distributed all over the vehicle, including as low as the cabin floor. As a consequence, the water resistance or water proof properties of such systems require validation.

An advantage of the pre-2010 criteria is its relative simplicity.

VEHICLE MANUFACTURE

McIntosh [3] states that the: "*Australian fleet is ageing with the average vehicle over ten years old*". Anderson [4] identified that the mean age of the Australian passenger car fleet was 9.9 years. It can be inferred that when the pre-2010 SWO criteria was developed (the mid-1990s), it was based on the Australian vehicle fleet at the time i.e. late 1980's or early 1990's. The design, manufacturing methods and electronics used in the majority of vehicles within the Australian fleet at that time could be characterised as:

• The fundamental vehicle structure would have been manufactured from press formed steel panels. The steel panels would have had a yield stress of 200MPa to 350MPa, and there would have been limited uses of high strength steels or other materials. The steel panels would be spot welded together.

• Crashworthiness requirements focused on the design and compliance of components within the vehicle such as:

- Seats and Seat Anchorages Australian Design Rule (ADR) 3.
- Seatbelts ADR 4.
- Steering Column ADR 10.
- Side Door Strength ADR 29.

• The electronics would be limited to the engine management system.

From circa 2000, the design, manufacturing methods and electronics used in the majority of vehicles within the Australian fleet could be characterised as:

• The fundamental vehicle structure is manufactured from formed parts.

- The majority of metal parts are pressed, however hydro-forming is used to create some formed parts.
- There is a range of steel used which have yield stresses which range from 150MPa to over 800MPa.
- Structural foam and structural plastics are increasingly used.
- The bonding techniques used in vehicles to connect structural elements include:
  - Spot welding.
  - Fasteners.
  - Adhesives.

• The crashworthiness requirements have increased to include evaluations of the vehicle as a whole system:

- Full Frontal Impact Occupant Protection ADR 69 (48km/h impact by the test vehicle into a rigid barrier).
- Dynamic Side Impact Occupant Protection ADR 72 (either: a 50km/h side impact by a 950kg deformable barrier into a stationary vehicle or a 54km/h 27° crabbed side impact by a 1360kg deformable barrier into a stationary vehicle).
- Australasian New Car Assessment Program (ANCAP):
  - Full Frontal (56km/h impact by the test vehicle into a rigid barrier).
  - Frontal Offset (64km/h impact by a test vehicle with a 40% overlap into a deformable barrier).
  - Side Impact (50km/h side impact by a 950kg deformable barrier into a stationary vehicle).
- Vehicle manufacturers have developed criteria to simulate vehicle collision and to conduct crash tests.

• Electronics are used extensively in engine management, transmission control, traction control, braking systems (Anti-lock Brake Systems (ABS)), airbag and seatbelt pre-tensioner deployment.

In 2010, the design, manufacturing methods and electronics used in the majority of vehicles could be characterised as:

• The fundamental vehicle structure is manufactured from formed parts.

- The majority of metal parts are pressed, however hydro-forming is a technique which is also used to create formed parts.
  - Tailored rolling is a new technique which allows smooth and quick transitions from one thickness to another. It involves creating a blank with various thicknesses which are then pressed or formed into the final shape.

- There are a range of metals (Steel and/or Aluminium) used which have yield stresses which range from 150MPa to over 1000MPa.
- Structural foam and structural plastics are now commonly used. The foams and plastics can be using in isolation, in combination with one another or the structural metals.
- The bonding techniques used in vehicles to connect structural elements include:
  - Spot welding.
  - Laser welding.
  - Fasteners.
  - Adhesives.

• The crashworthiness requirements have increased to include evaluations of the vehicle as a whole system:

- Full Frontal Impact Occupant Protection ADR 69 (48km/h impact by the test vehicle into a rigid barrier).
- Dynamic Side Impact Occupant Protection ADR 72 (either: a 50km/h side impact by a 950kg deformable barrier into a stationary vehicle or a 54km/h 27° crabbed side impact by a 1360kg deformable barrier into a stationary vehicle).
- Offset Frontal Impact Occupant Protection ADR 73 (56km/h impact by a test vehicle with a 40% overlap into a deformable barrier).
- ANCAP conducts 4 internationally recognised crash tests:
  - Frontal Offset (64km/h impact by a test vehicle with a 40% overlap into a deformable barrier)
  - Side Impact (50km/h side impact by a 950kg deformable barrier into a stationary vehicle)
  - Pole Test (29km/h side impact by a test vehicle mounted on a trolley into a rigid pole)
  - Pedestrian (40km/h impact)
- Vehicle manufacturers have developed criteria to simulate vehicle collision and to conduct crash tests.

• Electronics are used extensively in engine management, transmission control, braking systems (ABS, brake force distribution), collision avoidance (Electronic Stability Control), airbag and seatbelt pre-tensioner deployment, parking assistance (proximity sensing, reversing cameras), seat positioning, driver information display, tyre pressure sensors, etc.

The fundamental changes which have occurred and are occurring in the Australian passenger vehicle fleet from the late 1980's to present are:

• The move to using:

- More high strength, ultra high strength and boron steels to achieve improved structural performance and/or to reduce mass.
- Composite structures (combination of metals, foams, plastics and other materials).

• The increasing use of electronics.

• The increasing consumer, manufacturer and regulatory requirements for safety.

• The consideration of environmental impacts on the build, operation and disposal.

Any new SWO criteria need not only to address the existing Australian passenger vehicle fleet but the future vehicle fleet to ensure that it remains relevant.

INITIAL CONSIDERATION

An initial consideration by the authors was to create an evaluation system based on rating classes of vehicles by their relative safety-related design characteristics, e.g. Class A, B, C etc. The individual criteria would be based on a vehicle's crash performance and methods of manufacture. Within the classes there would be different levels of sustainable damage criteria for different types of collision, such as:

• A lateral pole impact to the driver side door:

- A 2010 Audi TT could sustain up to 120mm deformation to the vehicle body in a lateral pole impact yet still be structurally sound, whereas
- A 1998 Holden (General Motors) Commodore could sustain 380mm deformation to the vehicle body in a lateral pole impact and be structurally sound.

To support such an approach a database would be required to correlate the vehicle (make, model and year), collision type (full frontal, frontal offset, frontal narrow object, side, side offset, side narrow object, full rear, rear offset, rear narrow object, rollover and other) and damage criteria. For thirty different vehicle makes, each producing on average twenty-five different models over a fifteen year period, there would be 750 vehicles each requiring criteria for the eight different identified collision types, which equates to 8,250 individual criteria.

The advice from the ERG was that if the system was not easy to use then it would not be practicable, this approach was discounted on grounds of its relative complexity. An alternative to classify vehicles using the New Car Assessment Program (NCAP) used by Australia, Europe, United States of America and Japan was also rejected on the basis that a separate process would be required to classify any vehicle not tested by NCAP and the collision type is not evaluated by NCAP (i.e. frontal narrow object, side offset, all rear impacts and rollover).

SECTION 2. ISSUES WITH THE PRE-2010 CRITERIA

THE STRUCTURAL DAMAGE CRITERIA

In three of the existing five impact damage indicators (Roof (turret), Floor pan (cabin area) and Firewall), a 300mm by 300mm (12″ ×12″) or more area is defined as an indicator of damage. Whilst a 300mm by 300mm (12″ ×12″) area of damage may represent significant structural damage for one type of vehicle, however for another type of vehicle it may not.

Indicators of structural loading are bending, fracturing, cutting, cracking, buckling and/or material folding over onto itself.

The identification of structural damage needs to expand from only allowing one area of significant structural damage per vehicle element (roof, floor pan, firewall and suspension) to allow for the possibility of multiple areas of significant damage i.e., if there is structural damage to three separate suspension stations, they should be assessed to be three distinct areas of damage rather than just one for the suspension as a whole.

Note that doors are structural elements however doors are also replaceable elements and hence have not been included as part of the structural damage criteria.

ROOF

The pre-2010 criteria specifically identify the vehicle roof as an area which can indicate impact damage. In some States and Territories the roof turret is also included.

The pillars on a modern vehicle are integral to the fundamental structural performance of the vehicle in forward, side and rollover collisions. The exclusion of the vehicle pillars in the current criteria is a weakness. An example of the weakness is:

> *Consider a vehicle which is involved in a collision such that the emergency services cut both A and B pillars, so that the roof can be folded back to allow extraction of the vehicle occupants. An interpretation of the current criteria is that the vehicle has sustained damage to only one of the three possible criteria. Having both A and B pillars cut and the roof deformed will structurally compromise the vehicle. The only effective repair is to replace both A and B pillars and the roof. Reattaching the cut and bent elements will result in a cosmetic repair, but will not provide an effective structural repair.*

The roof and the pillars should be separated into different impact damage indicators, with damage to the roof and to individual pillars considered as separate indicators of structural damage. Hence structural damage to the roof and two pillars or damage to three pillars would each represent three areas of structural damage.

FLOOR PAN

Damage to the vehicle floor pan should continue to be an indicator of structural loading.

FIREWALL

Damage to the vehicle firewall should continue to be an indicator of structural loading.

LONGITUDINAL STRUCTURAL RAILS/ CHASSIS

The design of vehicles has significantly improved from the early 1990s such that an NCAP crashed 5 star vehicle has limited damage to the firewall but significant damage to the forward structural rails/chassis. In a longitudinal collision, the structural rails of the vehicle control the amount of deformation. The pre-2010 criteria do not address this major transformation in vehicle design and the longitudinal structural rails/chassis should be considered to be a critical structural element in their own right.

Damage to an individual longitudinal structural rail should be counted as an individual area of structural damage and hence damage to two longitudinal structural rails would account for two areas of structural damage.

SUSPENSION

The pre-2010 criteria for the suspension should be modified. The pre-2010 criterion groups all suspension damage as one indicator of damage. The grouping of all suspension damage into one in the current criteria is a weakness. An example of this weakness is:

> *Consider a Ford Falcon XR6 utility which has slid sideways such that the front right wheel, the front left wheel and rear axle assembly are ripped off the vehicle. Using the current criteria this would count as one indicator of damage, when there have clearly been three (independent front left and right wheels and the rear axle).*

The damage to the mountings to the chassis/body of the independent suspension units and/or to connected axles should be considered as each representing an indicator of damage.

MECHANICAL COMPONENTS

The pre-2010 criteria for the mechanical components should be retained as an indicator of damage.

SUPPLEMENTARY RESTRAINTS

There were various discussions with ERG members about the deployment of airbags as an indicator of significant structural loading of the vehicle. The authors would accept that in the early to mid-1990s airbag deployment may or may not have been a good indicator of impact severity in all

makes and models of vehicles available. However, the proliferation and current understanding of triggers for airbags has improved such that the airbag is part of an overall vehicle safety system (structure, active restraints and passive restraints).

The current intent of airbags is that they deploy to protect the vehicle occupants when the vehicle is involved in a severe collision such that the structure has been dynamically structurally loaded beyond the capacity of just the seatbelt restraints[1]. It also needs to be recognised that the manufacturers of the majority of vehicles equipped with airbags will have spent considerable effort in designing, testing and evaluating the effect and trigger for the deployment of airbag(s).

The deployment of airbags (frontal, side and/or curtain) is defined by criteria developed by the vehicle designer/ manufacturer and indicate that the vehicle has been structurally loaded. Airbag deployment should therefore be used as an overall indicator of damage.

THE FIRE DAMAGE CRITERIA

The pre-2010 fire damage criteria are vague and open to significant interpretation.

Smoke only damage to a vehicle will not cause a safety concern. Smoke only damage to a vehicle should be addressed outside of the RWO and SWO criteria altogether.

Fire damage to non-structural panels i.e., doors, bonnet, boot and quarter panels are not sufficient to meet the SWO criteria.

Currently, significant numbers of vehicles are manufactured from high and ultra-high strength steels, aluminium, foams and/or composite materials and their use is increasing. These materials are susceptible to structural degradation when exposed to heat from a fire.

Structural fire damage can be caused internally (engine, cabin and/or boot) and/or externally (adjacent vehicle, building or bush).

The existing criteria need to be modified to specifically accommodate structural fire damage. The structure of the vehicle would be defined as the roof, pillars, floor, firewall and or structural rails/chassis. How best to assess the intensity of the fire was discussed extensively with members of the ERG.

Blistering of the paint was considered to be a pragmatic and practical method to assess if sufficient heat had been transferred into the vehicle structural elements to cause structural degradation of high and ultra-high strength steels, aluminium, foams and/or composite materials.

THE WATER DAMAGE CRITERIA

The ERG were able to identify that the pre-2010 salt water criteria was based on the corrosive characteristics of salt water on the vehicle structure. Discussions identified that a limitation of the pre-2010 criteria was immersion in brackish water and the effect of fresh water on current electronics and wiring.

The pre-2010 criteria allowed up to immersion in fresh water for 48 hours up to the dash/steering wheel. Current vehicles have electronic, electrical and pyrotechnic safety systems on or near the vehicle floor. The discussion within the ERG focused on obtaining credible information about the water resistance, water proofing and/or depth of immersion build standard of vehicle electronic, electrical and pyrotechnic safety systems.

The question of water resistance was raised directly with the vehicle manufacturers. In his response on behalf of manufacturers Mr Hurnall advised that: "*The industry considers that any immersion in fresh water would adversely affect electronics/wiring. Consequently, the criteria for fresh water immersion should reflect that for salt water immersion, i.e. "If the vehicle is immersed in salt/fresh water above the door sill level ....for any period the vehicle must be classified as a SWO.*""

The exiting criteria need to be modified to accommodate the immersion of electronic, electrical and pyrotechnic safety systems.

SECTION 3. SWO CRITERIA

STRUCTURAL CRITERIA

The structural criteria should be expanded from five to eight criteria, with the requirement that once a vehicle has received damage to any three of the identified seven structural areas and/or supplementary restraints it is deemed a SWO, i.e. two structural areas and supplementary restraints or three structural areas. Currently, and it is expected that into the future, it is anticipated that there will be a range of vehicles available most likely from 2 star crash performance to 5 star crash performance. The expansion to eight criteria and the retention of damage to three of the eight to categorise a vehicle as an SWO will increase the number of SWO's. The approach taken errs on the side of caution and safety to further restrict significantly damaged vehicles sold by insurers at public auctions.

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[1] **The following is extracted from Autoliv's web site:** *"Airbags are among the most important automotive safety products, since the concept of inflating a textile cushion could be used in both frontal impacts and side impact collisions to protect a great variety of body parts. In frontal impacts, for instance, driver airbags are estimated to reduce fatalities by 25% for belted drivers and serious head injuries by over 60%. For front-seat passengers (that are further away from the instrument panel than a driver from a steering wheel) the protective effect is estimated to be 20%. In side impacts curtain airbags are estimated to reduce the risk for life-threatening head injuries when occupants are sitting on the side of the vehicle that is struck, while thorax airbags reduce serious injuries to the chest by approximately 25% in side-impact collisions. There is also an increasing demand for knee airbags and anti-sliding airbags, because frontal airbags and modern seatbelts have reduced the risk for head injuries but not the injuries to the legs. Consequently, there is a growing focus on using airbags to also prevent long-term disabling leg injuries. It is important that people not only survive crashes but also are able to walk, and lead a normal life."* http://www.autoliv.com/wps/wcm/connect/autoliv/Home/What+We+Do/Airbags

Figure 2. View of the roof, windscreen header, front left door header and 'A' pillar. The roof has been structurally loaded such that the windscreen header has buckled.

1. ROOF

The criteria to be used are that if the Roof has been loaded such that individual structural element(s)/member(s) have been structurally: fractured, cut, cracked, buckled and/or is folded over onto itself, then the Roof has an area of structural damage, refer to Figure 2 and Figure 3.

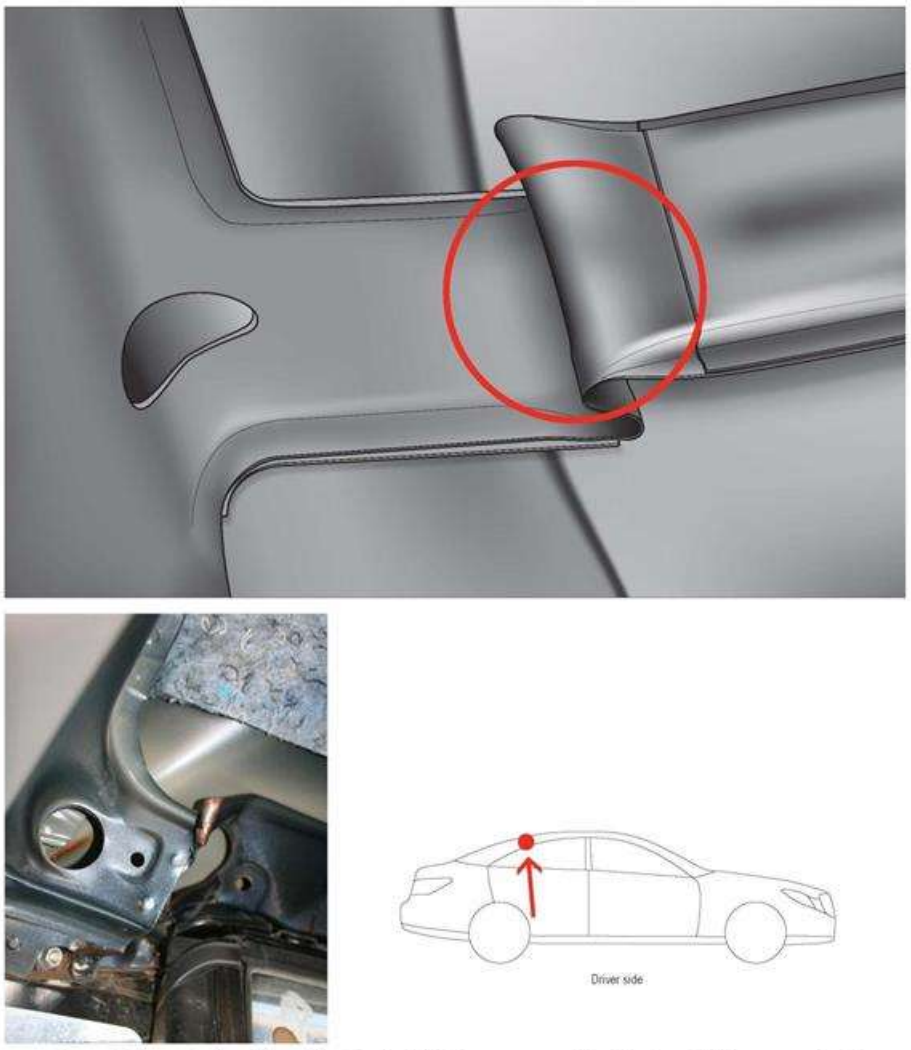

Figure 3. Internal view of lateral roof rail which due to structural loading has folded over onto itself

2. PILLARS

The criteria to be used if the Pillar(s) is that, it have been loaded such that an individual structural element has been structurally: fractured, cut, cracked, buckled and/or is folded over onto itself, then the Pillar has an area of structural damage. Each pillar counts separately i.e., if three pillars are structurally damaged then based on the pillar damage alone the vehicle would have three areas of structural damage. Hence, the vehicle with three damaged pillars would be classified as a SWO, refer to Figure 4 and Figure 5.

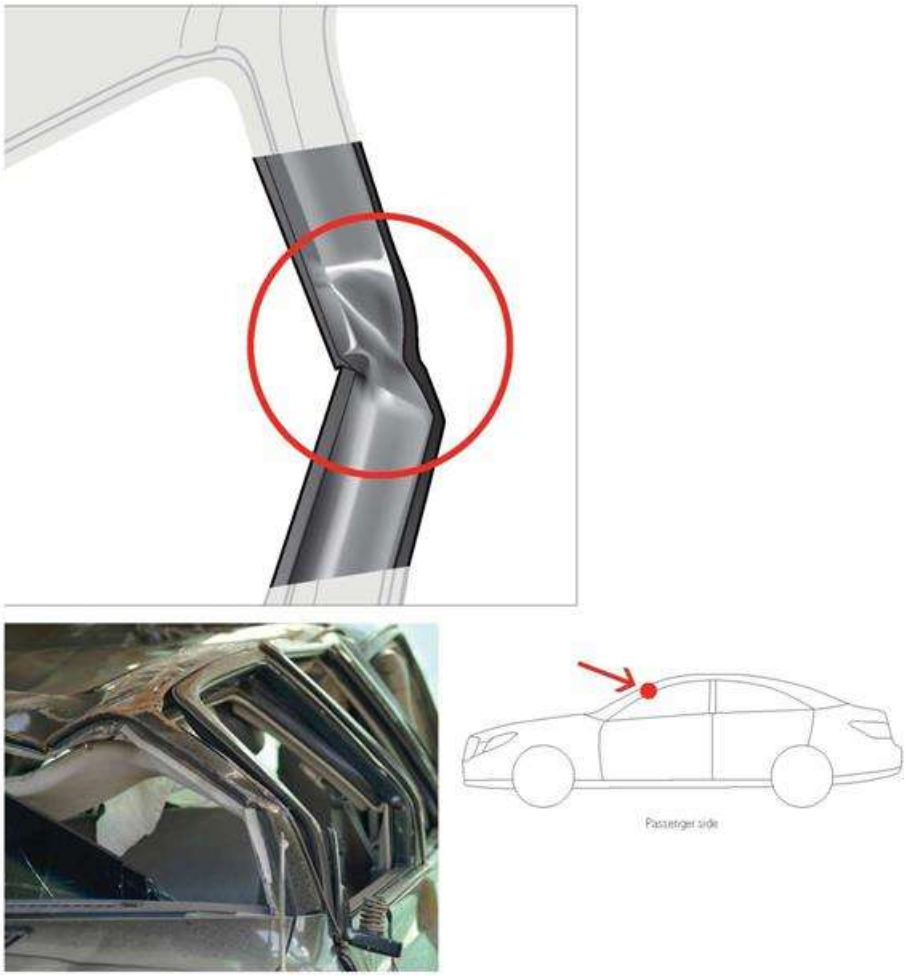

Figure 4. A vehicle 'A' pillar which has failed by buckling due to structural loads to the roof.

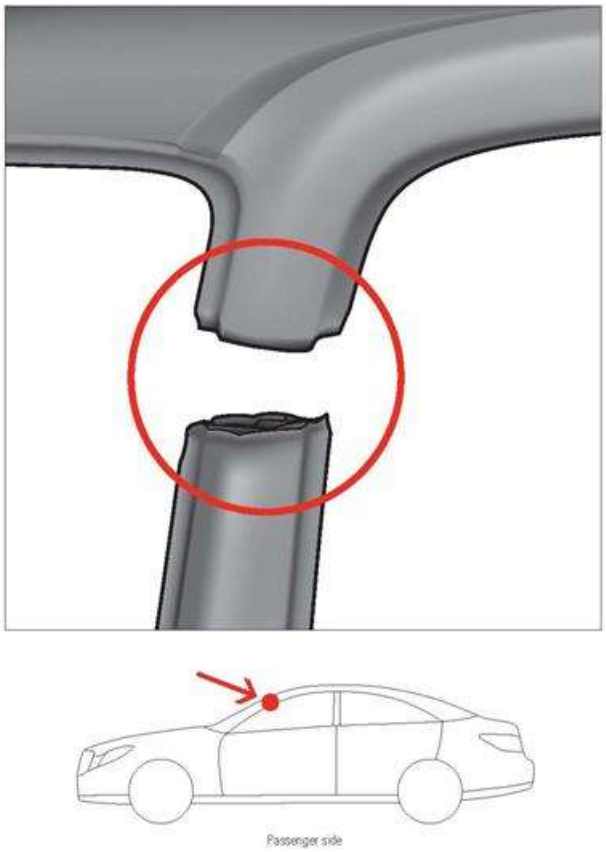

Figure 5. The 'A' pillar of a vehicle which has been cut (e.g. by emergency services personnel to permit occupant extraction).

3. FLOOR PAN

The criteria to be used if the floor pan is that it has been loaded such that individual structural element(s)/member(s) have been: fractured, cut, cracked, buckled and/or is folded over onto itself, then the Floor pan has an area of structural damage. If different and unconnected areas of damage are identified, then each area counts separately (i.e., damage under the driver's seat and damage under the rear passenger side seat would represent two areas of structural damage). Hence the vehicle would require only one other area of structural damage to be classified as a SWO, refer to Figure 6 and Figure 7.

4. FIREWALL

The criteria to be used for the Firewall is that it has been structurally loaded such that an individual structural element(s)/member(s) have been: fractured, cut, cracked, buckled and/or is folded over onto itself, then the Firewall has an area of structural damage. If different and unconnected areas of damage are identified, each area counts separately, refer to Figure 8 and Figure 9.

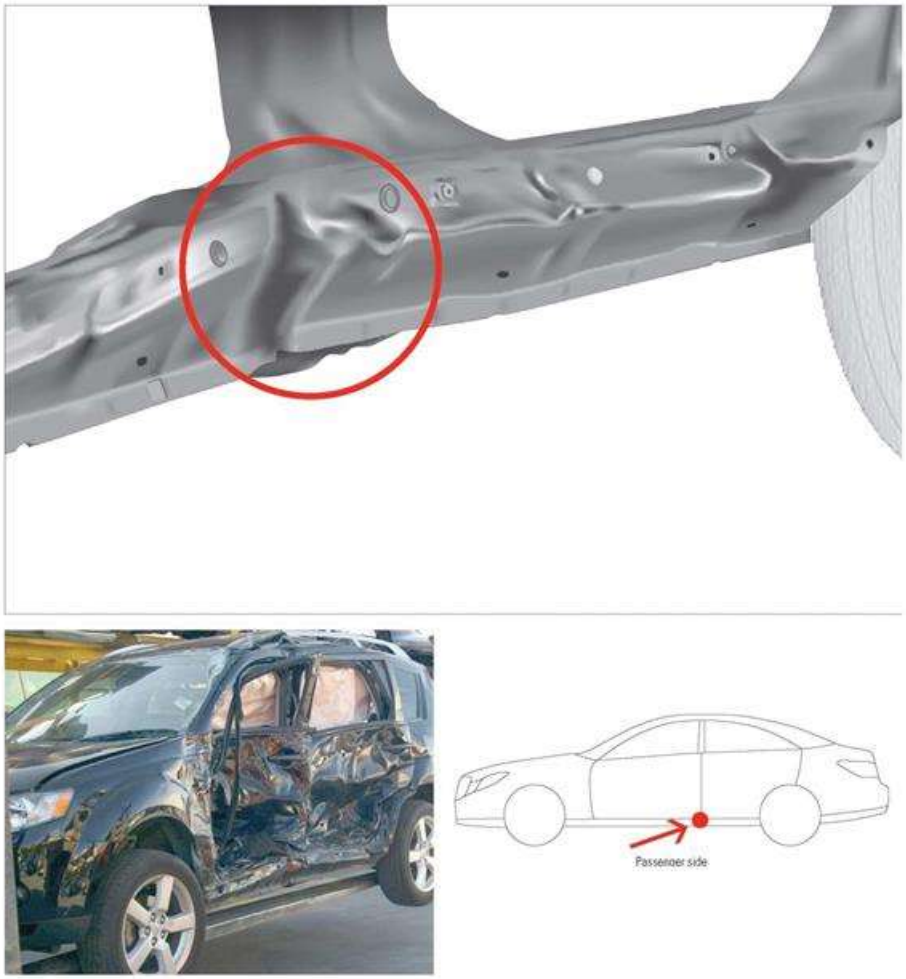

Figure 6. A side view of a vehicle showing buckling and folding of the floor.

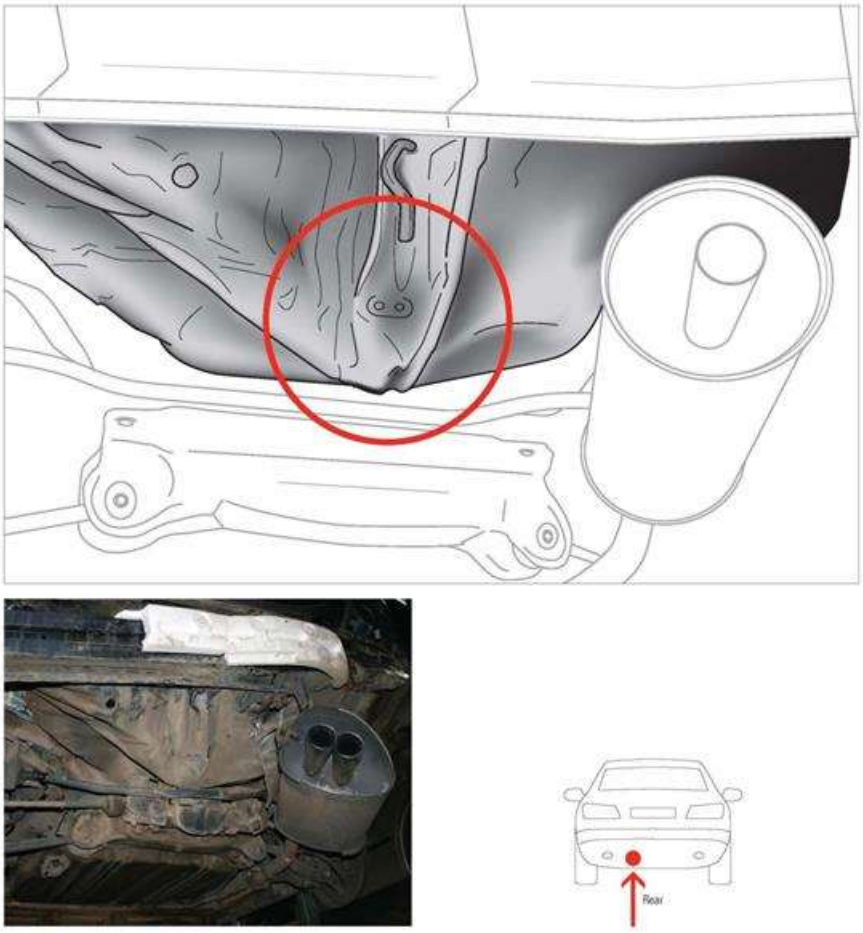

Figure 7. View of the rear underneath of a vehicle showing buckling of the floor pan.

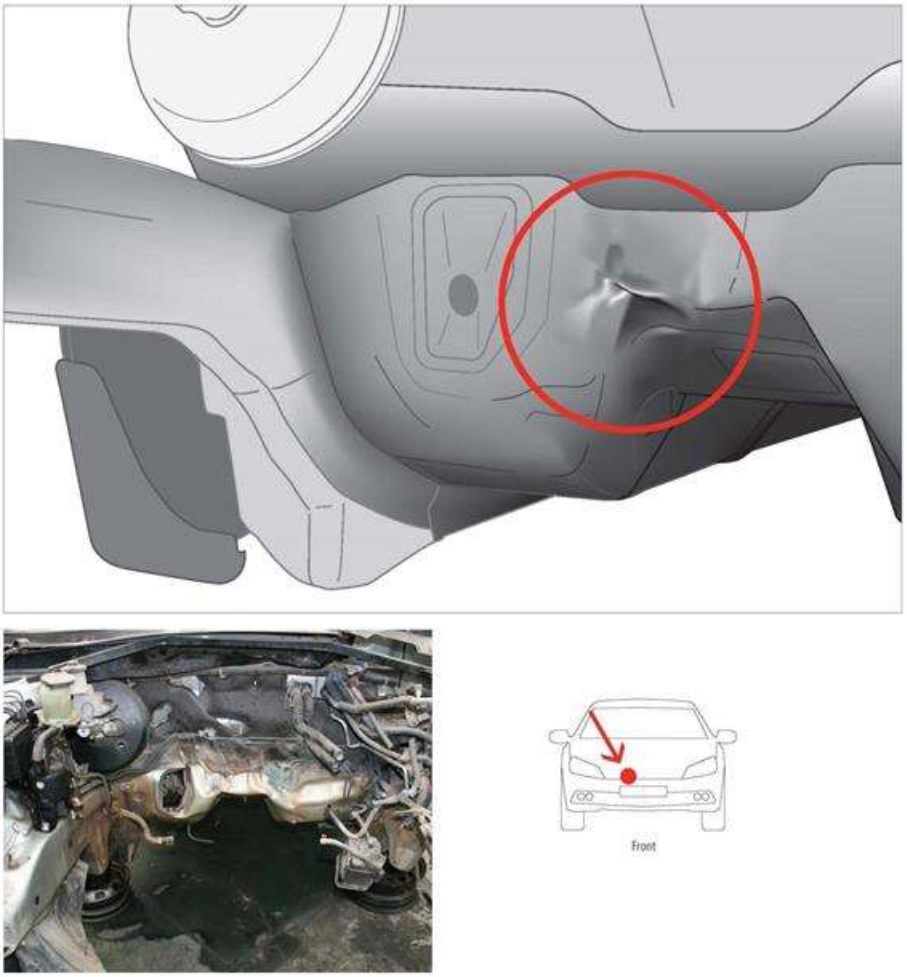

Figure 8. View of the firewall showing a fold induced by impact damage.

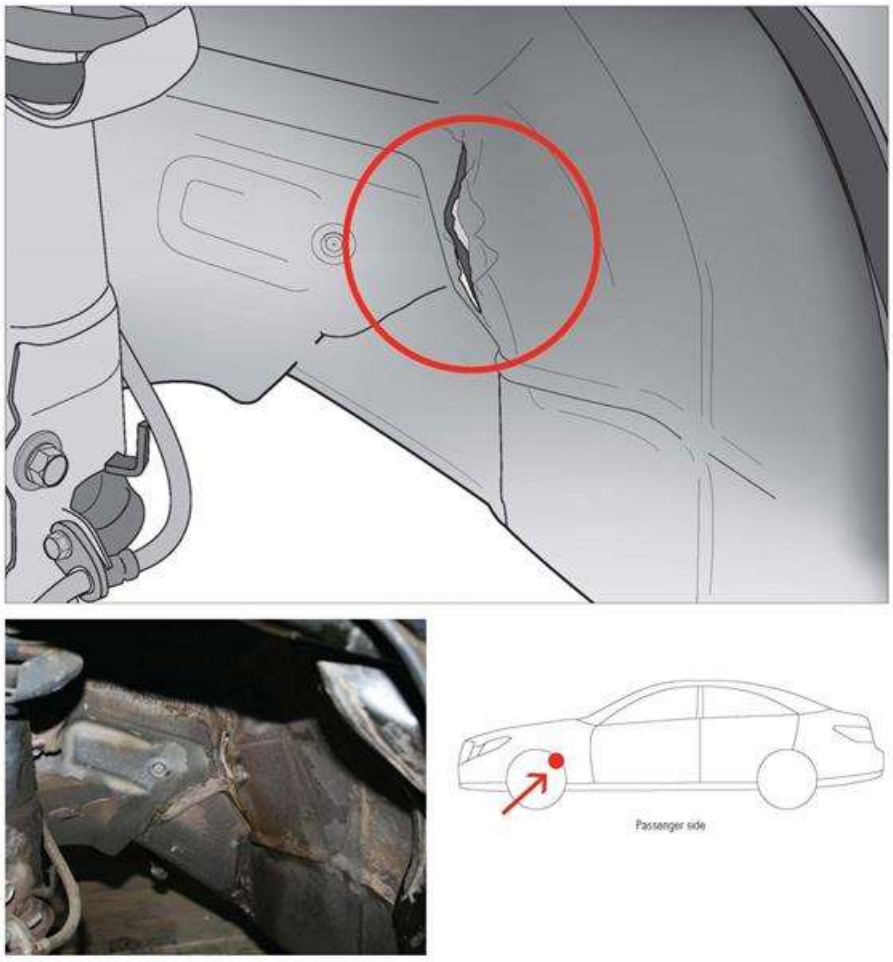

Figure 9. View through the front left wheel-well of the firewall showing a crack in the firewall.

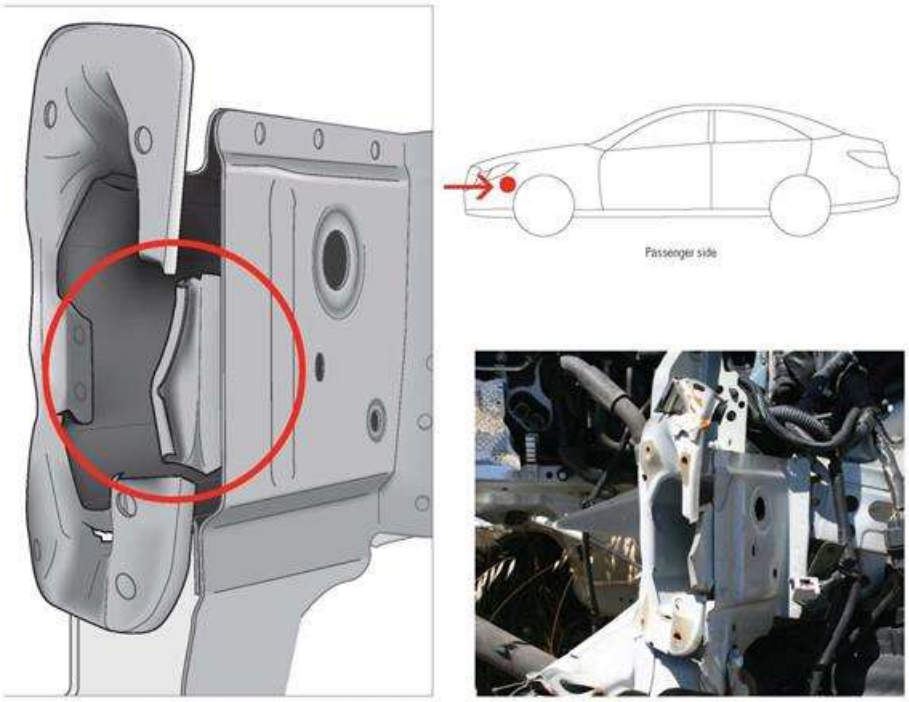

Figure 10. View of longitudinal structural rail/chassis fractured due to impact.

5. LONGITUDINAL STRUCTURAL RAILS/ CHASSIS

The criteria to be used are whether the longitudinal rails/ chassis have been structurally loaded such that longitudinal structural element(s)/member(s) have been structurally; fractured, cut, cracked, buckled and/or is folded over onto itself.

Each longitudinal structural rail counts separately (i.e., if two longitudinal structural rails are buckled and the front right suspension is damaged the vehicle would have three areas of structural damage and thereby be classified as a SWO), refer to Figure 10, Figure 11 and Figure 12.

A deformable member that is designed to be removed and replaced is not considered a fundamental structure of the vehicle if damaged and such components are not to be registered as structural damage, refer to Figure 13.

6. SUSPENSION

The criteria to be used for item 6 (Suspension) are whether there has been any collision induced damage to any of the suspension mounts to the chassis/body refer to Figure 14.

Independent suspension units and connected axles count separately (i.e., if two axle lines (front and rear) are torn away such that the suspension mounts to the chassis/body are damaged and one of the pillars is buckled, the vehicle would have three areas of structural damage and be classified as a SWO).

If two rear and one front independent suspension mounts to the chassis/body are damaged there would be three areas of structural damage and the vehicle should be classified as a SWO.

Damage to suspension arms and/or linkages which can be replaced are not to be registered as structural damage, refer to Figure 15.

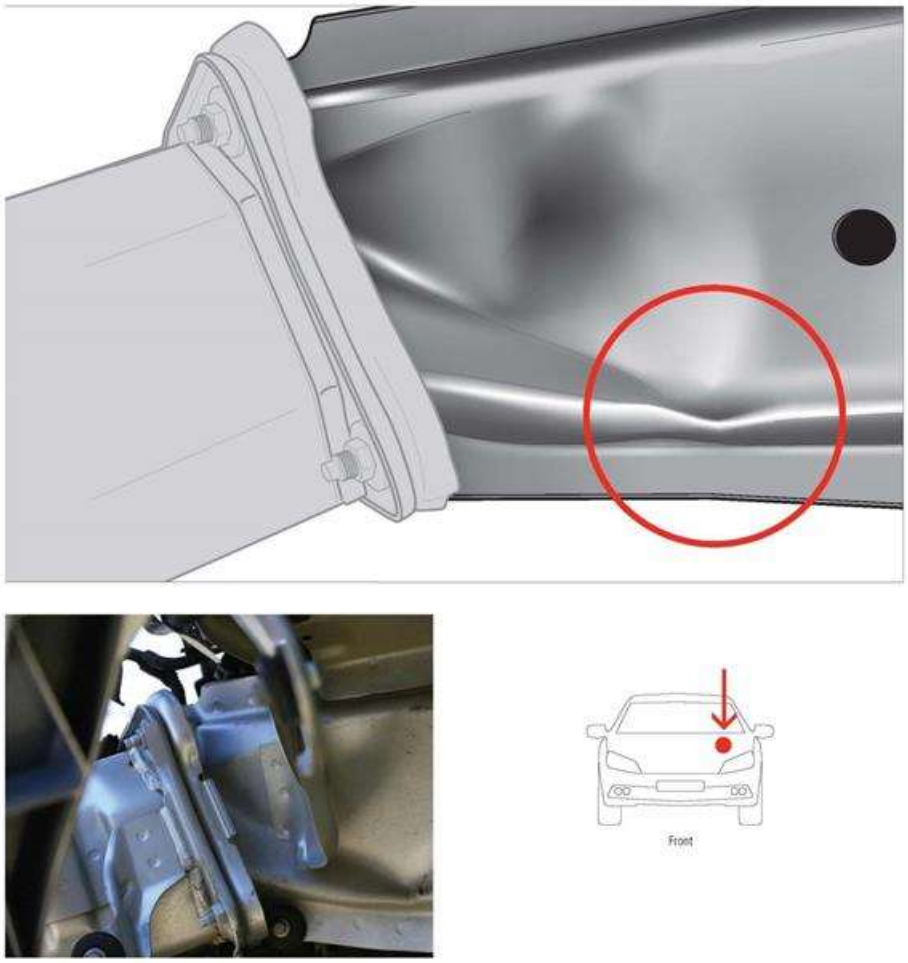

Figure 11. View of a longitudinal structural/chassis rail which has buckled due to structural impact loading.

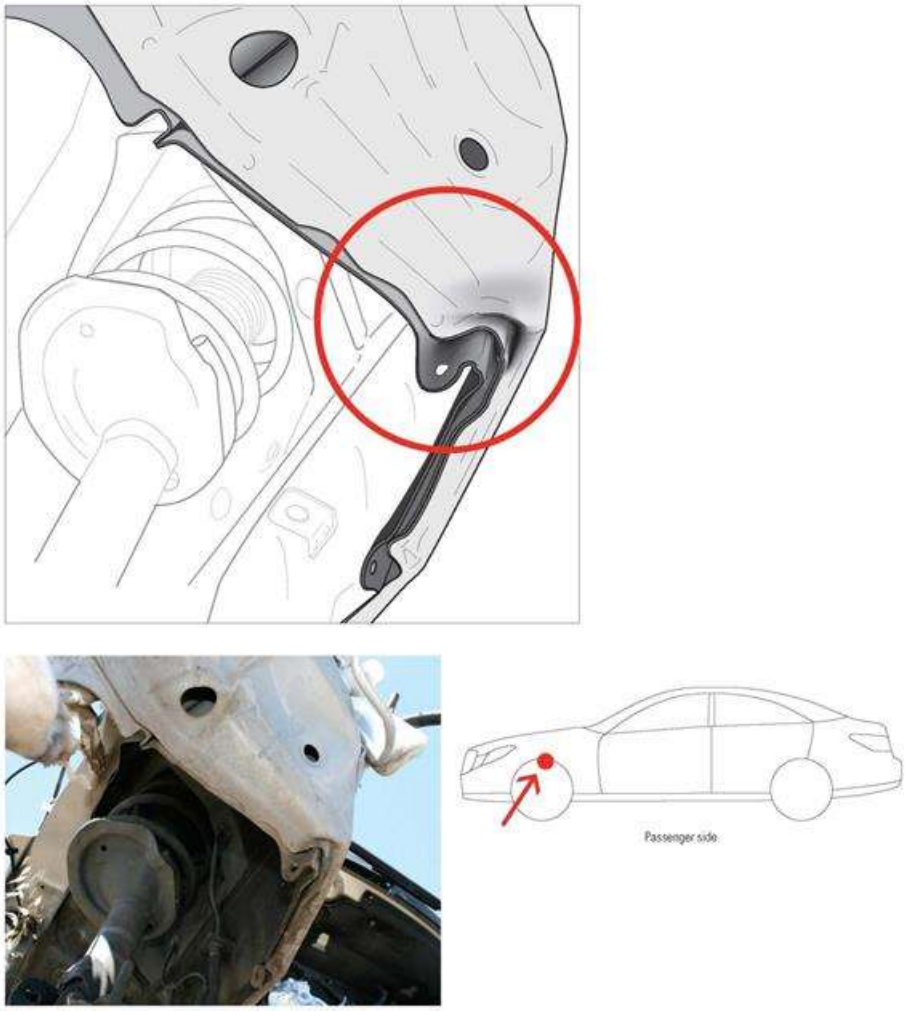

Figure 12. View of a longitudinal structural/chassis rail which has folded due to a side impact.

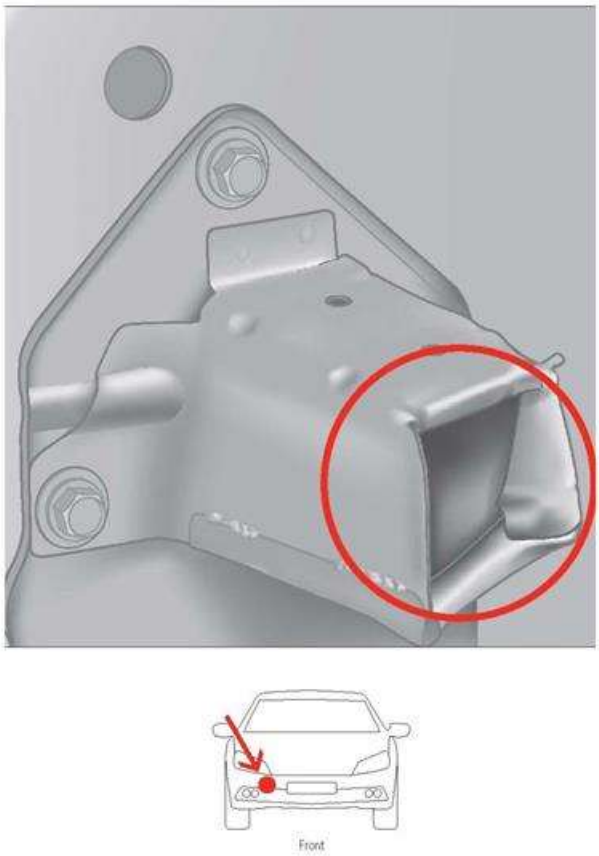

Figure 13. This is an example of a deformable end tube that is designed to be removed and replaced. Such components are not to be registered as a damage count.

7. MECHANICAL COMPONENTS

The criteria to be used for Mechanical Components is whether there has been any collision induced damage to the: engine block, transmission case, differential case(s) and axle housings such that the items are cracked, deformed and/or broken. Damage to the mechanical components would be grouped. Damage to single or multiple mechanical components can only account for one area of structural damage.

8. SUPPLEMENTARY RESTRAINTS

The criteria for Supplementary Restraints is whether there has been any deployment of either an airbag (frontal, side and/or curtain) system within the vehicle occupant cabin and/or the activation of a seatbelt pre-tensioner. Deployment of supplementary restraint system would be grouped. Deployment of a single or multiple airbag(s) or pre-tensioner(s) can only account for one area of structural damage.

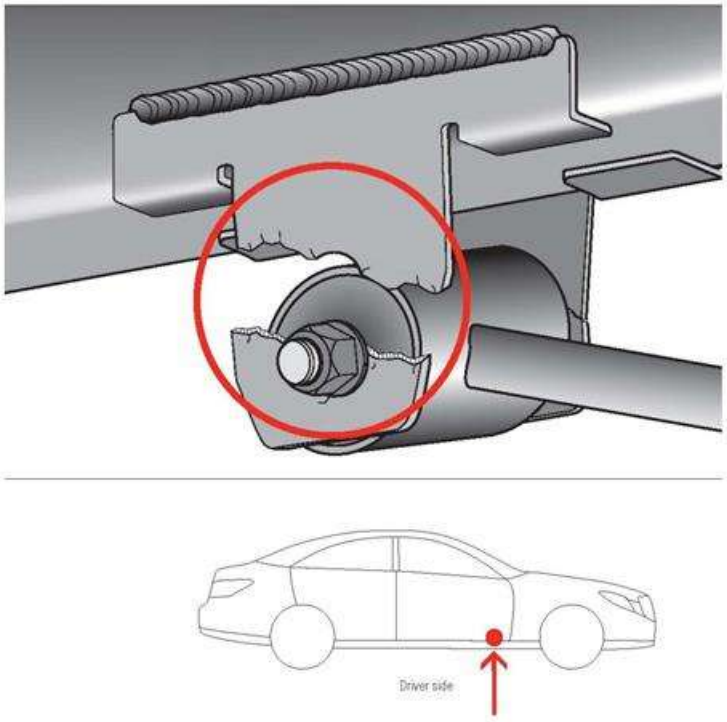

Figure 14. View of a fractured suspension mount.

Figure 16 and Figure 17 illustrate a pre-tensioner seatbelt latch with an active pre-tensioner and a deployed pre-tensioner respectively.

FIRE CRITERIA

The fire damage SWO criteria should be expanded to consider the following: in-vehicle (engine compartment, occupant cabin and/or boot/trunk) and external. A fire (whether in-cabin or external) which causes the internal and/or external paint to blister on any 3 of the following structural members; roof, pillars, floor pan, firewall and or structural rails/chassis shall be deemed a SWO.

Paint blistering on the doors and/or the external panels is not sufficient for the vehicle to be classified a SWO. Fire damaged doors and/or the external panels can be detached and replaced.

(Note: it is accepted that doors are structural members however, doors can be replaced.)

WATER DAMAGE CRITERIA

When the internal cabin of a vehicle is inundated with any water (fresh, salt and/or brackish water) such that the internal cabin water level rises above the level of the door sill for any period the vehicle will be a SWO.

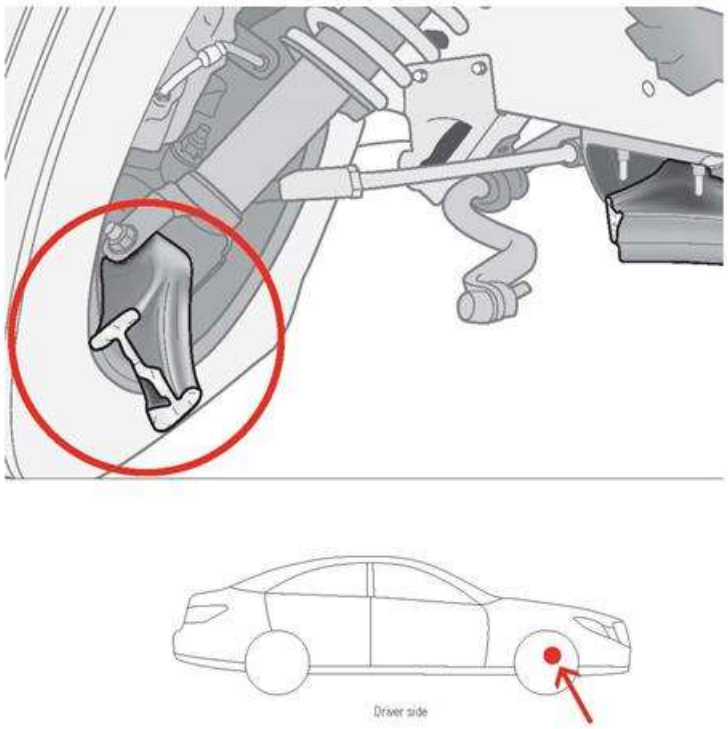

Figure 15. Damage to suspension arms and/or linkages which can be replaced are not to be registered as structural damage.

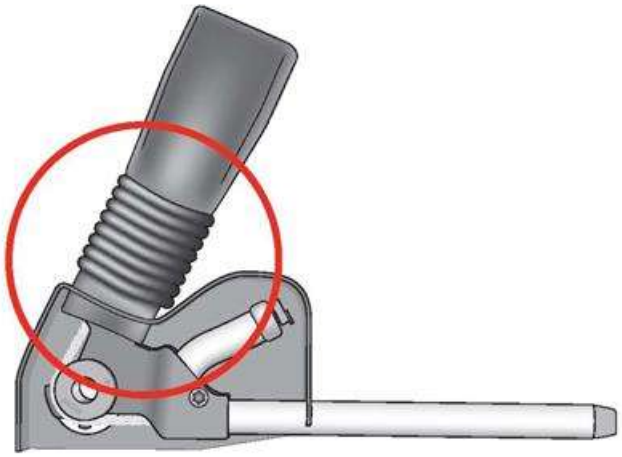

Figure 16. An active pre-tensioner.

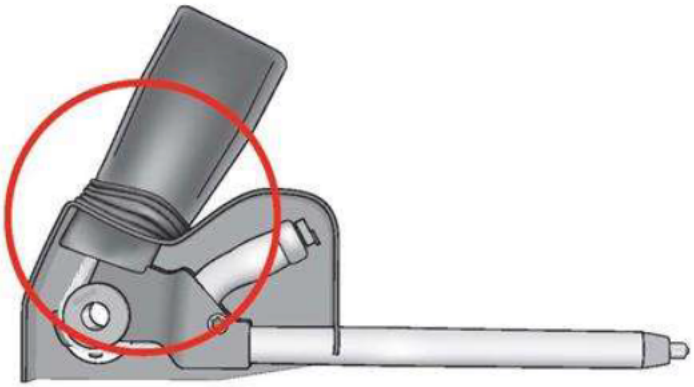

Figure 17. A deployed pre-tensioner.

VEHICLE STRIPPING CRITERIA

If stripped, the vehicle should be a SWO if the value of the removed parts, panels and/or components makes the vehicle economically unviable to repair.

CONCLUSION

The SWO criteria have been developed to err on the side of caution in terms of safety to ensure that vehicles that have sustained significant damage are consistently identified and appropriately classified as suitable only for dismantling or processing as scrap.

The SWO criteria will require a local law change in each of Australia's six states and two territories to be adopted. The implementation 'window' is expected to take up to 18 months. The NMVTRC has ensured that peak industry bodies and key agencies have been kept informed of progress throughout the development process through newsletters, specialist reports and other communications. The NMVTRC is now working closely with road agencies to develop a nationally co-ordinated communications program to ensure affected parties understand how to apply the new criteria well in advance of implementation. The program will include the illustrated technical guide, some of the images from which are included in this paper, an audio-visual industry training resource and face-to-face briefings delivered by insurance assessing experts.

The NMVTRC is also working with industry to integrate the technical guide and other material, such as reporting forms, with the major software systems used by assessors and insurers.

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CONTACT INFORMATION

Dr Shane Richardson
Delta-V Experts
[redacted]

Mr Geoff Hughes
NMVTRC/CarSafe
[redacted]

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Trevor Maughan	Department of Transport (WA)
Daren McDonald	Roads and Traffic Authority (NSW)
Robert McDonald	Insurance Australia Group
Chris McNally	VicRoads
Will Morgan	Pickles Auctions
Greig Newbery	New South Wales Police
Tony Phillips	RAA Insurance (SA)
John Pinney	Victoria Police
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DEFINITIONS/ABBREVIATIONS

RWO
Repairable Write-Off
SWO
Statutory Write-Off
WOW
Written-Off Vehicle's
NMVTRC
National Motor Vehicle Theft Reduction Council
ERG
Expert Reference Group of the NMVTRC
ADR
Australian Design Rules
ANCAP
Australasian New Car Assessment Program
ABS
Anti-lock Brake Systems