

# **Good Practice in Forensic Road Collision Investigation**

**A guide for practitioners**





This guide is a collaboration between:  
the National Police Chiefs Council (NPCC)  
the Institute of Traffic Accident Investigators (ITAI)  
and  
Ai Training Services Ltd (AiTS)

The guide is authored and maintained by a committee of police collision investigators,  
independent collision investigators and collision investigation trainers.

The committee can be contacted via Ai Training Services Ltd  
Unit A5 Lakeside Business Park  
South Cerney  
GL7 5XL

Tel: +44 (0)1285 864650  
Email: [mail@aitsuk.com](mailto:mail@aitsuk.com)

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**V 2A**  
**January 2019**



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## **Preface**

Forensic Collision Investigation is a multi-faceted discipline and practitioners are required to have a good understanding of the principals governing the movement of objects involved in collisions. They are also required to master many skills and have a good understanding of a wide-ranging number of subjects associated with the investigation and the reconstruction of collisions. This includes data collection and processing, the preparation of reports and the presentation of that information to the Courts.

There is a danger, over time, to develop poor practices that diverge from the original training and approved methods. Some of these might come about due to experience of knowing what does or does not work, or from outside influences that impose time constraints and thus compel the variances to the fore.

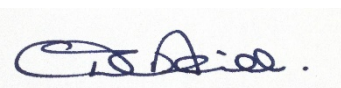
In addition, the environment in which the practitioner works in might dictate how they approach a particular task. Practitioners drawn from the police service have the advantage of attending live scenes whereas private or civil practitioners working in the same judicial arena are unlikely to do so. The latter group are, therefore, often reliant upon the data collected by the police and from their own enquiries and investigations.

These Good Practice Guides provide a minimum level of acceptable practice. They are not intended to teach the reader how to be a collision investigator or conduct reconstruction work. It is assumed, therefore, that the reader will have undergone approved training in the elements covered. The Guides are designed to ensure that a practitioner collects, processes and reports on the data and evidence collected in a consistent and robust manner, such that others will have confidence in its veracity. Clearly, a practitioner can exceed the guidance; indeed, that is what is expected. Practitioners should never fall below these standards and will deviate from them only when there is a compelling reason for so doing. In such an instance, the reasons will be documented.

These Guides are aimed at the Forensic Collision Investigation community, both police and civilian, to provide consistency and a minimum level of acceptable practice.

These Guides are compiled at the behest of the National Police Chiefs Council for England and Wales (NPCC), the National Senior Forensic Collision Investigators working group from the NPCC, The Institute of Traffic Accident Investigators (ITAI) and Ai Training Services Ltd (AiTS). This encompasses police, private practitioners and the main training provider in the UK.

These Guides are living documents. As new technologies and practices emerge these Guides will be updated. It is hoped that they will provide a valuable resource to practitioners, to ensure that the discipline achieves a consistent and acceptable standard.



Colin O'Neil  
Sussex Police



Jon Stubbs  
ITAI



Ric Ward  
AiTS





**Identification and recording of marks - road and adjacent surfaces**

Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording marks at the collision scene, sufficient and accurate information is gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>• the scene can be described accurately by cross referencing to photographs;</li> <li>• the dynamics of vehicles and other objects can be described accurately; and</li> <li>• marks are recorded so that measurements can later be used accurately to calculate speed, timings etc.</li> </ul>
Data Capture – Method of marking	<p>Identify, mark, record, measure and photograph the start, transitional points, changes in direction and end of all marks. Where there is directionality or patterns within the marks this should also be noted and photographed.</p> <ul style="list-style-type: none"> <li>• The measurement method will depend on the type of survey equipment being used. Both manual measurements by tape and measurements taken later from an electronic survey are acceptable.</li> <li>• As part of the recording process marks should be described using the standard glossary of terms.</li> </ul> <p>Use numbered or lettered marker boards at the start of a mark to allow easy identification when later describing the scene.</p> <p>Use road marking paint or chalk to denote the course of the marks at regular interval. Use a 'U' shaped mark to encompass the commencement of a mark to denote the start and a 'V' shaped mark adjacent to the end to define the conclusion of that mark, (see figure 1.)</p> <p>For smaller marks, gouges etc., circle the relevant item with the appropriate marking medium, and identify with a marker board.</p> <p>When marking, white tyre chalk is exceptionally good for this task and shows up well in photographs. Using reflective markers along marks at regular intervals also assists, both in respect to photographing the marks, or where a laser scanner is being used.</p> <p>Ensure that when a marking medium is used, it runs closely along the edges of the marks to be recorded, to better aide identification and descriptions at a later stage. The use of photographic scale markers or similar, is also useful where marks change in width.</p> <p>Do not mask other marks or evidence when using marker boards or other visual aids such as reflective markers.</p> <p>On softer surfaces, consider the use of marker boards, cones or flag markers and the use of road marking paint to more easily identify the marks in photographs and during the electronic data capture process.</p>

## Good Practice in Forensic Road Collision Investigation

Types of marks	All relevant marks are to be identified and recorded, but typically include, although not exclusively: emergency braking marks, acceleration scuff marks, striated tyre scuff marks, striated cornering scuff marks, body scuff and slide marks, body fluid trails, scratches, gouges, drip trails, tyre prints, rolling tyre marks in soft material, furrows, kerb strikes, debris deposits, smears in material, and flattening of vegetation.
Equipment - marking	Road marking paint (yellow or white), road chalk (yellow), tyre chalk (white and softer than road chalk), reflective markers, marker boards, flag markers, tent pegs (with a small ribbon, or similar, affixed thereto), photographic scale markers.
Equipment - recording	Camera, Laser scanner, Total station, GPS, Photogrammetry, Aerial imagery (UAV), tape measure, measuring wheel and scene note book.
Considerations	<p>Whilst road marking paint and chalk are not designed to be permanent, they can remain on a road surface for days or even weeks depending upon traffic flow. Consider the possible consequences of these marks on road users after the road is re-opened. If an adverse impact or dangerous distraction might be an issue, consider having the road swept by the local authority, or hosed down by the fire service. Consult with the LA or HA to determine the best approach.</p> <p>Consider the circumstances of the collision and follow anti-contamination procedures when required.</p>
References	Suggested but not limited to; Goddard, C & Hansen, The Manual of Collision Scene Evidence ISBN 978-87-995320-2-5
Cross reference to guides	Good Practice Guide – Photography Good Practice Guide – Pedestrian Throw Calculations Good Practice Guide – Anti-contamination Procedures Good Practice Guide – Identification and Recording of Critical Speed Marks

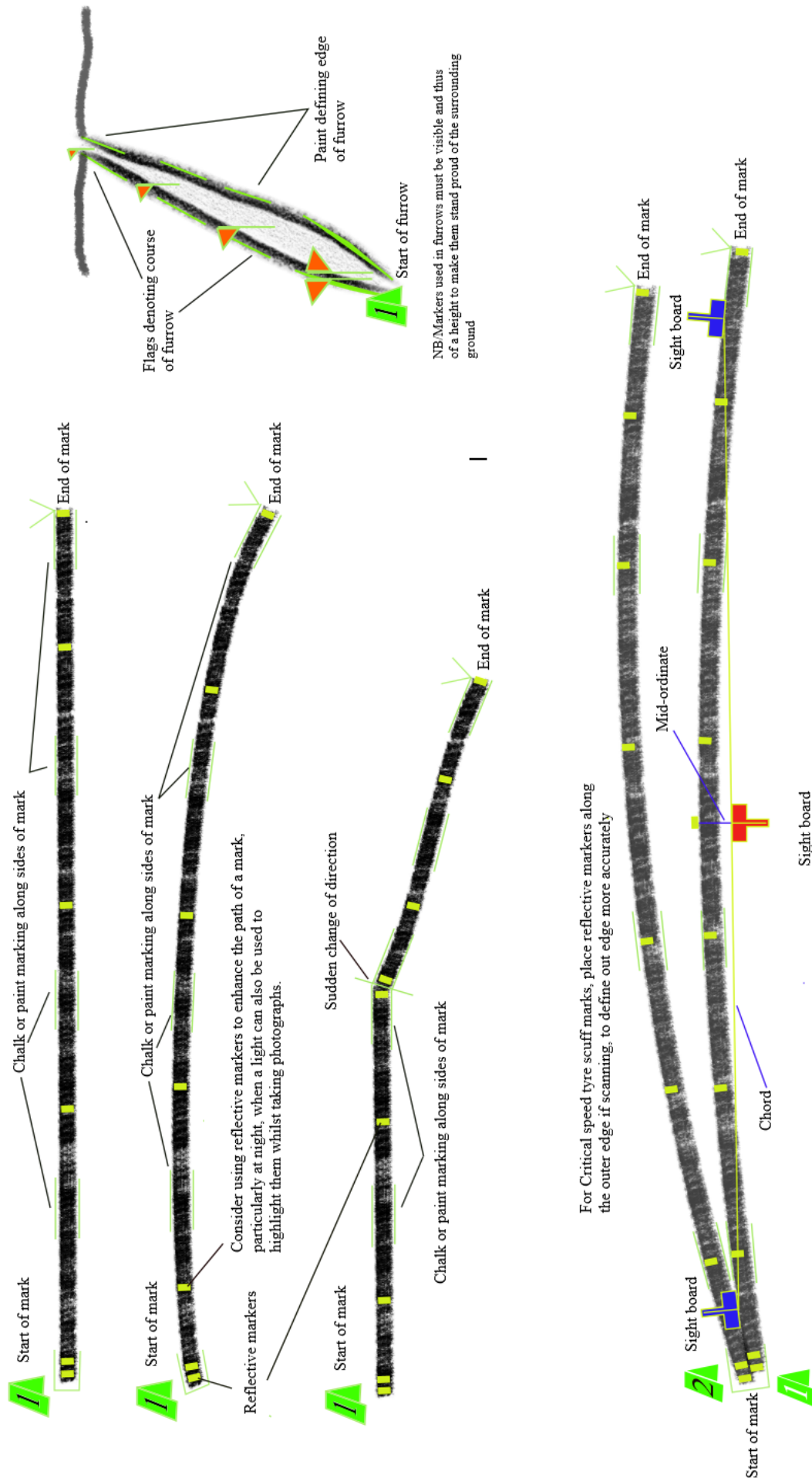
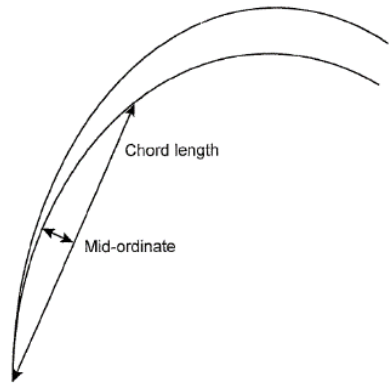


Figure 1. — National method of denoting the path of marks generated by a vehicle during a collision or loss of control. Placing chalk or paint lines along the edges at regular intervals or around marks etc., assists both in identifying the mark, its path and the nature of the mark. Use a 'U' shaped bracketing mark to start and a 'V' shaped mark at the end of marks. This is particularly useful if the mark finishes at a wheel, as you can denote the centre of the contact patch at the same time. Vehicle corners should also be marked using a similar system.

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## Identification and Recording of Critical Speed Marks

Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording Critical Speed Marks at a collision scene, sufficient and accurate information is gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>the dynamics and position of a perpetrating vehicle can be determined accurately; and</li> <li>measurements can be used to calculate the speed of the vehicle.</li> </ul>
Data Capture	<p>Identify, mark, record, measure and photograph the start, transitional points and end of all marks.</p> <p>Use numbered or lettered marker boards at the start of a mark to allow easy identification when later describing the mark.</p> <p>Use road marking paint, markers or chalk to denote the outer edge and course of the marks at regular intervals. Using reflective markers assists in respect to photographing the marks. Where a laser scanner is being used markers must have a clearly defined edge to enable the outer edge of the tyre mark to be measured accurately.</p>
Data Capture - Measuring	<p>The measurement method can be by tape, taken from an electronic survey or laser scan.</p> <p>Manual Method:</p> <ul style="list-style-type: none"> <li>Measure the chord and mid-ordinate to the outer edge of the front outer tyre mark from a point where the tyre marks have separated.</li> <li>A minimum chord length of 15 metres is desirable. Care must be taken when recording the mid-ordinate measurement as small errors can lead to significant errors when calculating the radius. A minimum mid-ordinate measurement of 300 millimetres should be used where practical.</li> <li>Caution should be exercised where the separation of the marks exceeds <math>\frac{1}{2}</math> the track width.</li> <li>It is recommended that sight boards be used to ensure accurate measurements are recorded.</li> </ul> <p>Electronic survey method:</p> <ul style="list-style-type: none"> <li>The electronic method of measuring is significantly more accurate than the manual method and is recommended.</li> <li>Any electronic method is acceptable but in order of accuracy the preference would be to use: reflectorless; TPS mini prism; TPS pole; and finally, GPS pole.</li> <li>It is suggested that one point is surveyed every 1 metre to allow so that point combinations can be considered and to allow for any erroneous points to be readily identified later.</li> </ul>  <p style="text-align: right;"><i>Continued ...</i></p>

Data Capture – Measuring	<ul style="list-style-type: none"><li>• The outer defined edge of the front outer tyre mark shall be surveyed.</li><li>• The data can then be analysed using proprietary software normally used in the preparation of scale plans. Such software calculates the radius after three individual points are identified.</li></ul> <p>Laser scanning method: Laser scanning of such marks is acceptable, but care must be taken to mark the outer edge of the mark and the whole mark should be captured in a single scan and scanned from the inside edge.</p>
Considerations	It must be established that the vehicle is in a critical speed state and not just rotating.
References	<p>Suggested but not limited to;</p> <p>Lambourn, R.F. (1989) <i>The calculation of motor car speeds from curved tyre marks</i> Journal of the Forensic Science Society Vol. 29 No. 6</p> <p>Neades, J. (2007) Determining the maximum speed at which a bend can be negotiated Impact Vol. 16 No. 1.</p> <p>Dobbins, C and Neades, J. (2012) <i>Measuring Critical Speed Marks</i> Impact Vol. 20 No. 1.</p> <p>Neades, J and Ward, R. (2006) Manual for 'Police Forensic Collision Investigation'.</p>
Cross referencing to guides	<p>Good Practice Guide – Identification and Recording of Marks</p> <p>Good Practice Guide – Photography</p> <p>Good Practice Guide – Anti Contamination Procedures</p>

Pedestrian Throw Calculations	
Purpose	<p>The purpose of this guide is to ensure that, sufficient and accurate information is gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>calculations can be made to establish the speed of a vehicle from the distance a pedestrian was thrown following a collision with a vehicle such as (but not limited to) a car, lorry or bus.</li> </ul>
Data Capture	<p>At the scene, identify, mark, record and photograph:</p> <ul style="list-style-type: none"> <li>the point of rest of the pedestrian;</li> <li>where it can be established, the point of impact; and</li> <li>where present, any scuffs or scratches left by the pedestrian as he or she slid or tumbled across the road or other surface.</li> </ul> <p>Identify, mark, record and photograph damage to the vehicle including damage to the bumper, bonnet, windscreen and roof, record lateral movement across the bonnet.</p> <p>Record height change between launch and landing point. Record slope in the area of the slide.</p> <p>Where the point of impact cannot be established consider whether an area of impact can be established for example on a pedestrian crossing or other limiting feature.</p> <p>Consider the evidence of debris in alternate calculations.</p>
Calculations	<p>Calculations based on most of the more common pedestrian throw models will give a range of speeds (<math>V_{min}</math> and <math>V_{max}</math>). Forward projection calculations might only give a single speed.</p> <p>Before calculating speed consider whether:</p> <ul style="list-style-type: none"> <li>the collision was sufficient to accelerate the pedestrian to the full post impact speed of the striking vehicle;</li> <li>the flight or slide was impeded by another physical feature;</li> <li>In cases of late or no braking (where the vehicle drove under the pedestrian) consider whether the pedestrian struck the roof in a substantive secondary impact thereby extending the flight distance; and</li> <li>height change and slope might need to be included in a calculation or might render a calculation unsuitable altogether.</li> </ul> <p>There are several equations that can be used to calculate speed from the throw distance including (but not restricted to):</p> <ul style="list-style-type: none"> <li>Searle (1993) that finds the speed of the pedestrian from throw distance where the coefficient of friction is either known or can be estimated. Momentum can be included to find the speed of the vehicle, Searle (2011). 'Carry' can be accounted for where necessary, Searle (2011). This is an empirical method that models the flight, landing and the slide.</li> </ul> <p style="text-align: right;"><i>Continued ...</i></p>

Continued ...	<ul style="list-style-type: none"> <li>• Evans and Smith (1999) which finds the speed of the vehicle by a statistical analysis of real-world collisions, note that child pedestrians were excluded from the study and the method is not suited to significant changes in height or slope.</li> <li>• Hague (2001) finds the launch speed of the pedestrian where no point of impact was found although the slide distance is required to be known.</li> </ul>
Considerations	<p>Data from both real-world and experimental dummy collisions show that short throw distances may give unreliable results, see Ward (2017.)</p> <p>The use of debris and glass might lead to an under-estimation of speed see Rau et al (2000.)</p> <p>As the difference in mass between the striking object and the pedestrian reduces, consider the use of momentum in equations to find the launch speed of the pedestrian, see Searle (2011.)</p> <p>A 'pedestrian throw' technique can be applied to circumstances in which a motorcyclist or pedal-cyclist thrown from his or her machine and projected forward. Consideration should, however, be given to whether the flight was impeded by either entanglement with the machine being ridden or with some other physical feature see Broker and Hottman (2017).</p> <p>Consider the circumstances of the collision and follow anti-contamination procedures when required.</p>
References	<p>Suggested but not limited to;</p> <p>Rau, H et al (2000) <i>Car-pedestrian collisions at high speeds</i>. Verkehrsunfall und Fahrzeugtechnik December.</p> <p>Evans, A &amp; Smith, R (1999) <i>Vehicle Speed Calculations from Pedestrian Throw</i>. Proc Instn Mech Engrs Vol 213 Part D.</p> <p>Searle, J &amp; Searle, A (1983) The trajectories of pedestrians, motorcycles, motorcyclists, etc., following a road accident. Society of Automotive Engineers, Paper No 831622.</p> <p>Searle, J (1993) <i>The physics of Throw Distance in Accident Reconstruction</i>. Society of Automotive Engineers, Paper No 930659.</p> <p>Searle, J (2011) <i>The Application of the Throw Distance Formulae</i>. The Journal of the Institute of Traffic Accident Investigators Volume 19 No 2.</p> <p>Hague, D (2001) <i>Calculation of Impact Speed from Pedestrian Slide Distance</i>. Presented at the 5<sup>th</sup> International Conference of the Institute of Traffic Accident Investigators November.</p> <p>Ward, R (2018) <i>Pedestrian and Pedal Cycle Collisions</i>. ENGS2003 De Montfort University.</p> <p>Broker, J &amp; Hottman, M (2017) <i>Bicycle Accidents, Crashes and Collisions, Second Edition</i>, Lawyers and Judges Publishing Company.</p>
Cross referencing to guides	<p>Good Practice Guide – Identification and Recording of Marks</p> <p>Good Practice Guide – Identification and Recording of Marks on Vehicles</p> <p>Good Practice Guide – Photography</p> <p>Good Practice Guide – Anti Contamination Procedures</p>



Identification and Recording of Marks on Vehicles	
Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording marks on vehicles, sufficient and accurate information is gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>• all markings and damage can be described accurately by cross referencing to photographs;</li> <li>• marks are recorded so that accurate measurements and correct assessment can be included in subsequent assessments and analysis;</li> <li>• the consistent marks, relative to the incident under review, can be identified accurately; and</li> <li>• pre-existing damage and any damage caused post-incident can be identified.</li> </ul>
Data Capture – Method	<p>Identify and where appropriate mark, record, measure and photograph each area containing marks and, where relevant, individual marks; transitional points across different panels, etc.</p> <ul style="list-style-type: none"> <li>• Where there is directionality or patterns within the marks this should also be recorded and photographed.</li> <li>• Identify separately direct contact damage and induced damage.</li> <li>• Identify indentations or marks that <i>might or might not</i> match features/structures on other involved vehicles, objects or pedestrians, etc. This aids subsequent analysis of the manner and position in which involved vehicles/parties might have interacted during the collision process.</li> <li>• Where possible identify the Principle Direction of Force (PDOF).</li> </ul> <p>Light scuff marks, scratches, etc. in the painted or lacquered panel surfaces might need to be enhanced with dusting powders. This should only be done once other CSI forensic processes have been completed.</p>
Equipment	<p>Light adhesive transparent markers/arrows; gel adhesive or magnetic scale rule markers; photochromic and other powders; fine dusting brush; wax crayon; painter's paper masking tape; camera/video.</p>
Considerations	<p>Consider partial dismantling of components or panels. Pedestrian or low speed impacts might not leave any physical/visible damage or marking externally on, say a front or rear bumper cover, but there may be underlying damage or contact marks to internal components.</p> <p>Consider obtaining measurements from undamaged items; i.e. grille badges or number plate fixings. These measurements might show later that these undamaged items could (or in fraud case, should) have left a contact mark on the target or bullet vehicle.</p> <p>Consider bringing the involved vehicles together to test a 'mechanical fit' of the damage/marks on each.</p> <p>Allowances for load transfer leading to 'suspension dip' should be a consideration of the investigator/engineer.</p> <p style="text-align: right;"><i>Continued ...</i></p>

<i>Continued ...</i>	<p>Consider scanning damaged areas with a laser scanner or using photogrammetry methods.</p> <p>When measuring the height of marks on vertical vehicle panels, consider placing a suitable ruler or scale vertically adjacent to the side of the vehicle being measured, and take steps to minimise parallax error.</p>
References	<p>Suggested but not limited to; Goddard, C &amp; Hansen, The Manual of Collision Scene Evidence ISBN 978-87-995320-2-5</p>
Cross reference to guides	<p>Good Practice Guide – Photography Good Practice Guide – Pedestrian Throw Calculations. Good Practice Guide – Anti Contamination Procedures</p>

Conspicuity of Road Users and Vehicles	
Purpose	<p>The purpose of this guide is to ensure that, when dealing with incidents where the conspicuity of an object should be considered, sufficient and appropriate testing is carried out, so that later, during the writing of the expert report consideration can be given to:</p> <ul style="list-style-type: none"> <li>• whether a conspicuity issue exists; and, where so,</li> <li>• appropriate assessment is undertaken and measured from the viewpoint of the parties involved.</li> </ul>
Data Capture – Method of assessment	<p>Ensure that the scene has been restored to its pre-collision state prior to carrying out observations and measurements.</p> <p>Identify the location, course followed, area, etc. of the observer and subject under consideration.</p> <p>If testing whether a pedestrian might or might not have contrasted with the ambient background features. Ensure that the assistant acting as the ‘target’ is wearing the same or similar clothing and is of a similar stature etc.</p> <p>When using a vehicle from which to take observations, where possible, utilise the collision vehicle or an exemplar model to replicate as closely as possible, the fall of the headlamps on dipped/main beam.</p> <p>Make observations from the appropriate height and location of the parties involved.</p> <p>Consider mapping the dipped headlamp beams of the vehicle involved.</p> <p>Consider the use of a light-meter to measure contrasting areas of the scene/clothing or objects within the scene.</p>
Data Capture - Recording	<p>Where possible, utilise a DSLR camera with ‘Live View’ to closely replicate the perspective of the human eye. Compact, mobile telephone or video cameras are inappropriate for this task.</p> <p>Support the camera appropriately.</p> <p>Set the white balance of the camera manually to match the ambient lighting conditions.</p>
Equipment - recording	DSLR Camera, light meter, tripod, tape measure, white or grey card, measuring wheel.
Cautionary Notes - Considerations	It is <b>not</b> possible to replicate exactly what someone saw (this should be emphasised in the report). It is possible, however, to set the camera to give a good impression of the conspicuity issues.

References	<p>Suggested but not limited to;</p> <p>Krauss, D (2015). Forensic Aspects of Driver Perception and Response: Fourth Edition. Lawyers and Judges Publishing Company, Inc</p> <p>Green, M et al 'Forensic Vision with Application to Highway Safety': Third Edition. Lawyers and Judges Publishing</p> <p>Hole, G (2014). <i>The Psychology of Driving</i> The Psychology Press New York</p> <p>Muttart, J 'Drivers' Responses in Emergency Situations. Crash Safety Solutions</p>
Cross reference to guides	<p>Good Practice Guide – Photography</p> <p>Good Practice Guide – Anti Contamination Procedures</p>

## Recording the Scene - TPS/GPS

Pending

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<b>Recording the Scene – Laser Scanning</b>	
Purpose	<p>The purpose of this guide is to ensure that, when laser scanning evidence or other aspects of the collision scene and vehicles involved, sufficient, accurate and clear images are gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>• the scene can be described accurately by cross referencing to the scanning;</li> <li>• a 2D or 3D representation can be produced to provide a reliable ‘reality capture;’</li> <li>• the dynamics/movement of vehicles and other objects can be described accurately; and</li> <li>• evidence is recorded accurately, and images properly represent the information being presented.</li> </ul>
Preparation	<p>The scanner, at the time of use, must have a current calibration certificate from the manufacturer that must trace to a UKAS standard or international equivalent. Test scans using fixed targets at the base shall be made on a regular basis to verify that the system is operating correctly and capturing reality accurately. The time period between checks must not exceed three months and will be documented. This can be undertaken by having pre-set immovable targets at known distances, calculated between points by using conventional survey methods.</p> <p>Targets at a known distance shall be present in at least one scan on each scene to verify the system is working. These could be targets fixed permanently to the vehicle or a calibrated bar mounted on a tripod.</p>
Data Capture	<p>Identify and mark all potential evidence or other ephemeral data that might not be identified within a scan easily or clearly by using a bright coloured paint, crayon, Liquid Chalk or low-profile markers (see Marking Guide.)</p> <p>The height of the scanner shall be as high as practicable to ensure that all objects are infilled.</p> <p>Accuracy can be affected by minor vibrations and steps should be taken to mitigate these, particularly on elevated sections of motorways, bridges or carriageways with HGVs passing.</p> <p>To create a useable ‘Point Cloud’, the separation of the points shall not be greater than 7mm x 7mm at 10 metres. The use of full colour scans shall be the default wherever possible and the use of portable lighting should be considered at night to facilitate this.</p> <p>Separation of scan positions should not exceed 30 metres at this setting. Greater separation can be considered, however, if the resolution of the scans are higher and careful selection of scanning positions will prevent any data voids.</p> <p>The footprint of the scanner should be known and, wherever possible, ensure that the scanner is not sited closer to any significant object than this distance. The scene should be clear of all personnel.</p> <p style="text-align: right;"><i>Continued ...</i></p>

<i>Continued ...</i>	<p>Most collision scenes require only that the scanned data to be accurate to itself. Where the scan may be used in conjunction with a further scan or other measurements some distance away, consideration must be made to locate the scan on the OS grid.</p> <p>All scanners vary and the use of targets should be considered where the area is featureless or where reality capture might be affected by luminance of the scene, dark features / vehicles or climatic conditions.</p>
Vehicle Damage Scanning	<p>The use of scanning to measure crush damage is an acceptable method but to ensure accurate results, the following should be considered. The scanner should be set to the same height and as close as possible as the damage, taking the footprint into account. The scanner should be placed to maximise the intrusion into the damaged area. More than one scan should be considered to achieve a comprehensive profile of the damage.</p> <p>The marks used for crush damage analysis need to be clear and consideration should be made to placing the marks on masking tape, with the indices marked clearly in yellow, and attached to the vehicle along the profile, starting at an identifiable feature.</p> <p>Scanning the undamaged vehicle should be scanned in a similar manner, but the scanner might need to be further away to allow the capture of the vehicle's full width.</p> <p>Consideration to using the same method to place the marks used for crush damage analysis.</p>
Download and Continuity	<p>Ensure that there is continuity of evidence between scanning and secure storage of the data file(s).</p> <p>Create a master copy of the data to ensure that the authenticity and integrity are not compromised.</p> <p>Make working copies from which any further work must be undertaken.</p> <p>All work on images must be recorded in an auditable manner.</p>
Plans	<p>The provision of an orthogonal projection, such as a scale plan, from a 3D Point Cloud needs to be completed with care. Scenes that are on hills, where the road undulates or has a significant camber, can cause the distances represented on the orthogonal projection to be foreshortened without correction.</p> <p>The angle of the orthogonal projection shall be parallel to the ground to minimise any error. Where this cannot be achieved, the plan must be marked accordingly and measurements taken only from the Point Cloud.</p>



Mirror Survey	<p>A driver's mirror survey allows the limitations of the mirror view to be represented in a 3D format. The person in the driver's seat shall have their eye level at the same height as the driver in the incident. This does not equate to the same height as the person.</p> <p>The markers should be set not to the limit of the view but 'clearly in view'. Consideration of using different low profiled colour markers placed on the ground representing the view for each mirror, will ensure accurate and correct identification of this point on the ground.</p> <p>Once placed, the vehicle and the associated markers shall be scanned and processed.</p> <p>The lines created from this scan are from the marker to the centre of the respective mirror. (Use a system to ensure the correct edge or point of the marker is selected.)</p> <p>This ensures that the minimum view is represented, whilst the driver can extend that view by head and body movement.</p>
'Fly Through'	<p>The view from a 'fly through' should ensure that the viewpoint represents correctly the distances and views of the actual scene. Care shall be taken not to allow the apparent foreshortening or lengthening of distances, similar to focal length distortion in photography.</p>
Visualisation	<p>Where a visualisation or representation of views from specific locations is considered, care must be taken to provide the full range views available from that position. This shall be provided in a single video output to ensure the information cannot be misrepresented or not all videos presented to the Court.</p>
Simulations	<p>Where a simulation is created, it must be based on data. Any attempt at providing a visualisation of vehicle or people movements without underpinning data, is an animation and should not be considered.</p> <p>Such data could include Tachograph data, CCTV analysis, GPS data or calculations.</p> <p>Where there is any range of figures, the simulation should demonstrate the average and both extremes. Each scenario shall be provided as single video outputs.</p>

References	<p>Auty R., 2012. <i>Using Laser Scanning Saves Time &amp; Improves Collision Investigation</i>, Collision Magazine Fall 2012 Volume 7, Issue 2, Data Publishing, Temecula, US,.</p> <p>Boardman, C 2018. <i>3D Laser Scanning for Heritage</i>. Rep. no. 2nd Edition. London: English Heritage.</p> <p>ASTM E2544: <i>Standard Terminology for Three-Dimensional (3D) Imaging Systems</i>. Rep. Vol. 11a. West Conshohocken, PA:</p> <p>ASTM International, 2011. Print. 3. ASTM E2807: <i>Standard Specification for 3D Imaging Data Exchange</i>. Rep. Vol. 1.0. West Conshohocken, PA: ASTM International, 2011. Print.</p> <p>Carter, N. et al 2016. <i>Evaluation of the Accuracy of Image Based Scanning as a Basis for Photogrammetric Reconstruction of Physical Evidence</i>, SAE Technical Paper 2016-01-1467.</p> <p>Callahan, M. et al, 2012 <i>Close-Range Photogrammetry with Laser Scan Point Clouds</i>, SAE Technical Paper 2012-01-0607.</p> <p>Forman, P and Parry, D. 2001. <i>Data Collection at Major Incident Scenes Using Three Dimensional Laser Scanning Techniques</i>. Proceedings of the Institute of Traffic Accident Investigators Conference, 2001.</p> <p>Grimes, C. et al, 2018. <i>Comparing the Accuracy of Image Based Scanning Techniques to Laser Scanners</i>, SAE Technical Paper 2018-01-0525.</p> <p>Kemeny, J, et al. 2008. <i>Three-Dimensional Digital Imaging for the Identification, Evaluation, and Management of Unstable Highway Slopes</i>. Rep. IDEA Project 119 ed. Vol. Final Report. N.p.: Transportation Research Board.</p> <p>Tandy, D. et al. 2012, <i>Benefits and Methodology for Dimensioning a Vehicle Using a 3D Scanner for Accident Reconstruction Purposes</i>, SAE Technical Paper 2012-01-0617.</p>
Cross reference to guides	<p>Good Practice Guide – Identification and recording of marks</p> <p>Good Practice Guide – Anti-contamination Procedures</p> <p>Good Practice Guide – Establishing a driver's sightlines</p>

<b>Recording the Scene – Manual Measurement</b>	
Purpose	<p>The purpose of this guide is to ensure that, when recording evidence from a collision scene, sufficient and accurate measurements and information are gathered for the production of a scale plan.</p> <p>This guide assumes that electronic measuring devices are unavailable or inappropriate.</p>
Data Capture	<p>In these circumstances, both the ephemeral evidence and the wider road environment can be measured manually. The scene in general will be measured to the nearest 0.05 metre albeit that specific features might be measured to far greater accuracy.</p> <p>The investigator shall decide upon the method of manual measurement that is most suitable to the circumstances. On occasion more than one method might be employed for a single scene.</p> <p>Irrespective of the measurement method employed, regular check measurements shall be taken to minimise accumulative error.</p> <p>Some of the methods available include line and offset, direct linear measurement and triangulation. Reference or datum points shall be permanent features so that the investigator can return to the scene for further measurements if necessary.</p> <p>The origin of the datum line shall be set at an easily identifiable point and the tape shall be laid in a known and repeatable direction, preferably terminating at another known point.</p> <p>Gradients and heights can be measured with the use of a clinometer or spirit level and steel tape.</p>
Equipment	<p>Tape measures and measuring wheels  Surveyors MAG Nails (to mark origins of measurements)  Clinometer  Level</p>
Cautionary Notes - Risk	<p>All measuring devices should be checked periodically for accuracy</p> <p>Road camber might distort straight line measurement</p>
References	<p>Traffic Collision Investigation by Northwestern University Center for Public Safety ISBN 0-912642-09-2, pp189-205</p>
Cross reference to guides	<p>Good Practice Guide – Identification and recording of marks  Good Practice Guide – Anti-contamination Procedures</p>

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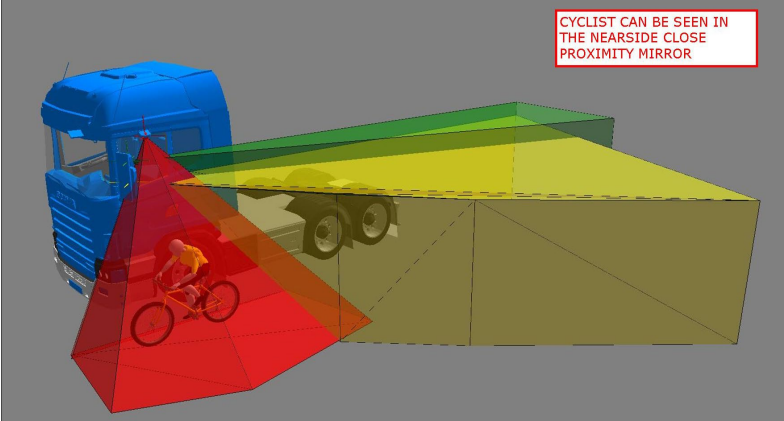
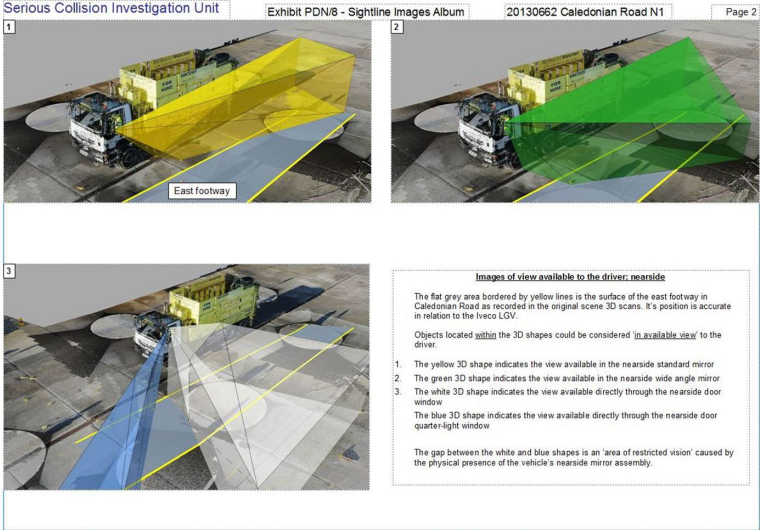
<b>Preliminary Vehicle Examination at Scenes.</b>	
Purpose	<p>The purpose of this guide is to ensure that, when recording evidence from vehicles at a collision scene, sufficient and accurate measurements and information are gathered so that later, during the writing of the expert report, consideration can be given to:</p> <ul style="list-style-type: none"> <li>the position, condition and levels of vehicle controls and mechanical components.</li> </ul> <p>In this way, any changes in vehicle condition between scene and a subsequent full mechanical vehicle examination will be identified.</p>
Considerations	<ul style="list-style-type: none"> <li>Clarify that the forensic strategy is compatible with a preliminary vehicle examination; i.e. cross contamination issues.</li> <li>Ensure the vehicle is stable and safe to be worked upon, inside and out.</li> <li>Hybrid vehicle charging systems: secure the vehicle keys and consider whether there is a likelihood that the vehicle could start and /or move inadvertently.</li> <li>Airbags and other elements of the restraint system that might not have deployed.</li> <li>Contamination of the vehicle by body fluids.</li> <li>Sharp projections and glass.</li> </ul> <p>Identify any changes caused by Fire and Rescue Services/Ambulance staff etc. such as seat movements, seatbelts etc.</p>
Skills / Qualification	<p>Any person carrying out preliminary vehicle examinations should be authorised as per the legislation:</p> <p>When examining electric or electric hybrid vehicles examiners must hold a Level 2 Award in electric hybrid vehicles routine maintenance activities.</p>
Data Capture-Method	<ul style="list-style-type: none"> <li>Preliminary Vehicle Examination form/audio notes.</li> <li>Photography/video.</li> <li>Laser scan/photogrammetry.</li> <li>Calibrated tyre pressure gauge.</li> </ul> <p>Initial visual examination of each vehicle at the collision scene should include:</p> <ul style="list-style-type: none"> <li>Tyre pressures</li> <li>Steering linkage</li> <li>Braking system</li> <li>Ventilation controls</li> <li>Light switch settings</li> <li>Windscreen wipers</li> <li>Audio/visual equipment</li> <li>Dashcams</li> <li>Seat belts</li> <li>Navigation aids</li> </ul> <p>This is not an exclusive list.</p>

## Good Practice in Forensic Road Collision Investigation

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References	Section 38 Policing and Crime Act 2017 and S.67 Road Traffic Act 1988.
Cross reference to guides	Good Practice Guide – Anti-Contamination Procedures Good Practice Guide – Laser Scanning Good Practice Guide – Photography - terrestrial

<b>Establishing a driver's sight lines</b>	
Purpose	<p>The purpose of this guide is to ensure that, when recording evidence from vehicles at a collision scene, sufficient and accurate measurements and information are gathered so that later, during the writing of the expert report, consideration can be given to:</p> <ul style="list-style-type: none"> <li>the determination of the available sight lines for a driver either directly or through any mirrors or CCTV devices fitted to the vehicle.</li> </ul>
Data Capture	<p>Ascertain that the vehicle's seating, mirror or camera positions have not been moved prior to inspection and ensure that their position is preserved during recovery. If these items have been disturbed it should be noted.</p> <p>The driver's seat, mirror and camera position must be recorded, photographed and marked to identify its post collision position.</p> <p>Where possible, the seat to eye line measurement of the driver will be measured.</p> <p>The sight line survey can be carried out at the scene if practicable and where moving the vehicle would compromise the integrity or accuracy of the survey; otherwise the survey shall be carried out at an alternative venue.</p>
Methodology	<p>The chosen methodology for recording the lines of sight / field of view shall be decided upon and documented as part of the vehicle examination strategy. The vehicle shall be positioned in a level area of sufficient in size to include the field of view for all the mirrors, direct line of sight and other driver aids (Fresnel lenses, on-board CCTV reversing/area of restricted vision aids.)</p> <p>Verify that the seat, mirror and CCTV camera positions have not been altered during the recovery process.</p> <p>In the case of mirrors, lenses and direct lines of sight it is necessary to match, as best as possible, the ocular point to that of the driver involved in the incident.</p> <p>The boundaries of the field of views shall be identified using markers, spray chalk etc.</p> <p>To assist with locating objects in the view from on-board CCTV, a grid of appropriately sized squares will be constructed and recorded.</p> <p>Laser scans, TPS surveys or similar methods should be used to record the field and position of view of windows, cameras and mirrors.</p> <p>The engine of the vehicle used should be running if it is a factor in raising or maintaining the seat and suspension height.</p> <p>A subjective assessment shall be made as to when an object becomes recognisable and this is where the marker should be placed.</p> <p>If a mirror is found to be adjusted incorrectly, consideration shall be given to readjustment and resurveying with the mirror positioned correctly (after all measurements are complete with its 'collision' position.)</p>

<p>Caution</p>	<p>The methodology described has inherent limitations and can record only those sightlines / fields of view from a static ocular point.</p> <p>It is not possible to replicate the dynamic field of view experienced by a driver who moves his or her head (and therefore the point of vision or ocular point) to obtain or maintain the optimum view available to the driver. This method can provide only a minimum view available to the driver and not the maximum.</p>
<p>Deliverables</p>	<p>The analysis should be tailored to the needs of the particular investigation. A 2D drawing might suffice for some; however best practice would dictate that a 3D drawing (showing the areas of vision and restricted vision, direct and indirect sight through mirrors and, where appropriate, areas of restricted vision is preferable. It can also include the field of view from any CCTV driver aids (this can be more precise as the ocular point is the camera and does not move.)</p> <p>The limitations of the process and evidence shall be set out clearly, especially with the driver's view being a dynamic ocular point.</p>   <p><b>Images of view available to the driver: nearside</b></p> <p>The flat grey area bordered by yellow lines is the surface of the east footway in Caledonian Road as recorded in the original scene 3D scans. It's position is accurate in relation to the Iveco LGV.</p> <p>Objects located within the 3D shapes could be considered 'in available view' to the driver:</p> <ol style="list-style-type: none"> <li>1. The yellow 3D shape indicates the view available in the nearside standard mirror</li> <li>2. The green 3D shape indicates the view available in the nearside wide angle mirror</li> <li>3. The white 3D shape indicates the view available directly through the nearside door window</li> </ol> <p>The blue 3D shape indicates the view available directly through the nearside door quarter-light window</p> <p>The gap between the white and blue shapes is an 'area of restricted vision' caused by the physical presence of the vehicle's nearside mirror assembly.</p>
<p>Cross reference to guides</p>	<p>Good Practice Guide – Laser Scanning</p> <p>Good Practice Guide – TPS/GPS Surveying</p> <p>Good Practice Guide – Photography - terrestrial</p> <p>Good Practice Guide – Anti-Contamination Procedures</p>



Vehicle Light Bulb Examination	
Purpose	<p>The purpose of this guide is to ensure that, when recording evidence from vehicles at a collision scene, sufficient and accurate measurements and information are gathered so that later, during the writing of the expert report, consideration can be given to:</p> <ul style="list-style-type: none"> <li>the determination of whether light bulbs were illuminated at the time when a road traffic collision occurred.</li> </ul> <p>This guide relates to tungsten filament light bulbs.</p>
Data Capture	<p>Photograph the vehicle concerned, in-situ at the collision scene.</p> <p>At the scene, identify record and photograph the lightbulb in situ. Mark their pre-impact orientation in relation to the vehicle to which they are / were fitted.</p> <p>At the scene, or subsequently at recovery premises, seize the bulbs to be examined. Where possible remove the bulbs within their mountings. Where this is not possible mark the bulb with a gravitational arrow.</p> <p>If a bulb, or an individual bulb and fitment, has become detached from the complete light cluster unit at the collision scene, note and make record of the final rest position of the bulb / fitment and seize.</p> <p>Record and package seized items in accordance with forensic practice and submit for examination together with an accompanying statement, outlining fully all actions taken.</p>
Examination	<p>Bulbs seized should only be examined by someone who is competent to do so.</p> <p>Bulbs shall be examined progressively, as appropriate to the circumstances, using the following methods:</p> <ul style="list-style-type: none"> <li>with the naked eye;</li> <li>with a suitable magnifying glass;</li> <li>via a suitable stereo or digital microscope; and</li> <li>consideration might be given to examining the bulb(s) via a Scanning Electron Microscope (SEM).</li> </ul> <p>Suitable photographic evidence showing the results of any examination(s) must be provided.</p>
Considerations	<p>Oxides left on broken bulbs are water soluble thus the bulbs shall be recovered at the earliest opportunity and sealed environmentally.</p> <p>Note that halogen bulbs contain gas under pressure and should be handled appropriately.</p>
References	<p>Suggested but not limited to;</p> <p>Smith A. &amp; Fielden I. (2016) Forensic Examination of Light Bulbs Materials and Engineering Research Institute, Sheffield Hallam University.</p>

Cross referencing	Good Practice Guide – Photography Good Practice Guide – Anti Contamination Procedures
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## Evidence from Vehicle Occupant Restraint Systems (Seatbelts)

Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording evidence from motor vehicle seatbelt hardware, sufficient and accurate information is gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>• the seatbelts can be described accurately and be cross referenced to photographs;</li> <li>• defects to any component can be described; and</li> <li>• marks on the seatbelt components are recorded and measurements taken such that the investigator can determine accurately: <ul style="list-style-type: none"> <li>○ whether the seatbelt was serviceable;</li> <li>○ whether it was being used at the time of the collision; and</li> <li>○ the seating position of occupants.</li> </ul> </li> </ul>
Data Capture	<p>Identify the type of seatbelt(s) fitted to the vehicle. For example: full harness, 3 point fixed , 3 point active or passive inertia reel.</p> <p>Where appropriate;</p> <ul style="list-style-type: none"> <li>• Consider recording and photographing all the manufacturers labelling.</li> <li>• Measure and photograph the relative positions of floor mountings, upper mountings and clasps, particularly where these are adjustable.</li> <li>• Measure the length of seatbelt webbing either adjusted or spooled out to be slack.</li> <li>• Measure the position of the driver's seat relative to foot controls and steering wheel. Other seats should be measured relative to fixed objects within the vehicle.</li> </ul> <p>Identify, mark, record, measure and photograph the start, transitional points, changes in direction and end of all marks on the webbing and hardware of the seatbelt. Where there is directionality or patterns within the marks this should also be noted and photographed.</p> <ul style="list-style-type: none"> <li>• The measurement method will be by tape.</li> <li>• As part of the recording process marks should be described using the standard glossary of terms.</li> </ul> <p>Use single use adhesive tags to allow easy identification of marks or features on the seatbelt. The use of photographic scale markers or similar are also useful.</p> <p>Do not mask other marks or evidence when using visual aids such as reflective markers or flags.</p> <p>If necessary, remove the inertia reel from the vehicle for future examination.</p>

## Good Practice in Forensic Road Collision Investigation

Types of marks	<p>All relevant marks are to be identified by visual inspection and recorded, including but not limited to:</p> <ul style="list-style-type: none"><li>• Friction burns to:<ul style="list-style-type: none"><li>○ webbing;</li><li>○ upper fixing hardware ('D' Ring); and</li><li>○ fastening tongues/latchplates.</li></ul></li><li>• The webbing might also become 'roped' within the hardware.</li><li>• Clothing fibres, fluids or tissue melted or fused on the webbing.</li><li>• Whether pre-tensioners have activated.</li></ul>
Equipment - marking	Adhesive flags, reflective markers, photographic scales.
Equipment - recording	<p>Camera, tape measure, and scene note book.</p> <p>NB: an external light source, sometimes from an oblique angle, might make marks more easily seen and photographed.</p>
Cautionary Notes - Risk	<p>Contamination/infection from bodily fluids.</p> <p>Unfired pyrotechnic discharge with respect to pre-tensioning devices.</p>
References	<p>Suggested but not limited to;</p> <p>Felicella, Donald J, <i>Forensic Analysis of Seat Belts 2<sup>nd</sup> Edition</i>, ISBN 978-0-9716634-2-8</p> <p>Cofone, Joseph N, <i>A Guide to Determining Occupant Seating Positions from Physical Evidence &amp; Injury Patterns</i>. ISBN 1-884566-29-4</p> <p>Rivers, Robert W, <i>Evidence in Traffic Crash Investigation &amp; Reconstruction</i>, ISBN 0-398-07644-8</p> <p>Goddard, C &amp; Hansen, <i>The Manual of Collision Scene Evidence</i> ISBN 978-87-995320-2-5</p> <p>Moffat C, Moffat E &amp; Weiman T, <i>Diagnosis of Seat Belt Usage in Accidents</i>, SAE Paper 840396</p> <p>Dalmotas Dainus J, <i>Injury Mechanisms to Occupants Restrained by Three Point Seatbelts in Side Impacts</i>, SAE Paper 830462</p>
Cross references	<p>Good Practice Guide – Photography</p> <p>Good Practice Guide – Anti Contamination Procedures</p>

Recovery of digital tachograph data	
Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording evidence from tachograph recording equipment, sufficient and accurate information and data are gathered, so that later, during the writing of the expert report, consideration and analysis can be given to:</p> <ul style="list-style-type: none"> <li>• calibration data;</li> <li>• route tracing; and/or</li> <li>• the speed, distance, acceleration and time linked to the vehicle's movements.</li> </ul>
Data Capture	<p>Where possible the vehicle tachograph unit will be downloaded prior to the vehicle being moved or recovered from its post incident position.</p> <p>In the case of Siemens tachographs, where the vehicle unit stores 4Hz data, some data loss will occur if the vehicle is moved prior to download.</p> <p>Record any time discrepancy in the format HH:MM:SS against UTC.</p>
Processing and storage	<p>Ensure that there is continuity of evidence between downloading and secure storage of the data.</p> <p>Create a master copy of the download to ensure that its authenticity and integrity is not compromised.</p> <p>Make working copies from which any further work will be undertaken.</p> <p>All work on downloaded data must be recorded in an auditable manner.</p>
Equipment	<p>Download device. Note where a data download device has formattable memory, that memory should be reformatted between uses.</p> <p>Control Card.</p>
References	Appropriate download tool users guide
Cross referencing	Good Practice Guide – Anti-Contamination Procedures

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<b>Establishing the deceleration rate of a vehicle through brake testing (non ABS)</b>	
Purpose	<p>Establishing an accurate deceleration rate at the tyre/road interface is important to the process of calculating vehicle speed in collision reconstruction.</p> <p>The purpose of this guide is to ensure that, when testing vehicles without ABS or where the ABS is defective or has been disabled through collision, sufficient and accurate information and data are gathered, so that later, during the writing of the expert report, consideration and analysis can be founded upon:</p> <ul style="list-style-type: none"> <li>the application of the correct acceleration rate.</li> </ul>
Data Capture	<p>Use the subject vehicle if it remains suitable from an evidential and safety perspective or, where this is not possible, an appropriate alternate test vehicle.</p> <ul style="list-style-type: none"> <li>To obtain accurate and repeatable tests, where possible, carry out tests on the same road surface where the collision occurred, in similar conditions and in the same direction.</li> <li>Measure gradients if the collision occurred on a gradient and the testing takes place on a different slope.</li> <li>When skid testing for the purpose of carrying out calculations later conduct three tests.</li> <li>Ensure tests are within 10% and preferably 5% of the lowest result.</li> <li>Where safe, a minimum test speed of 30 mph shall be used up to the estimated speed of the vehicle involved in the collision.</li> </ul> <p>To establish the acceleration at a tyre/road interface consider one of the following methods that should be conducted in a safe environment.</p> <p><u>Accelerometer:</u> Accelerometers in use include, but are not limited to, Vericom and Turnkey Brakesafe (Skidman).</p> <ul style="list-style-type: none"> <li>Use an accelerometer that is in calibration and working correctly.</li> <li>Mount the accelerometer in position within the vehicle as per the manufacturer's guidelines and complete the set-up procedure.</li> <li>Carry out tests from an appropriate constant speed.</li> </ul> <p><u>Braking from a known speed:</u> Where an accelerometer is unavailable, but tests need to be conducted, consider braking from a known speed.</p> <ul style="list-style-type: none"> <li>Determine the test vehicle's speed accurately.</li> <li>Identify marks generated and record the longest tyre mark.</li> <li>Carry out tests from an appropriate constant speed, relative to the collision circumstances.</li> </ul>
Calculations	Use arithmetic mean result in subsequent calculations.

Considerations	<p>The correct application of brakes is critical in obtaining accurate and consistent results. The driver must either use a spotter to check the wheels locked or check themselves by examining the tyres/ tyre marks left by the test vehicle.</p> <p>Consider arithmetic adjustments for braking defects.</p> <p>If ABS scuffs are present, test with the ABS active.</p> <p>Further considerations should be given where the vehicle is:</p> <ul style="list-style-type: none"><li>• towing</li><li>• decelerating over multiple surfaces; and/or</li><li>• decelerating on a gradient.</li></ul> <p>Where the subject vehicle is used for skid testing consider the circumstances of the collision, safety considerations, evidence destruction and follow anti-contamination procedures when required.</p>
References	<p>Suggested but not limited to:</p> <p>Neades, J <i>Skid testing with confidence</i>. The Journal of the Institute of traffic Accident Investigators Vol 21 No 1 pp 4-8</p> <p>Ward, R Neades J (2018) <i>Forensic Road Collision Investigation</i></p> <p>Lambourn, R &amp; Hague ,D (1999) <i>Determination of a car's speed at the start of emergency braking</i></p> <p>Cash, S (2017) <i>The effects of road surface technology on vehicle deceleration calculations</i></p> <p>Marks, C <i>Pavement Skid Resistance Measurement and Analysis in the Forensic Context</i></p> <p>Martin, D &amp; Schaefer, G <i>Tire-Road Friction in Winter Conditions for Accident Reconstruction</i>, SAE 960657</p> <p>Garden, A, Cribb J (2007), <i>Skid Testing of ABS v Non ABS vehicles</i>. Impact Vol 16 No 1 pp 4-6.</p> <p>Shellshear, G (1992) <i>Skid testing – Accuracy in speed measurement</i>. The Journal of the Institute of traffic Accident Investigators. 2 (2), pp. 34-35</p> <p>Lambourn, RF and Wesley, A (2010) <i>Motorcycle tyre/road friction</i>. The Journal of the Institute of traffic Accident Investigators. 18 (3) pp. 8-18</p> <p>Newby, J (1997) <i>Typical goods vehicle deceleration rates</i>. The Journal of the Institute of traffic Accident Investigators. 6 (1) pp. 10-11</p>
Cross referencing to guides	<p>Good Practice Guide – Establishing the deceleration rate of a vehicle through testing (ABS)</p> <p>Good Practice Guide – Establishing the deceleration rate of a vehicle through testing (Drag testing)</p> <p>Good Practice Guide – Anti-contamination Procedures</p>

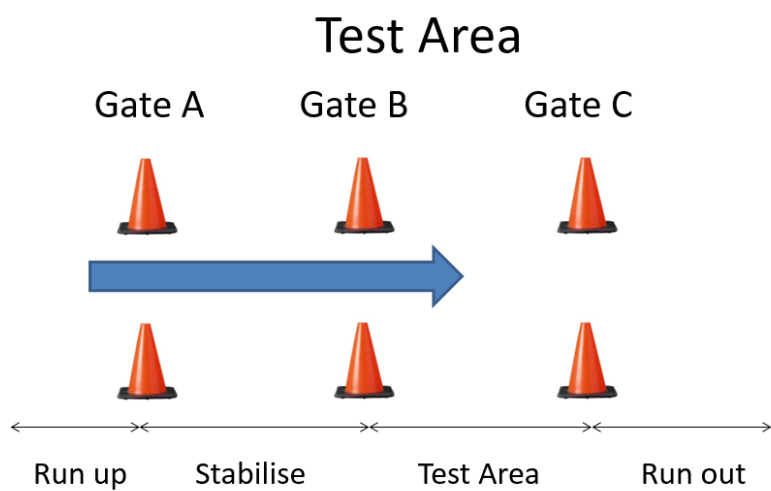


<b>Establishing the deceleration rate of a vehicle through testing (ABS)</b>	
Purpose	<p>Establishing an accurate acceleration rate at the tyre/road interface is important to the process of calculating vehicle speed in collision reconstruction.</p> <p>The purpose of this guide is to ensure that, when testing ABS enabled vehicles, sufficient and accurate information and data are gathered, so that later, during the writing of the expert report, consideration and analysis can be founded upon:</p> <ul style="list-style-type: none"> <li>the application of the correct acceleration rate.</li> </ul>
Data Capture	<p>Use the subject vehicle if it remains suitable from an evidential and safety aspect or an appropriate test vehicle where this is not possible.</p> <ul style="list-style-type: none"> <li>Carry out tests in a vehicle of the same year.</li> <li>To obtain accurate and repeatable tests, where possible carry out tests on the same road surface where the collision occurred, in similar conditions and in the same direction.</li> <li>Measure gradients if the collision occurred on a gradient and the testing takes place on a different slope.</li> <li>When skid testing for the purpose of later carrying out calculations carry out three tests.</li> <li>Ensure tests are within 10% and preferably 5% of the lowest result.</li> <li>A minimum test speed of 30 mph should be used up to the estimated speed of the vehicle involved in the collision.</li> </ul> <p>To establish the acceleration at a tyre/road interface consider one of the following methods that should be conducted in a safe environment.</p> <p><u>Accelerometer</u></p> <p>Accelerometers in use include, but are not limited to, Vericom and Brakesafe (Skidman).</p> <ul style="list-style-type: none"> <li>Use an accelerometer which is in calibration and working correctly.</li> <li>Mount the accelerometer in position within the vehicle as per the manufacturer's guidelines and complete the set-up procedure.</li> <li>Carry out tests from an appropriate constant speed.</li> </ul> <p><u>Braking from a known speed</u></p> <p>Where an accelerometer is unavailable, but tests need to be carried out consider braking from a known speed.</p> <ul style="list-style-type: none"> <li>Determine the test vehicle's speed accurately.</li> <li>Use a chalk gun to establish the point of braking.</li> <li>Carry out tests from an appropriate constant speed, relative to the collision circumstances.</li> </ul>
Calculations	<p>Use arithmetic mean result in subsequent calculations.</p> <p>Correct for gradient where necessary.</p> <p>The correct application of brakes is critical in obtaining accurate and consistent results.</p> <p style="text-align: right;"><i>Continued ...</i></p>

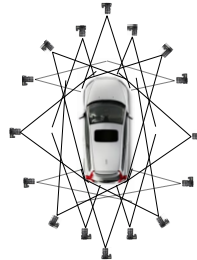
Continued ...	<p>The practice of establishing an ABS acceleration from locked wheel brake testing may lead to an incorrect value being used in subsequent calculations.</p> <p>Consider arithmetic adjustments for braking defects.</p> <p>Further considerations should be given where the vehicle is:</p> <ul style="list-style-type: none"> <li>• towing;</li> <li>• decelerating over multiple surfaces; and / or</li> <li>• decelerating on a gradient</li> </ul> <p>Where the subject vehicle is used for skid testing consider the circumstances of the collision, safety considerations, evidence destruction and follow anti-contamination procedures when required.</p>
References	<p>Suggested but not limited to:</p> <p>Neades, J <i>Skid testing with confidence</i>. The Journal of the Institute of traffic Accident Investigators Vol 21 No 1 pp 4-8</p> <p>Ward, R Neades J (2018) Forensic Road Collision Investigation</p> <p>Cash, S <i>The effects of road surface technology on vehicle deceleration calculations</i> 2017</p> <p>Greibe, P <i>Braking distance, friction and behaviour</i> www.trafitec.dk</p> <p>Martin, D &amp; Schaefer, G <i>Tire-Road Friction in Winter Conditions for Accident Reconstruction</i>, SAE 960657</p> <p>Garden, A, Cribb J (2007), <i>Skid Testing of ABS –v- Non ABS vehicles</i>. The Journal of the Institute of traffic Accident Investigators Vol 16 No 1 pp 4-6.</p> <p>Shellshear, G (1992) <i>Skid testing – Accuracy in speed measurement</i>. The Journal of the Institute of traffic Accident Investigators. 2 (2), pp. 34-35</p> <p>Labbett, S (1997) <i>Are calculations for modified coefficient of friction accurate?</i> The Journal of the Institute of traffic Accident Investigators 6 (1) pp. 10-11</p> <p>Lambourn, RF and Wesley, A (2010) <i>Motorcycle tyre/road friction</i>. The Journal of the Institute of traffic Accident Investigators. 18 (3) pp. 8-18</p> <p>Lambourn (2012)</p> <p>Newby, J (1997) <i>Typical goods vehicle deceleration rates</i>. The Journal of the Institute of traffic Accident Investigators. 6 (1) pp. 10-11</p>
Cross referencing to guides	<p>Good Practice Guide – Establishing the deceleration rate of a vehicle through testing (Non ABS)</p> <p>Good Practice Guide – Establishing the deceleration rate of a vehicle through drag testing</p> <p>Good Practice Guide – Anti Contamination Procedures</p>

<b>Establishing coefficient of friction for a sliding object by drag testing</b>	
Purpose	<p>Establishing an accurate coefficient of friction or acceleration rate for a sliding object is important to the process of calculating speed in collision reconstruction.</p> <p>The purpose of this guide is to ensure that, through testing, sufficient and accurate information and data are gathered, so that later, during the writing of the expert report, consideration and analysis can be founded upon:</p> <ul style="list-style-type: none"> <li>the application of the correct coefficient of friction or acceleration rate.</li> </ul>
Data Capture	<p>Using a calibrated device such as an electronic load cell or other force measuring device, measure the resistive force at the scene.</p> <p>This should be done by dragging the object over the same surface and the same direction on which it slid in the incident and in similar conditions.</p> <ul style="list-style-type: none"> <li>A constant velocity must be maintained during the measurement phase.</li> <li>The drag line should be as close to the centre of mass of the object and parallel to the ground.</li> <li>Three tests at least should be conducted.</li> </ul> <p>The use of an electronic load cell or other force measuring device with a data logging facility is recommended.</p> <p>When obtaining the weight of the dragged object and where practicable use the same measuring device as was used during the test.</p>
Calculations	<p>Use arithmetic mean result in subsequent calculations.</p> <p>Correct for gradient where necessary.</p>
Considerations	<p>In the case of motorcycles, the damaged side of the machine should be used.</p> <p>Test significantly different surfaces independently.</p> <p>The distance of any test should be representative of the surface/topography over which the object travelled.</p> <p>The use of cones or other markers to establish the end of the acceleration phase and the start and stop positions of data logging is recommended (see diagram).</p>
References	<p>Suggested but not limited to;</p> <p>Lambourn, R (1991) The Calculation of Object Speeds from Sliding Distances SAE 910125</p> <p>Hague, D (2004) <i>Calculation of Speed from Object Slide Marks</i> Journal of the Institute of Traffic Accident Investigators Vol 13 No 1</p> <p>McNally &amp; Bartlett, (2003) <i>Object Sliding Coefficient of Friction Tests</i>, Presented at the 21st Annual Special Problems in Accident Reconstruction IPTM</p> <p>Bartlett, Baxter &amp; Robar (2007) <i>Object Slide to Stop Tests: IPTM Accident Investigation Quarterly</i>, Issue 46 Spring</p> <p>Dunn, C (2018) <i>Motorcycle Collisions Manual</i>; AITS South Cerney.</p>

Cross referencing to guides	Good Practice Guide – Establishing the deceleration rate of a vehicle through testing (non ABS) Good Practice Guide – Establishing the deceleration rate of a vehicle through testing (ABS) Good Practice Guide – Anti Contamination Procedures
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<b>Scene and Vehicle Photography – Terrestrial</b>	
Purpose	<p>The purpose of this guide is to ensure that, when photographing evidence, views or other aspects of the collision scene and vehicles/persons involved, sufficient, accurate and clear images are gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>• the scene can be described accurately by cross referencing to photographs;</li> <li>• the dynamics/movement of vehicles and other objects can be described accurately; and</li> <li>• evidence is recorded accurately, and images properly represent the information being presented.</li> </ul>
Equipment	<p>Ideally but not limited to:</p> <ul style="list-style-type: none"> <li>• a digital SLR camera with appropriate lenses;</li> <li>• lighting equipment;</li> <li>• stabilisation equipment such as monopods, tripods and miniature stands;</li> <li>• ensure the availability of sufficient formatted and empty storage media for the incident;</li> <li>• ensure that the camera is set to record images in RAW format;</li> <li>• jpeg images may also be recorded; and</li> <li>• marker boards and marking materials.</li> </ul>
Considerations	<ul style="list-style-type: none"> <li>• Mounting the camera on a tripod or monopod and using a remote or delay to reduce any camera shake.</li> <li>• Consider using a flash gun, either mounted on the camera or off camera. Consider flood lighting and painting objects with torches. Consider oblique lighting.</li> <li>• Review each image for quality. Do not delete images even if they appear poor. Take a new photograph if necessary.</li> </ul>
Photographing scene views	<p>Images of the scene are designed to provide regular views along each possible approach or position of every party involved in the incident. They are designed to assist the Court and interested parties.</p> <p>The focal length should be set to best replicate the view of the human eye.</p> <p>The lateral position of a vehicle on the road at the time of the collision might not be known. Hence, multiple approach paths might need to be considered and photographed.</p> <p>Photographs of approach paths shall be taken at regular identifiable intervals. Longer intervals can be used on faster or more open roads, depending upon the topography.</p>
Photographing marks and evidence	<p>Marks shall be photographed from their starting point through to their end point and at several intermediate points, if appropriate.</p> <p style="text-align: right;"><i>Continued ...</i></p>

Continued ...	Close up images might also be taken to show and patterning within the marks, however, they should be preceded by contextual shots leading into the close-up view.
Vehicle views	<p>Vehicles shall be photographed utilising a series of general images. Consider using a 16 point process as shown in the image to the right.</p> <ul style="list-style-type: none"> <li>Consider adding markers, adhesive scales etc. to highlight points of interest or marks.</li> <li>Consider the use of fingerprint powders to enhance cleaning marks or fabric marks but only after other forensic processes are complete.</li> <li>Close up views of damage should be preceded by contextual views leading into the close-up view.</li> </ul> 
Driver/pedestrian views	<p>When taking views from the perspective of a person, whether they are standing or sitting, as in a pedestrian or driving a vehicle, ensure that the camera is set up correctly so that it most closely resembles the view of the human eye.</p> <p>When replicating the view from a mirror consider the following:</p> <ul style="list-style-type: none"> <li>take images of each mirror as they are available from the driver's seat and zoom into the lens to show what view was covered by the mirror;</li> <li>ensure that the <i>contents</i> of the mirror are in focus;</li> <li>consideration should be given to taking images from different seating positions to illustrate any sensitivity to camera position;</li> <li>Consider use of flash if details of the vehicle's interior are relevant (NB. flash will not normally assist with the mirror view;) and</li> <li>if a long exposure is needed for the mirror view, consider using a tripod or gorilla-pod within the vehicle.</li> </ul>
Processing and storage	<p>Ensure that there is continuity of evidence between photographing and secure storage of the images.</p> <p>Create a master copy of the images to ensure that their authenticity and integrity are not compromised.</p> <p>Make working copies from which any further work shall be undertaken.</p> <p>All work on images must be recorded in an auditable manner.</p>
Cautionary Notes - Risk	<p>Any images of people should protect their dignity.</p> <p>Any images passed to third parties should carry the appropriate level of encryption.</p>
References	<p>Goddard, C &amp; Hansen, The Manual of Collision Scene Evidence ISBN 978-87-995320-2-5</p> <p>ACPO Good Practice Guide for Digital Evidence 2012</p>
Cross reference to guides	<p>Good Practice Guide – Anti-Contamination Procedures</p> <p>Good Practice Guide – Aerial photography</p>

## Scene and Vehicle Photography – Aerial

Pending

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Vehicle Recovery	
Purpose	<p>The purpose of this guide is to ensure that, all vehicles involved in an incident are:</p> <ul style="list-style-type: none"> <li>• removed from the scene of the incident;</li> <li>• transported; and</li> <li>• stored in an appropriate manner.</li> </ul> <p>The object is to maximise the preservation and retention of potential evidence and information whilst maintaining forensic integrity and providing continuity of evidence.</p> <p>At all times the storage and release must comply with the judgement of R v Beckford.</p>
Processes to Maintain Forensic Integrity	<p>Where and when appropriate, ensure that persons approaching the vehicle are both authorised and wearing Personal Protection Equipment (PPE.)</p> <p>Prior to removal of the vehicle, capture all available ephemeral evidence in accordance with all other relevant Good Practice Guides.</p> <p>For the purposes of retaining data in infotainment/CDR/insurance telematics and for the purposes of safety in hybrid/electric vehicles, ensure the ignition is turned off and where a key is a proximity key that it stored in a Faraday bag.</p> <p>The battery on non-hybrid/electric vehicle should be disconnected. Hybrid/electric vehicles should have their battery disconnected only by trained personnel.</p> <p>If evidential recovery within the vehicle is part of the forensic strategy, the vehicle shall be secured to maintain the integrity of the vehicle's interior. Windows that are open, should be recorded as such before being closed. Where a window is smashed, collision wrap shall be used to secure the aperture. Any external forensic opportunities shall be considered prior to the use of collision wrap.</p> <p>Where appropriate, numbered seals shall be placed on all doors that could allow access to the interior of the vehicle. These seals will be placed in lower corners of doors where there is unlikely to be a forensic opportunity. Numbered seals around the Collision Wrap must be used to ensure the integrity of the film. Full vehicle covers can be placed over the car and secured to the car with numbered seals on each corner and two on each side. A new cover should be used on each occasion.</p> <p>Vehicles shall be recovered on a flatbed vehicle using an appropriate method for the circumstances of the incident following discussion with the recovery agent. No vehicle should be started and driven onto the recovery vehicle.</p> <p>When doors, roofs or other components are removed from the car they must not be placed in or on any of the collision vehicles during recovery or storage.</p>

Continuity	<p>Continuity of evidence of each vehicle must be maintained. Whatever the record process, any person who handles or controls the vehicle will record it. Any additional damage caused post incident, must be recorded clearly. Whatever the process adopted, the continuity of evidence must be robust to ensure that any evidence obtained from the vehicle is valid. This might include officers following the vehicle to its secure location from the collection site.</p> <p>The vehicle must be in a covered, secured and restricted area, away from any public gaze. Only authorised individuals may enter, and their entry must be recorded in the continuity process. Any person viewing or conducting work on the vehicle must be added to the continuity record.</p>
Considerations	<p>Generally, nothing shall be added or removed from the vehicle post collision. Vehicular components to be seized for future or more detailed inspection shall be done only after the impact of such a course of action has been considered with respect to the overall integrity of the vehicle and the evidence that it holds. Such seizures shall be documented appropriately.</p> <p>It is acceptable, however, when not part of the investigation, to separate the key(s) from the vehicle. The vehicle key(s) are to be recovered with the vehicle.</p> <p>Should deceleration testing take place with this vehicle at the site, it is important that the condition of the brakes, steering and the position of all controls within the cockpit are recorded fully prior to this activity.</p> <p>Where the weight of the vehicle is likely to be required for subsequent calculations, the recovery vehicles should be weighed prior to arrival at the site. Once the vehicles have been loaded, they should be returned to the same weighbridge to attain the vehicle weight.</p> <p>Video/photograph the recovery process and storage of the vehicle.</p>
Reference	<p>Institute of Vehicle Recovery - VR 19 Preservation of Evidence R v Beckford EWCA CD APP R94 21/12/1994</p>
Cross referencing to guides	<p>Good Practice Guide – Photography Good Practice Guide – Anti Contamination Procedures</p>

<b>Determining the Change Speed of a Vehicle from the Measurement of Crush Damage</b>	
Purpose	<p>The purpose of this guide is to ensure that sufficient and accurate measurements, information and data are gathered, so that later, during the writing of the expert report:</p> <ul style="list-style-type: none"> <li>• consideration and analysis can be given to calculate the energy required to cause the crush to a vehicle; and, thereafter,</li> <li>• to find the change in speed of the vehicle.</li> </ul>
Examination of the damaged vehicle	<p>Vehicular crush is assessed to establish the depth of any damage and doing so the investigator will determine:</p> <ul style="list-style-type: none"> <li>• which areas of the vehicle have been damaged or influenced by the impact impulse, and which areas are undamaged;</li> <li>• the location and involvement of the underlying crush structure; and</li> <li>• areas of largely cosmetic damage that have not absorbed significant collision energy.</li> </ul> <p>The examiner will estimate the principle direction of the force (PDOF) applied to the vehicle. This assessment will normally be given as a range. In assessing the PDOF the examiner will consider:</p> <ul style="list-style-type: none"> <li>• damage to the vehicle;</li> <li>• movement of components and structures should be considered and documented; and</li> <li>• the impact path geometry.</li> </ul>
Documentation of the damaged and exemplar vehicles	<p>Vehicular damage shall be recorded comprehensively. Photographing the vehicle to show the damage profile and exemplar vehicle is essential. Where possible this will include an overhead view.</p> <p>Vehicle details shall be recorded including:</p> <ul style="list-style-type: none"> <li>• registration number;</li> <li>• VIN (where accessible);</li> <li>• make, model and specific variant (S, SE, Sport, Sri etc);</li> <li>• number of doors; and</li> <li>• engine type and size.</li> </ul>
Measurement of the damage profile	<p>The essential premise of the measurement of crush is that the positions of identified points along the damage profile are measured so that they can be correlated to their original undamaged positions.</p> <p><i>Establishing a frame of reference</i></p> <p>A well-defined frame of reference shall be established from which to measure. This can be duplicated later on an undamaged exemplar vehicle.</p> <p><i>Profile measurements</i></p> <p>Profile measurements must be taken at equal intervals along the damage profile and must include a measurement that captures maximum crush depth.</p> <p style="text-align: right;"><i>Continued ...</i></p>

Continued ...	<p><i>Side impact and bowed vehicles</i></p> <p>Where there is any doubt that the vehicle has been bowed by side impact, measurements must be taken using the Pythagorean method.</p> <p><i>Height differentiated damage</i></p> <p>It is common, particularly with side damage, that the deepest damage occurs above the level of the sill and floorplan. Consideration shall be given to the level that best represents the energy transferred to the vehicle structure by taking a mean value for the crush.</p> <p><i>3D scans and surveys</i></p> <p>Where 3D scans are used to record crush, it is essential to ensure that the quality is such that individual measurements can be identified.</p>
Measurement of the undamaged profile	<p>Comparison measurements shall be made at the same height as the damage profile measurements using the same reference frame as the damaged vehicle.</p> <p>Where an undamaged vehicle is measured it might not be possible to measure to the same components identified on the damage profile. This is particularly so when it is not acceptable to remove exterior body panels from the comparison vehicle. In this case it may be acceptable to measure to the external skin of the vehicle and make an allowance for the distance between the vehicle skin and the crushed component measured in the damaged profile.</p>
Calculations	<p>Calculations shall be made manually or, more usually, by using a validated software program.</p>
Cautionary notes	<p>Ensure that the crash pulse has impacted the energy absorbing structure of the vehicle.</p> <p>Any areas of damage that would cause the 'CRASH3' algorithm to underestimate the crush energy absorbed by the vehicle must also be addressed.</p> <p>Bowing of the vehicle might be difficult to detect by eye. Unless certain that the vehicle has remained straight, a bowed impact tactic should be employed.</p>
References	<p>AiDamage course notes for the Damage Analysis Course.</p> <p>Neades, J and Shephard, R (2009) <i>Review of Measurement Protocols Applicable to Speed from Damage Programs</i>. The Journal of the Institute of Traffic Accident Investigators Volume 17(1) pp. 4-12.</p> <p>Jennings PW, (1999) <i>Methods for Assessing Vehicle Speed from Impact Damage</i>. Accident Reconstruction Seminar 1999.</p> <p>Neades, J (2011) <i>Developments in Road Vehicle Crush Analysis for Forensic Collision Investigation</i>. Faculty of Technology De Montfort University.</p>
Cross referencing to guides	<p>Good Practice Guide – Photography</p> <p>Good Practice Guide – Anti Contamination Procedures</p>

<b>Instrument Cluster Examination</b>	
Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording evidence from an instrument cluster of a vehicle, sufficient and accurate information and data are gathered, so that later, during the writing of the expert report, consideration and analysis can be given to:</p> <ul style="list-style-type: none"> <li>• the pre-collision speed of the vehicle; and</li> <li>• that evidence so collected will be preserved correctly.</li> </ul>
Equipment	<p>Appropriate tools for removing the instrument cluster from the vehicle. Typically, this will include screwdrivers, Torx bits and pliers.</p>
Data Capture	<p>Photograph the instrument in situ. Position the camera to minimise parallax error of the needle against the dial scale.</p> <p>Record:</p> <ul style="list-style-type: none"> <li>• full details of the make and model of vehicle including the VIN number;</li> <li>• tyre sizes fitted to the vehicle;</li> <li>• rolling tyre circumference;</li> <li>• evidence of pre-impact braking;</li> <li>• which gear was selected; and</li> <li>• principle direction of force from the impact(s).</li> </ul>
Examination	<p>If the battery has been disconnected, do not attempt to reconnect any power.</p> <p>Retrieved instrument clusters should be photographed and details recorded of any manufacturer's marks or labels present.</p> <p>Photograph all the dials within the instrument cluster.</p> <p>Dismantle the instrument sufficiently to inspect and identify the manufacturer of the circuit board and model of stepper motors driving the needles. Record and photograph any part numbers or identifying marks or features on the motors.</p> <p>Establish the class of stepper motor.</p> <p>Inspect the dial face closely to reveal any needle witness marks. Consider the use of different light sources to obtain the best results.</p> <p>Record any marks with macro photography.</p>
Analysis Criteria	<p>Type A motors will hold their position in all types of impact.</p> <p>Type B motors hold their position reliably in predominantly frontal impacts and might hold their position in side impacts.</p> <p>Type C motors will hold their position in frontal collisions only.</p> <p style="text-align: right;"><i>Continued ...</i></p>

Continued ...	Type D motors are unlikely to hold position in an impact.  There should be no evidence of multiple impacts.  There must be an obvious cause of instantaneous power loss at impact.
References	Goddard, C. and Price, D. (2017) <i>Speedometers and Collision Reconstruction</i> , SAE Technical Paper 2017-01-1412. Goddard, C & Hansen P, <i>The Manual of Collision Scene Evidence</i> ISBN 978-87-995320-2-5.
Cross referencing to guides	Good Practice Guide – Photography Good Practice Guide – Anti Contamination Procedures

Analysis of speed from CCTV	
Purpose	<p>The purpose of this guide is to ensure that, when identifying and recording evidence from CCTV, sufficient and accurate information and data are gathered, so that later, during the writing of the expert report, consideration and analysis can be given to:</p> <ul style="list-style-type: none"> <li>calculating the pre-collision speeds of the participants within appropriate error bounds.</li> </ul>
Data Capture	<p>Recovery will normally be completed by the Police who will be guided by local or national procedures.</p> <p>Identify cameras that may have captured relevant events. This might include CCTV on other vehicles such as buses or dash cameras, head cams etc., local authority CCTV or CCTV from private premises.</p> <p>Carry out lightboard testing in similar lighting conditions.</p> <p>When downloading, check the system time against the current time. Check system to glean information about the recording settings and recording schedule.</p> <p>Secure CCTV according to local procedure but, in any case, onto a suitable storage medium.</p>
Playback	<p>View footage with proprietary player where possible.</p> <p>Alternative codec reading playback software may be used to view footage.</p> <p>Caution must be exercised if the video is played using a generic codec.</p> <p>Ensure original footage is being used and not a re-rendering of the footage.</p>
Time	<p>Establish whether the footage contains a timestamp, either burnt into the imagery or contained within metadata.</p> <p>Establish the frame rate of the footage and subsequently the time interval between frames. Care must be taken when the time intervals are not equal.</p> <p>Utilise a lightboard or similar device to confirm frame interval times.</p> <p>Consider the type of sensor being used to capture the images and the effect of this on the relevant times.</p>
Distance	<p>Make position judgements relating to the participant in question within appropriate error bounds.</p> <p style="text-align: right;"><i>Continued ...</i></p>

Continued ...	<p>Consider the following when applying error bounds:</p> <ul style="list-style-type: none"><li>• video Compression;</li><li>• lens distortion;</li><li>• chromatic aberration;</li><li>• video artifacts;</li><li>• image skew; motion blur;</li><li>• camera mount vibration;</li><li>• image interlacing;</li><li>• camera angle;</li><li>• parallax; and</li><li>• image smear.</li></ul> <p>Establish the distance between two or more positions.</p>
Calculations	<p>Utilise constant speed calculations to establish average vehicle speeds over the measured distances.</p> <p>Utilise error ranges established for the distance to apply a reliable range for the final speed calculation.</p>
Cautionary notes	<p>If generic codecs are used to playback footage, then the playback rate might not be correct.</p> <p>If no time stamp is present, the playback rate alone cannot be relied upon to establish time intervals.</p> <p>Playback software other than proprietary players might not read and display the metadata of a video file in its entirety.</p> <p>Check for duplicated or dropped frames and the reasons this may occur.</p>
References	<p>Crouch, M., Cash, S., (2017), <i>Video Analysis in Collision Reconstruction</i>, Independent Publishing Network, ISBN: 978-1788089308</p> <p>Damjanovski, V., (2014), <i>CCTV: From Light to Pixels</i>, Third Edition, Butterworth-Heinemann, ISBN: 978-0-12-404557-6</p>



Anti-Contamination Procedures	
Purpose	<p>For the purposes of this guidance, contamination is defined as ‘the introduction of DNA, biological material or other trace evidence types at or after the point when a controlled forensic process commences.’</p> <p>This includes the scene examination, searching, recording, recovery, preservation, transport and storage of exhibits and screening tests for use in the field.</p> <p>It is accepted that the preservation of life and protection of the injured is paramount.</p>
Scene actions	<p>The actions set out below shall be considered against the context of the circumstances of the incident being investigated and will be proportionate to those circumstances.</p> <p>On the commencement of a scientific forensic examination of an active scene, all unnecessary personnel shall be moved out of the scene to a suitable rendezvous point and an inner cordon shall be implemented. Only staff essential to the examination shall enter the inner cordon in accordance with the procedures below. A single point of entry to the inner cordon shall be established.</p> <p>A scene log shall capture all people entering or leaving in order that DNA and fingerprint elimination samples can be obtained if required.</p> <p><i>Personal Protective Equipment (PPE)</i></p> <ul style="list-style-type: none"> <li>• Within the cordon two pairs of disposable powder free gloves must be worn, the inner pair shall cover the wearers cuffs and the top pair shall be changed after handling each individual item/area. Gloves shall come from an individual’s personal box of gloves, which shall be kept in a grip seal bag and easily identifiable.</li> <li>• When searching vehicles or when handling items gloves and face masks must be worn.</li> <li>• At Category A and B incidents over-suits/boots/hair nets must be worn.</li> </ul> <p><i>Documentation</i></p> <p>Actions undertaken at/in the vehicle must be documented fully in the scene examination notes, along with the PPE worn at the time.</p> <p><i>Packaging of Exhibits</i></p> <ul style="list-style-type: none"> <li>• All exhibits shall be packaged, sealed and labelled as soon as they are taken.</li> <li>• Handle items as carefully and as little as possible.</li> <li>• Consideration shall be given as to whether a CSI should be requested to the scene to seize and package any contact trace evidence exhibits.</li> </ul>

Cleaning of equipment	<p>An equipment cleaning protocol shall be in place. Wherever possible, sterile, disposable materials shall be used to prevent DNA contamination. Cleaning records shall be maintained in accordance with the equipment cleaning protocol.</p> <p>All items of equipment must be marked individually and be uniquely identifiable, and an inventory maintained of use, cleaning and storage.</p> <p>Before and after, every use:</p> <ul style="list-style-type: none"><li>• all containers used for transportation shall be cleaned;</li><li>• working surfaces and non-disposable equipment shall be cleaned with Trigene wipes* or by using other suitable methods; and</li><li>• materials and equipment shall be cleaned before use and maintained in a packaged and sterile condition.</li></ul> <p>Larger items such as marker flags, imaging equipment and lighting equipment shall be cleaned fully after each use.</p> <p>FCI vehicles must be deep cleaned – removing all equipment and wiping down with appropriate cleaning fluids on a regular basis.</p>
Considerations	<p>Conditions such as eczema or severe dandruff might require the wearing of additional barrier clothing.</p> <p>All packaging materials shall be from the approved supplier list and stored in appropriately managed store rooms.</p> <p>Anti-contamination methodology and documentation must be in place for the store room facility.</p> <p>Consider the risks from:</p> <ul style="list-style-type: none"><li>• contamination/infection from bodily fluids;</li><li>• chemicals – sensitivity to, inhalation; and</li><li>• cleaning fluids.</li></ul>
References	FSR Guidance on anti-contamination
Cross references	Equipment cleaning protocol

Calculations - Using the Equations of Motion	
Purpose	To find speed, acceleration, distance or time in the process of reconstruction a collision.
Background	Newton's Laws of Motion can be used where there is uniform acceleration to calculate speed, acceleration distance or time.
Equation	<p>There are different presentations of the equations including,</p> $v^2 = u^2 + 2as$ $v = u + at$ $s = \frac{1}{2}(u + v)t$ $s = ut + \frac{1}{2}at^2$
Considerations	<p>Consider the error associated with each variable to be used.</p> <p>For speed calculations where a vehicle has been under emergency braking and it is not possible to identify whether the start of a mark was left by the front or the rear wheels, use the actual length and treat the error as <math>\pm</math> one wheelbase.</p>
Results	<p>Give the mean result in the appropriate units having regard for the Forensic Science Regulator's guidance.</p> <p>Calculate and state the error range.</p>
References	<p>Suggested but not limited to:</p> <p>UCPD in forensic road collision investigation (manual) published by AiTS.</p> <p>UKAS document M3003, The Expression of Uncertainty and confidence in measurement (Appendix 2.)</p> <p>Paragraph 26.4 of the Forensic Science Regulator's Codes of Practice and Conduct.</p> <p>Ward, R Neades J Forensic Road Collision Investigation AiTS.</p>
Cross referencing	<p>See also the following guides:</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (non ABS)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (ABS)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through drag testing</p>

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Calculations – Limited Visibility	
Purpose:	To identify the maximum speed at which a driver/rider can travel so as to be able to react and stop or slow to a speed in the distance they can see to be clear.
Background:	This is a first principles calculation based on $s = Vt$ and $v^2 = u^2 + 2as$
Equation:	<p>The equation can be written in different forms but the two most common are:</p> $u_{\max} = a \left[ -t_R \pm \sqrt{t_R^2 + \frac{2}{a} \times \left( s_t + \frac{v^2}{2a} \right)} \right]$ <p>Where <math>v = 0</math></p> $u_{\max} = a \left[ -t_R \pm \sqrt{t_R^2 + \frac{2s_t}{a}} \right]$
Considerations:	<p>When finding the available braking distance, consider the sightline afforded to the driver and how this might vary with height of view point and the lateral position of the vehicle on the road. Use the sightline to establish the distance available in which to react and slow; they might not be the same.</p> <p>Use an appropriate range for the perception response.</p>
Results	<p>Give the mean result in the appropriate units having regard for the Forensic Science Regulator's guidance.</p> <p>Calculate and state the error range.</p>
References:	<p>Suggested but not limited to:</p> <p>UCPD in forensic road collision investigation (manual) published by AiTS.</p> <p>UKAS document M3003, The Expression of uncertainty and confidence in measurement (Appendix 2.)</p> <p>Paragraph 26.4 of the Forensic Science Regulator's Codes of Practice and Conduct.</p>
Cross referencing	<p>See also the following guides:</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (non ABS.)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (ABS.)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through drag testing.</p>

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Calculations – Momentum	
Purpose	To find the speed of a vehicle or vehicles by applying the law of conservation of linear momentum.
Background	<p>The law of conservation of linear momentum states that, in a closed system, momentum is conserved.</p> <p>Whilst in a collision it is unlikely that the system is closed; however the external forces are insignificant when compared to the forces involved in the collision.</p> <p>This equation can be derived from Newton’s first and second laws of motion.</p>
Equation	<p>There are different presentations of the equation including,</p> $p_{before} = p_{after}$ <p>or for a two vehicle collision,</p> $m_a u_a + m_b u_b = m_a v_a + m_b v_b$ <p>The equations may be adapted to suit the circumstances.</p>
Considerations	<p>The law of conservation of linear momentum applies in all collisions albeit that the centre(s) of mass might not always reach a common speed. In these circumstances, vehicle speed cannot be calculated.</p> <p>There is no mass ratio beyond which the equation does not work. Large mass ratios, where the lighter vehicle is the subject of a speed calculation, will become sensitive to small errors in measurement.</p> <p>Where both vehicles are in motion, the largest errors will come from evaluation of the entry and exit angles. Where there is uncertainty, measurements should be ranged.</p>
Results	<p>Give the mean result in the appropriate units having regard for the Forensic Science Regulator’s guidance.</p> <p>Calculate and state the error range.</p>
References	<p>Suggested but not limited to:</p> <p>UCPD in forensic road collision investigation (manual) published by AiTS.</p> <p>UKAS document M3003, The Expression of Uncertainty and confidence in measurement (Appendix 2.)</p> <p>Paragraph 26.4 of the Forensic Science Regulator’s Codes of Practice and Conduct.</p>

Cross referencing	<p>See also the following guides:</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (non ABS.)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (ABS.)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through drag testing</p>
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Calculations – Projectiles	
Purpose:	To identify the launch speed of a vehicle or object.
Background:	This is a first principles calculation based on $s = Vt$ and $s = ut + \frac{1}{2}at^2$
Equation:	<p>The equation can be written in different forms but the two most common are:</p> <p>For a horizontal launch</p> $V = R \sqrt{\frac{g}{2h}}$ <p>For a launch from a known angle</p> $V = R \sqrt{\frac{g}{2(R \tan \theta \pm h) \cos^2 \theta}}$ <p>Where <math>h</math> is the change in height of centre of mass, with positive defined as downwards.</p> <p>To find the optimum launch angle</p> $\theta = \frac{90 - \tan^{-1}\left(\frac{\pm h}{R}\right)}{2}$
Considerations:	<p>Rotation in flight, aerofoil effect and air resistance can affect the height through which the object falls and/or the range.</p> <p>Where objects ‘brake away’ from a vehicle consider whether calculations will lead to a significant underestimate of speed.</p> <p>Consider the error associated with each variable used.</p>
Results	<p>Give the mean result in the appropriate units having regard for the Forensic Science Regulator’s guidance.</p> <p>Calculate and state the error range.</p>
References:	<p>Suggested but not limited to:</p> <p>UCPD in forensic road collision investigation (manual) published by AiTS.</p> <p>UKAS document M3003, The Expression of uncertainty and confidence in measurement (Appendix 2.)</p> <p>Paragraph 26.4 of the Forensic Science Regulator’s Codes of Practice and Conduct.</p>
Cross referencing	<p>See also the following guides:</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (non ABS.)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through testing (ABS.)</p> <p>Good practice Guide - Establishing the deceleration rate of a vehicle through drag testing</p>

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## Glossary

### A

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**ABS** – Anti-lock Braking System. A braking system that prevents the wheels from locking to allow steering and so avoiding uncontrolled skidding.

**ABS mark or ABS scuff** – a mark created from a tyre that is being controlled by the ABS system.

**Acceleration** is the rate of change of velocity ( $\text{ms}^{-2}$ )

**Acceleration Scuff** – a mark made by a tyre rotating faster than the vehicle speed.

**Accurate** - correct in all details; exact to a standard or known value.

**Active Scene** – A scene where contamination of any evidence would compromise the investigation.

**Aquaplaning** – The loss of direct contact between the road surface and the tyre because of undispersed surface water.

**Automatic Registration** - the method in which two or more scans are accurately joined together to form a Point Cloud which is completed by software without operator interaction.

### B

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**Bullseye** – The radiating pattern of fracture lines in laminated glass centred on the point of contact.

**Braking stages of** – The stages of braking leading up to locking the wheels.

Stage 1 – The brakes are applied and are applying a retardation force without causing any wheel slip.

Stage 2 – The brake force is approaching maximum. Some wheel slip is present (< 20%). Small stones cause short (<20cm) road grinding marks.

Stage 3 – The braked wheel is approaching full lock up. A feint tyre mark develops as the heat builds. Road grinding, longer than 20cm are present.

Stage 4 - The wheel is fully locked at 100% slip. The friction has created sufficient heat to melt any bitumen binder present in the road surface creating a darker mark.

### C

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**Centripetal force** – the net force required to keep a body moving around a circular path.

**Centre of mass** (centre of gravity) of a body is the point of application of the resultant forces acting (due to gravity) on that body.

**Chord** - a straight line segment across a circle whose endpoints both lie on the circle.

**Cleaning Mark** – a clean surface, created when an object has wiped away dirt following contact.

**Cloud Density** – The separation distance between points in the vertical and horizontal plane in a scan are defined at 10m from the scanner on a vertical surface. These are expressed as 6mm x 6mm at 10m. (6mm separation both vertically and horizontally between points).

**Coefficient of Restitution** - The ratio of the final to initial relative velocity between two objects after they collide.

**Coefficient of sliding friction** is the ratio of the force required to maintain constant sliding motion of two surfaces compared with the normal reaction between those two surfaces.

**Collision Scene:** The term “Collision Scene” is used to identify the extent of a scene of incident.

The scene is not solely restricted to the location of the incident, but also includes areas where relevant acts were carried out before or after the incident. Suspects, victims and vehicles that are subject to an examination for the recovery of forensic evidence can also be considered to be part of the scene.

## Good Practice in Forensic Road Collision Investigation

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**Conspicuity** – those characteristics of an object or condition that determine the likelihood that it will come to the attention of an observer who does not necessarily expect it to be there.

**Critical Speed Mark** - a tyre mark left by a vehicle that is travelling at the maximum velocity for a given radius.

**Crush/deformation** – The displacement of a point on a vehicle from pre to post impact.

## D

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**Day time** – The duration of the day when any part of the sun is above the horizon.

**Deceleration Scuff** - a mark made by a tyre rotating slower than the vehicle speed.

**Direct damage** – Damage caused as a result of direct contact.

**Displacement** is the measure of a change in position.

**Distance** is the length between two points.

**Divot** – a short, broad mark in a surface where material has been removed as a result of an impact .

## E

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**Expert report** – A technical report presenting findings of technical fact and opinion that fully complies with the requirements of the appropriate criminal or civil procedure rules.

**Event data recorder** - is a device installed in some automobiles to record information related to vehicle crashes or accidents.

## F

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**Fabric marks** – an imprint mark on a surface from a fabric that has left the pattern of the fabric within the mark.

**Feathering** – The worn tapered edge of a freestanding tread block.

**Friction** is the force which opposes the movement of two surfaces in contact with each other.

**Friction circle** – The shape described by direction and magnitude of the forces capable of being generated by a tyre to road interface.

**Friction sliding** – The frictional force developed between two surfaces that are sliding across each other.

**Friction static** – The maximum frictional force developed between two surfaces prior to the point where surfaces begin to slide.

**Furrow** – a rut or trench created by the movements of material by an object moving through a surface.

## G

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**Gouge** – a narrow mark on a surface that significantly extends into the surface.

## H

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**Heel and toe wear** – a non-uniform tread wear pattern of freestanding tread blocks where the leading and trailing edge of the block wear at different rates.

**High side** - is loss of control of a cycle characterized by a sudden and violent rotation of the bike around its longitudinal axis in the direction of travel.

I

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**Impression** – The shape of one object that has been transferred to another surface.

**Imprint** – a pattern on a surface that has been transferred from another surface.

**Impulse** – a force applied for a period of time (Ns)

**Induced damage** – Damage caused as a result of movement of an adjacent component.

J

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K

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**Kerb strike** – a tyre or wheel mark left on the kerb edge as a result of tyre/kerb contact.

L

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**Lacquer Burn** – The discolouration of the top (Lacquer) layer of paint as a result of contact friction.

**Laser scan** – Data containing the 3D position of a point by the use of measuring the distance and angle of a pulsed laser beam.

**Lift off oversteer** - oversteer caused by closing the throttle, causing the rear tyres lose grip.

**Lighting up time** - Half an hour after sunset to half an hour before sunrise, during which all motor vehicles on unlit public roads (except if parked) must use their headlights.

**Locked wheel Mark** – a mark made by the abrasion of a locked tyre on a surface.

**Low side** - is loss of control of a cycle characterized by a rotation of the bike around its longitudinal axis against the direction of travel.

M

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**Mass** is a measure of the amount of inertia of a body. In everyday terms, mass is the quantity of matter contained within a body (kg).

**Manual Registration** - the method in which two or more scans are accurately joined together to form a Point Cloud by a practitioner selecting points that are present in each scan

**Mid Ordinate** – The minimum distance from the centre position of a chord to the circle

N

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**Newton** is the force required to produce an acceleration of  $1\text{ms}^{-2}$  on a mass of 1 kg (N)

**Night time** – The duration when the centre of the sun is  $18^\circ$  below the horizon.

O

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**Oversteer** – a change in direction greater than that attributed to the steering geometry.

### P

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**Parallax** – the displacement or difference in the apparent position of an object viewed along two different lines of sight.

**Peak friction** – The maximum frictional force developed between two sliding surfaces.

**Pedestrian throw distance** – The straight line distance from the point of impact to the centre of mass of rest of a struck pedestrian.

**Perception response time** – (In relation to drivers and riders) the interval that starts when some object or condition first becomes possible for a reasonably alert driver to detect and ends when the driver has initiated a discernible response.

**Photogrammetry** - is the technique of making 3D measurements from multiple photographs.

**Point of actual perception** - The point at which the driver or rider, having recognised the need for action, starts to react.

**Point of Impact** -The point at which the collision actually occurred.

**Point of possible perception** - The point at which the driver or rider could have first seen the need for action.

**Point of Rest** -The point of rest is defined as the point at which the vehicle or pedestrians finally stopped after the collision.

**Point of application** - The point at which the wheels of the vehicles lock, (the start of the skid marks).

**Precise** – Defined or strictly stated. Exactness. Closeness of two or more measurements to each other.

**Pressure/loading mark** – a tyre mark generated by an increase in force applied through the tyre/road interface.

**Principle direction of force (PDOF)** –the direction of the resultant collision forces upon the subject vehicle.

**Point Cloud** - A collection of data points defined by a given coordinates system, recorded from two or more positions, which are registered into a single entity.

### Q

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### R

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**Reaction time** - The time between a person perceiving the need for action and the time for them to take the action.

**Reality Capture** - the digital recording of the real world to provide a virtual 3D model representation of a scene to a high level of accuracy and precision

**Road grinding** – fine scratches within a tyre mark caused by abraded dirt or gravel between the tyre and the road.

### S

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**Scalar** quantity is defined in terms of its magnitude only.

**Scallop** – an oscillating or undulating tyre mark caused by the lateral movement of a deflated tyre.

**Scan** – a collection of data points defined by given coordinates system from a single position.

**Scratch** – a narrow mark on a surface that does not significantly extend below the surface.

**Scuff** – an abrasive mark.

**Seat belt mark** – a mark on the seat belt webbing, fastening tongue, or shoulder 'D' Ring, caused by friction while in use during a significant impulse.

**Seat Belt 'Roping'** – The folding of the seat belt webbing through either the tongue or shoulder loops.

**Shadow Mark** – a faint tyre mark associated with stage 3 braking.

**Sinusoidal mark** – tyre, scratch or gouge marks that follow the path of a sine wave.

**Sliding** – the lateral movement of a vehicle that is not attributable to the steering geometry.

**Slip angle** - is the **angle** between a rolling wheel's actual direction of travel and the direction towards which it is pointing.

**Smear** – the residue of deposited material across a surface.

**Speed** is the rate of change of distance. ( $\text{ms}^{-1}$ )

**Stoppie** - A braking manoeuvre in which the rear wheel or wheels lift off the ground allowing the vehicle to travel only on the front wheel or wheels.

**Striation** – fine abrasion marks within a tyre mark indicating the direction of contact movement.

**Sunrise** – The moment the upper edge of the sun rises above the horizon.

**Sunset** - The moment the upper edge of the sun drops below the horizon.

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## **T**

**Tachograph M file**– Electronic data relating to speed, distance and time stored on a tachograph for the previous 24 hours of driving at a resolution of 1Hz.

**Tachograph S file** – Electronic data relating to speed, distance and time stored on a tachograph for the previous 1 minute of driving at a resolution of 4Hz.

**Trace Evidence** – Any material that is transferable to another scene.

**Tramping** – intermittent tyre marks caused by tyre bounce.

**Tumble marks** – a non-continuous series of scuffs or other marks with a repeating pattern caused by an object that has tumbled across a surface.

**Twilight** – The period of the day when the sun is below the horizon but not below 18°.

Twilight is split into 3 phases, civil, nautical and astronomical. **Civil** twilight is when the sun is below the horizon but less than 6° below the horizon. **Nautical** twilight is when the sun is between 6° and 12° below the horizon. **Astronomical** twilight is when the sun is between 12° and 18° below the horizon.

**Tyre tread** – The part of a tyre that makes contact with the ground. Grooves in the tread are called the groove pattern.

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## **U**

**Understeer** - a change in direction less than that attributed to the steering geometry.

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## **V**

**Vector** quantity is defined as having both magnitude and direction.

**Velocity** is the rate of change of displacement. ( $\text{ms}^{-1}$ )

### W

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**Weight** – is a force produced on a mass due to gravity. (N)

**Wheelie** - a vehicle manoeuvre in which the front wheel or wheels lift off the ground allowing the vehicle to travel only on the rear wheel or wheels.

**Wheel slip** – the difference (quoted as a percentage) between the true speed of the vehicle and the speed of the rolling wheel.

### X

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### Y

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**Yaw mark** – a mark left by a tyre that is rotating as it is sliding sideways.

### Z

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