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Integrated Protocols for Accident Research On The Scene (OTS)

Undertaken on behalf of

Department of the Environment
Transport and the Regions
(VSE Division)

Prepared by

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The authors of this report are employed by Loughborough University. The work reported herein was carried out under a Contract placed on June 2, 1999 by the Secretary of State for the Environment, Transport and the Regions. Any views expressed are not necessarily those of the Secretary of State for the Environment, Transport and the Regions.

Summary

This report set out to develop an ‘On-The-Scene’ (OTS) protocol for investigation of road traffic accidents. It was intended that the main outcome would be to produce a methodology for investigating both accident and injury causation factors relating to road traffic accidents. These protocols are intended for use in a new research project working closely alongside police forces to gain a level of insight beyond existing studies without overtly concentrating on any one aspect of transport safety. This protocol report is an integration of earlier specialist reports prepared by VSRC at Loughborough University, the Transport Research Laboratory (TRL) and BARC at The University of Birmingham.

An OTS accident research project is described to address a wide range of current research questions including:

- Accident causation
- Highways design
- Effectiveness of accident counter-measures, current and proposed
- Traffic conditions related to the causes of accidents
- Modifying road user behaviour
- Development of collision avoidance technologies
- Ergonomic aspects of vehicle handling and braking
- Patterns of injury-type and severity (drivers, riders, passengers and pedestrians)
- Mechanisms for injuries sustained by road users including the “vulnerable road users”
- Vehicle crashworthiness (car, van, HGV, bus, motorcycle and pedal cycle)
- Effectiveness of vehicle-safety design legislation, current and proposed
- Development of “smart” in-vehicle technologies, including restraint and seating systems
- Vehicle instrumentation.

Methodology is discussed in detail for teams working alongside local police forces to establish investigators at the scene of accidents within a maximum of 20 minutes from first notification over the police radio system. Data gathering is prioritised to maximize the probability of obtaining “volatile” data at the scene. A comprehensive set of forms have been designed and are attached for collating information both at the scene and retrospectively. The protocol allows for the investigation of primary and secondary safety related evidence to be assessed in cars, LGVs, buses, motorcycles and pedal cycles. A full range of people participating in accidents can also be addressed including vehicle drivers, riders, passengers, cyclists, pedestrians and witnesses. Predisposing conditions and behavioural characteristics

may be assessed for road users. Finally, the environment and highway itself are also considered in order to assess the degree to which various factors contribute to the cause of accidents. A system has also been outlined by which witnesses may be traced and contacted where appropriate.

The above data will be considerably enhanced by medical data from hospitals, coroners and questionnaires sent to survivors. This data can then be correlated with contact and other scene evidence to ascribe causes to injuries which are also coded according to the internationally accepted Abbreviated Injury Scale. Thus, both vehicle collision and injury mechanisms are able to be reconstructed based on evidence gathered at the scene.

This protocol is compatible with the STAIRS and OECD motorcycle accident data collection procedures. There is, therefore, a section included for the collection of detailed exposure data relating to motorcycle accidents. Furthermore, it has also been possible to design vehicle and casualty measurement procedures to give measurements for comparison with proposed new pedestrian impact test procedures.

The report concludes by discussing ways to ensure that the integrity can be maximised of both the investigation protocol and accident reports to be generated. Suggestions are made for training and pooling of expertise in a OTS research project. Optional modules are also recommended that would further enhance methods and utilization of results.

In conclusion, the investigation protocol set out in this report may be implemented to obtain new real-world empirical evidence from road traffic accidents. Results generated will permit research to develop effective strategies to reduce road accidents, and reduce injuries to road users as a consequence of those accidents.

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1. Introduction

The DETR has the objective to ensure that the UK has the modern transport system it needs to achieve sustainable economic growth:

- with as little adverse impact as possible on the environment:
- in ways that ensure personal safety and freedom of choice: and
- at a costs it can afford.

The DETR requires scientific studies which provide detailed information relating to road traffic accidents (RTAs). In order to develop effective strategies to reduce road accidents and injuries to road users as a consequence of those accidents, it is necessary to determine what is happening in the real world. This can be done through accident investigation studies.

There are a number of subsets of such studies. For example, some studies concentrate on primary safety issues (accident causation, e.g. Treat, 1980) or secondary safety (crashworthiness and injury causation, e.g. Mackay et al. 1960's). In addition to gathering data pertaining to either the factors impinging on the causation of RTAs or the mechanisms producing injuries to those involved, such studies typically have three aims:

- the investigations are used to provide empirical evidence to determine the likely efficacy of potential road safety projects and to suggest new projects and countermeasures and to monitor and feedback road and vehicle safety countermeasure effectiveness;
- the studies are used to provide and test new research methodologies and to provide pointers towards likely new areas of research;
- the studies are used to provide data essential to the design of safe and efficient roads and vehicles and subsequently to obtain an empirical and objective measure of the relative risks associated with differing aspects of highway design, road and vehicle safety.

All in-depth investigations of RTAs use a number of information sources that are normally collected as part of official (i.e. Police STATS19 system) reporting. One of the first information sources sought in any in-depth study is to approach those involved in the RTA themselves. This is most often done directly by the investigators either through on-the-scene

interviews or by questionnaire surveys. Some data can also be obtained indirectly, for example by perusal of police notes or by obtaining hospital casualty notes. However, whilst the police records may provide valuable information, there exist legal issues relating to the investigation of RTAs which may influence the data that are obtained about the persons concerned. Also, the purposes of Police data collection may be different and it is unlikely that all information required for research purposes will be available. The final method of obtaining data about an RTA is the examination of the accident scene and examination of the vehicles involved for the purposes of reconstruction. This can be undertaken immediately after the accident, with the vehicles still in situ or even some days later by examining the vehicles in recovery yards or garages. The scene can be visited at any time but if it cannot be reached within minutes of the accident, it is always preferable that it is visited at the same time of day at which the accident occurred (Carsten, Tight and Southwell, 1989).

It is clear therefore that RTA studies can be undertaken in a number of ways. Firstly, there is the observational method whereby researchers devise means of recording data from the roadside to determine factors associated with the driving task that may be influential in the event or cause of an RTA. Secondly, there is the retrospective method whereby data are collected sometime after the accident and the evidence is forensically 'pieced' together so that the important factors can be established. A third method is the 'on-the-scene' approach whereby researchers attempt to reach the scene of an accident as soon as possible after its occurrence in order to determine the important factors before the evidence is 'lost'.

One of the main features of an 'on-the-scene' (OTS) study is that it is the only means of obtaining perishable data (e.g. skid-marks, pedestrian contact marks on roads and vehicles, rest positions of vehicles and weather, road and traffic conditions etc). This can be essential data, particularly for examining important factors that are associated with pedestrian and cyclist accidents.

The main advantage of the 'on-the-scene' methodology is that the quality and accuracy of the data is potentially enhanced over studies in which data are obtained by one of the other means listed above. Thus accurate measurements of the positions of debris and of the vehicles themselves after the impact can be obtained rather than relying on sketches from drivers or police accident investigators. Also interviews can be attempted on-the-scene with those who have been directly or indirectly involved in an RTA (i.e. RTA participants or witnesses). This

methodology also has the advantage that those interviewed will have a recent memory of the events and will not have had time to modify their version of events or shift blame to another person involved in the RTA.

One disadvantage of an on-the-scene study is that there are costs involved in having a team on standby at different hours of the day although this problem can be overcome by developing a shift system that allows representative sampling of accident types and severities. A prediction of the likely numbers of accidents in the sample area must however be made. Another issue with regard to an on-the-scene study concerns the matter of obtaining notifications of the RTAs sufficiently quickly for the research team to be able to arrive on-the-scene before the volatile information disappears. Some studies have addressed this issue by using a variety of methods including the establishment of direct phone-links with the police or ambulance service or by monitoring the emergency services radio frequencies (Hill et al., 1999a; Southwell et al., 1990).

Literature Review

There have been several past studies of accident investigations. Grime (1987) proposed perhaps the most complete list of basic information that is required at an accident scene. He suggested that the following information should be collected for each case in an on-the-scene accident investigation study:

- date, time and place;
- class of road and speed limit;
- state of light and weather and road conditions: class of street lighting (if any);
- a scale plan indicating the scene of the RTA and including gradients, hedges and obstructions. A vital aspect of this diagram is to accurately mark the positions of the vehicles involved when they have come to rest after the RTA in addition to any marks or debris deposits and damage to roadside furniture;
- photographs of the RTA scene and the approaches to it from the perspective of the drivers involved. Additionally, photographs of marks made on the road by, for example, skidding vehicles, together with any marks to kerbs, verges or other roadside furniture;
- photographs of the texture of the road surface may sometimes be useful if the road surface is wet due to recent rain or snow. If the road surface is dry, photographs of any skid marks

are useful in determining whether any avoiding action was attempted by drivers prior to an accident;

- witness statements should be obtained from all RTA participants and from any persons that were not directly involved in the RTA that witnessed it;
- particulars of all injuries.

Grime's study is a useful starting point although the procedure is principally focused on accident reconstruction. Furthermore, the information obtained only provides answers to the question 'what happened' rather than 'why it happened'. Most importantly, since it was proposed, new interests have obviously arisen about how and why injuries occur to vulnerable and other road users.

The following on-the-scene studies have also been conducted in the UK and Europe:

Mackay et al. (1960)

Detailed objective investigation of the causes and mechanisms of injuries in traffic crashes originated in the US in the 1930's at Cornell University. However it was not until the 1960's that such work commenced in the UK. Such on-the-scene work began with studies by Starks and Miller in 1961 at the Road Research Laboratory (RRL) and continued with Mackay in 1964 who formed a multi-disciplinary team working closely with the Birmingham Accident Hospital. Throughout the 1960's these two studies conducted a number of specific investigations covering both accident causation and the relationships between vehicle design and occupant injuries.

Sabey et al. (1975, 1980)

The TRRL studies involved a multi-disciplinary team of researchers being on-call 24 hours a day for a period of four years between 1970 and 1974 in the area in and around the Transport and Road Research Laboratory in South East Berkshire, UK. The team was called to RTA scenes by the police authorities immediately on receipt of a notification of an incident. At the scene, the investigators recorded brief details of the volatile (i.e. non-permanent) information such as skid marks, debris and position of the vehicles involved after the impact. They also conducted brief interviews with those involved.

In total, the team investigated 2130 RTAs, which represented 60% of all injury accidents reported to the police in the area.

The most important outcome of the study was viewed to be an assessment of the contributory factors assigned to the RTAs studied. The factors studied included;

- those concerned with road design and environment;
- those concerned with the vehicle, its design and condition; and
- those concerned with the human factors (driver or pedestrian, driver skill, judgement and perception and fitness to drive).

They found that the road user was solely or partially responsible for the accident in 95% of the accidents studied. Adverse road and environment features were solely or partially responsible in 28% of cases and vehicle defects were solely or partially responsible in 8.5% of cases.

Additionally, they allotted responsibility to drivers or pedestrians involved in the RTAs by assigning each to an 'at-fault' or 'not-at-fault' category and judged errors made by drivers according to a series of categories of driver error specific to their RTA. In terms of fault, of the drivers, 40% were judged to be at fault, 19% partially at fault and 39% not at fault. Analysis of the data revealed that the survey was representative of the South East Berkshire area but not of the country as a whole.

Treat et al. (1980)

Treat's studies utilised essentially the same methodology as Sabey's studies with a slight modification such that a three-level approach to data collection was used so that each factor was allocated as being a 'definite', 'probable' or 'possible' factor in the causal chain of events leading to an RTA. The results of his study were essentially similar to those of the TRRL study indicating that human factors were definite causal factors in 70.7% of RTAs and definite or probable causal factors in 92.6% of RTAs.

Otte et al. (1973-present)

Otte et al. have continued to carry out on-the-scene investigations of RTAs since 1973. In this study, investigations are made on-the-scene using the Medical University of Hannover as

a base. A team consisting of doctors and technicians investigate traffic accidents involving injured persons in the greater vicinity of Hannover by a statistical spot-check procedure. Damage to vehicles, accident traces and injuries are documented in detail and the injury classification AIS (Abbreviated Injury Scale) is used to describe the injury severity of each occupant. The accident is analysed in detail and the kinematics of vehicles and passengers are reconstructed. Collision and driving speeds are determined from accident evidence including skid-marks and severity measures such as Equivalent Energy Speed (EES) and speed change at impact (Delta-V) calculated from vehicle deformations. The reconstruction also involves the calculation of the avoidance speed of the crash - the maximum travel speed at which the crash could have been avoided. The overall aim of the Hannover study is to derive an in-depth database that can be used for analyses of nearly all categories of traffic accidents involving injured persons.

The data collection operation is mainly focused on-the-scene although it is acknowledged that this entails some loss of information. Therefore the information that cannot be obtained from the scene is obtained using retrospective methodology (from hospitals, garages etc.).

An on-the-scene methodology is preferred in the study since it is accepted this methodology is crucial in the determination of characteristics of road user behaviour, (particularly physical and psychological condition), and also in the measurement of skid-marks, the state of the crashed vehicles, the conditions of the environment etc.

INRETS Study, (1980-1987)

Between 1980 and 1987, the Department of Accident Mechanisms at the Institut National de Recherche sur les Transports et leur Securite (INRETS) conducted an in-depth study of RTAs in the Salon de Provence region of France. Over the course of this study, 400 RTAs were examined in detail (Girard, 1993). The INRETS team was alerted to an RTA at the same time as the emergency services and collected as much information as possible at the scene of the crash. The study concentrated on 'vanishing' data such as skid marks, final rest locations of vehicles involved, weather and roadway conditions. These data together with preliminary assessments of the vehicles were collected by a trained technician, whilst a psychologist interviewed the driver either on the scene or as soon as was possible afterwards. A second phase of the study was undertaken subsequent to the accident comprising an investigation of the demographics of the driver, investigation of details of the journey being undertaken and a

technical vehicle inspection. The main outcome of the study was the development of 'prototypical accident scenarios' which were described as a series of processes 'corresponding to a series of accidents which are similar in terms of the chain of facts and causal relationships found throughout the various accident stages'. This concept of prototypical scenarios allows data from a number of RTAs to be combined to allow knowledge to be generalised across a number of studies. Because the main focus was on case studies rather than statistical representation, the team was able to direct a large analytical effort into a few cases.

2. Aims and Objectives

This report has been commissioned to develop an ‘on-the-scene’ (OTS) protocol for investigation of road traffic accidents. It was intended that the main outcome would be to produce a methodology for investigating accident causation in general and injury causation to specific road users to give a level of insight beyond existing studies, without overtly concentrating on only one aspect.

Interest in an on-the-scene study goes hand in hand with current research requirements to learn more about accident causation (primary safety). Also, secondary safety issues, injury prevention factors and vehicle crashworthiness continue to be worthy of innovative investigations. It is anticipated that this project will capture ‘volatile’ information that is only available on-the-scene. Furthermore, OTS research will also be able to address road user behaviour, highway design and other important highway safety issues. It will provide a new opportunity for a range of research interests and disciplines to work together.

It was not intended that this project would produce a detailed hand-book on how to conduct an on-the-scene study. Instead, it was intended that this study would achieve the following:

- definitions of the data to be collected (with appropriate data collection forms);
- definitions of the important characteristics of the procedure;
- definition of the sampling structure.

It was intended that the resultant study would allow this data to be collected by a number of participating teams whilst allowing for local variation, where appropriate.

Design of a protocol for on-the-scene accident investigations is an essential component of an on-the-scene study. An appropriately designed protocol will allow as much key data as possible about each accident to be captured in the small window of time that is available from the scene of a crash. It is expected that the protocol would also allow follow-up and secondary investigations where necessary.

An appropriately designed protocol will also assist in the development of an accident database, which will ultimately provide answers to research questions when sufficient data are available.

The following are also important considerations:

- the protocol will be of a readily analysable format to allow answers to specific research questions about vehicle accident and injury causation;
- the data-collection protocol will be suitable for determining future directions for vehicle engineering in the light of the development of new technology and will therefore be designed to assist system suppliers.

The VSRC propose that the data will be able to answer future research questions on the following:

- Accident causation
- Highways design
- Effectiveness of accident counter-measures, current and proposed
- Traffic conditions related to the causes of accidents
- Modifying road user behaviour
- Development of collision avoidance technologies
- Ergonomic aspects of vehicle handling and braking
- Patterns of injury-type and severity (drivers, riders, passengers and pedestrians)
- Mechanisms for injuries sustained by road users including the “vulnerable road users”
- Vehicle crashworthiness (car, van, HGV, bus, motorcycle and pedal cycle)
- Effectiveness of vehicle-safety design legislation, current and proposed
- Development of “smart” in-vehicle technologies, including restraint and seating systems
- Vehicle instrumentation.

3. Protocol Development Methodology

The protocol has been developed using the following approaches:

- Reference to current issues on road and vehicle safety;
- Reference to detailed data collection protocols that have been developed by the following institutions, for the following aspects of road safety:

Pedestrian safety	Birmingham Accident Research Centre (BARC) (Hill et al., 1999 a & b)
Cyclist safety	BARC (Hill et al., 1999 a & b)
Witness testimony	BARC (Hill et al., 1999a)
HGV safety	Transport Research Laboratory (Turner, 1999)
Highway design	TRL (Turner, 1999)
Motorcycle safety	TRL (McCarthy and Chinn, 1999)
Car and van safety	Vehicle Safety Research Centre (Morris et al., 1999a)
- Reviewing previous and current studies which use an on-the-scene approach to accident investigation;
- Reviewing previous and current studies of vehicle crash performance and occupant injury;
- Reference to an on-the-scene study of pedestrian and other vulnerable road-users in Nottingham conducted in 1999 (Morris et al., 1999b);
- Reference to the STAIRS procedure for accident investigation;
- Consultation with emergency services in the Nottinghamshire area including a two-week placement with the Nottinghamshire Traffic Police to establish the feasibility of accident scene data collection;
- Consultation with other organisations with expertise in the design of studies of road safety;
- Visiting the Medical University of Hannover to consult with members of an existing on-the-scene study team and to participate in some on-the-scene investigations;
- Trials of on-the-scene accident investigations held in the city of Nottingham between 1st May and 31st July 1999.

The literature concerning previous and current studies that use or have used an on-the-scene method of investigation has been reviewed above.

The VSRC was provided with data variable lists and protocols from other institutions. It was seen as the responsibility of the VSRC to develop data collection forms using these protocols as the basis.

The determination of data that would be required to provide the study with an indication of factors associated with accident causation was also established by reference to the studies listed above. However, a review was also made of other studies which have specifically examined the issue of accident causation (e.g. Fletcher, 1999, Broughton, 1998 etc). It was determined at the outset of the study that it would be necessary for the development of road-user questionnaires to supplement the data that could be obtained from the scene. The development of a questionnaire was made through co-operation with the Accident Research Unit based in the Department of Psychology in the University of Nottingham.

Consultation and collaboration with Emergency Services was seen as essential for the development of a protocol for on-the-scene investigations. After consultations with all emergency services and the DETR, it was established that the Police would be the most appropriate emergency service with which to be based. This is particularly so because research teams should aim to reach the scenes of accidents within fifteen minutes of accidents occurring, and within not more than twenty minutes from occurrence, in order to minimize the loss of essential 'volatile' information. The use of a blue flashing light is normally a prerequisite for achieving this. Reasons for VSRC choosing to work together with the Nottinghamshire Constabulary are summarized below:

- Use of blue lights for rapid access to accident scenes;
- Use of police communication channels allowing excellent notification facilities;
- Availability of consultation for police accident investigation techniques;
- Availability of police accident reconstructions;
- Availability of police reports of vehicle defects, witness reports and other information pertaining to the crash;
- Provision of personal security to accident investigators;
- Ease of establishing a link with STATS19 data for statistical sampling purposes.

Consideration was made about the possibility of basing research teams with the ambulance services, but this proposal was rejected at VSRC on the grounds that there would be

insufficient room for investigators and equipment to travel in ambulances. Further reasons for favouring police over ambulance services for gaining access to scenes included the need for transport back to the research base after completing investigations, equipment storage requirements, and assistance available from police officers with regard to health and safety at scenes of accidents.

4. Accident Investigation Protocols : On-the-Scene and Follow-up

This section covers recommendations for the general methodology for teams attending a road traffic crash for the purposes of crash investigation and data collection. Follow-up and case completion procedures are also described.

4.1. Preliminary Requirements

Before an on-the-scene study is conducted, it is essential that a professional risk assessment of the activity be conducted. This is to ensure compliance with the requirements of the Health and Safety at Work Act (1974). Under the auspices of this act, it is the duty of a responsible employer to provide a safe and healthy workplace and working environment for all its employees. Furthermore, employees are responsible for taking care of their own safety and to co-operate with the management of the organisation to which they belong so as to enable it to carry out its own responsibilities successfully. Safety training requirements are addressed on page 16 and, with emphasis on specific dangers on motorways, on page 51.

A team planning to conduct investigations of crashes on-the-scene should also consult with all emergency services to discuss conduct and etiquette whilst on-the-scene and to ensure that the emergency services are aware of the likely presence of an on-the-scene team. This ensures that the activities of the team do not interfere with the duties that are carried out by the emergency services since those duties must always take priority.

Consideration should also be made about the ethical implications of the project and approval may need to be sought from an appropriate ethical committee before the study proceeds. Another consideration involves insurance. It will be essential that teams participating in an on-the-scene project should obtain insurance protection in relation to research at the scene of accidents, travelling to and from accidents and working with the emergency services. The Police may not always provide insurance for civilian occupants of Police vehicles. Lastly, team members planning to work at the scenes of accidents should be inoculated against hepatitis B and tetanus, in line with current Co-operative Crash Injury Study policy.

4.2. **Establishing a Team to Undertake an On-The Scene Project**

As a first requirement, it is necessary to establish a team who will be responsible for undertaking an on-the-scene project. As a minimum requirement, the team should be capable of fulfilling the following functions:

- Project management
- Accident investigation
- Police officer duties
- Medical data co-ordination
- Co-ordination of information and case-report compilation
- Utilization of information technology, photographic equipment and other specialist equipment
- Project administration

This team requirement may vary according to the circumstances and needs of each individual centre participating in the study, the numbers of cases required by the sponsors of the project and the sampling methodology. Some teams may wish to employ staff on alternative shift days, others may wish to maintain staff on stand-by in which case the team requirements may be greater than is recommended.

The project manager for each team should preferably be an experienced researcher or accident investigator and someone who has first-hand experience of on-scene accident investigations.

The accident investigation team should have, collectively, experience and understanding of the following areas:

- Accident reconstruction
- Accident investigation
- Injury causation
- Crashed vehicle investigation techniques
- Statistics
- Injury scaling and injury coding

The driver of the response vehicle should be trained to the equivalent of class I.

The team should operate on a on-call-rotation basis; when an accident investigator is not working 'on-call' they will be expected to undertake the follow-up work that will be required for each accident investigated by the team. When investigators are working 'on-call' but are not actively visiting a scene, they should be finalising assembling cases for completion.

Additional team members would also be required to meet the requirements of any additional modules, as outlined below in the Discussion and Recommendations (page 49).

4.3. Training

Each team should ensure training is available for team members participating in data collection on an on-scene project (including the Police Officer, if appropriate). The following areas have been identified as outlining the training needs:

- Health and Safety (including safety on-scene, particularly on motorways, see page 51)
- First aid
- Terminology: vehicles and highways
- Terminology: accident investigation
- Intermediate/advanced road safety engineering
- Data collection equipment, data capture equipment & downloading

It is envisaged that these training requirements can be provided in parallel with the commencement of the study. However, it is recommended that the commencement of the study should not necessarily be delayed because these training requirements have not been fulfilled since training can be provided whilst working on the study. One possibility involves exchange of staff in the early stages of the study.

Training in specific areas of data capture could possibly be provided by the following organisations (who would need to be approached first):

- M1 and N1 vehicle inspections on the scene (*Vehicle Safety Research Centre, Loughborough University*)
- Pedestrian crash investigations (*Vehicle Safety Research Centre at Loughborough University and the crash investigation training team at West Midlands Police*)

- Highways issues in accident causation (*Investigations and Risk Management, Transport Research Laboratory, Crowthorne*)
- Heavy Goods Vehicle, bus and coach investigation (*HM Vehicle Inspectorate*)
- Motorcycle accident investigation (*Transport Research Laboratory*)
- Recognition of road user vision and road safety obscuration issues. (*Transport Unit, ICE Ergonomics*)

4.3.1. Training for Specialised Accident Investigators

As mentioned below (see page 49), it is the opinion of the Authors that if the sponsors require specialised motorcycle data (using the complete OECD methodology) study information, specialised staff may need to be employed as investigators as these are seen as specialised modules. The training requirements for staff in this module need to be determined.

4.4. Identification of Sample Area and Sampling Procedure

The aim of the on-the-scene project is to build up a data set of accidents that is truly representative of the accidents occurring in the study area. To achieve this, a sampling strategy is required. Furthermore, the precise boundary of the study area should be established. This should be based on the following:

- The geographical region within which accident scenes can be reached within 15 minutes (20 minutes maximum, see page 11) with consideration of travel times to be expected in typical traffic conditions;
- The willingness of local emergency services to co-operate;
- Local authority boundaries so that stats19 accident records can be clearly identified.
- Hospital catchment areas

It is imperative that every team involved in an on-the-scene project works to the same sampling procedure so that the data can be combined. The sample specification should include the following items:

- Specification of the accident population from which the sample is drawn, e.g. 999 call-outs;
- Case selection method;
- Any preferential selection of vehicle type;

- Sample area, especially if teams plan to use a stratified sampling system;
- Back-up information for statistical weighting purposes;
- The team rota system.

It is recommended that the sponsors should specify what the make-up of the sample should be and it would be then up to each team to develop methods to achieve the sampling targets.

One possibility for arranging the sampling rota would be to adopt the Hannover approach to sampling where teams operate six-hour shifts seven days per week which are at fixed times each week but change from week to week.

week 1	0600-1200
week 2	1200-1800
week 3	1800-2400
week 4	2400-0600 etc.

It is recommended that whatever sampling plan is chosen, the procedure should be reviewed after one year, with reference to population statistics for that year, to ensure that the sample is giving the right mix of road users and crash information. The sampling system should specify statistical case weighting factors that can be applied when appropriate to ensure that the data are representative of the UK national perspective with regard to road traffic accidents.

4.5. Accident Notification Procedure

It is proposed that an on-the-scene team is based the Police to ensure prompt attention at the scene and the team will need to establish that they have regular contact with an appropriate accident notification procedure. This can normally be achieved through the Police radio system, and the on-the-scene team should endeavour to establish a unique radio call-sign that they can respond to upon notification of an accident. A back-up telephone notification procedure should also be arranged with the respective Force control rooms.

4.6. Team Location and Transportation to the Scene

Unless it can be determined in advance that the accident scene has been 'closed' by the police (as occurs in most fatal accidents), crash-scenes should preferably be reached not greater than 15 minutes after the accident notification in order that the maximum amount of information is

captured. It is suggested that this will be the case for all accident types and so the location of the team and the means of transportation to the accident scene is a critical factor in the study. It is recommended that teams attending the scenes of crashes travel with members of the emergency services (who have permission to use a blue flashing light) in order to ensure that this time period is not exceeded. The Police normally use different response 'levels' of driving speed depending upon the circumstances which they are called to. These are as follows:

- Level I (immediate response in a life-threatening situation)
- Level II (reach scene quickly for preservation of evidence, but immediate full-level response not necessary) and
- Level III (the scene should be reached at normal driving speed).

A driving speed, which is comparable to level II above, is recommended for an on-the-scene project. This would entail travelling to the accident scene with a blue light and cautious red-light running as necessary. The response level to accidents should be determined in advance of the study commencing and it is up to each study team to establish this with the respective Police divisions and drivers.

4.7. Response Assignment and Notification Log

When a notification is received and an accident is to be attended, the team assignments for the crash investigation should be established.

It is proposed that one of the accident investigators should be solely responsible for photography and video evidence. However, it is envisaged that this team-member will be available to assist in other data-capture once the video and photographic evidence has been captured.

The on-the-scene investigation team should maintain log-books to monitor all notifications, whether they are attended or not. A member of the on-the-scene team should record any available information in the logbook. It is recommended that the information recorded should be as follows:

- Date and time of accident and notification

- Location of accident
- Reason for non-attendance (if applicable)
- On-the-scene accident number (if applicable)

When the on-the-scene team reach the accident scene, the arrival time should be noted and the location of the accident scene should be confirmed.

4.8. Team Assignment

It is recommended that a team of two accident investigators/researchers attend the scene of an accident accompanied by a Police Officer. The Police Officer would normally be the driver of the vehicle but who would also help out with data collection at the scene and would establish critical facts about the accident.

Furthermore, the on-the-scene team Police Officer would normally be responsible for establishing contact with the Officer in Charge (OIC) at the scene. The Officer in Charge must give permission for the on-the-scene team to proceed before the investigation commences.

If an accident scene is not deemed as safe by either the Officer in Charge or the on-the-scene team Police Officer, the on-the-scene data collection should be delayed until the scene can be rendered safe for the team (and this applies particularly in the case of motorway crashes). There may be chemical or explosion risks that the Officer-in-Charge will be able to identify.

4.9. Arriving First On-The-Scene

If an accident investigation team is first to arrive on-the-scene, it should endeavour to administer a suitable level of basic life-preserving first aid if this is deemed necessary. Data capture can begin providing that all emergency aid has been appropriately administered and the paramedics have taken charge of the casualties.

4.10. Priority Levels for Data Collection

The data collection forms are appended to this Report (Appendix I). Where possible, the forms have been organised in terms of the priority of events at the scene of the accident. For each accident, there are data at a number of levels and these have been classified as follows:

- Level 0 variable: STATS 19 data and unique references, although some of this may not be known at the time of the accident (e.g. exact time of accident, accident number, Police reference number, etc.)
- Level I variable: information likely to disappear permanently shortly after the crash (e.g. rest position of vehicles, pedestrian clothing, contact marks on cars in pedestrian or cycle crashes, etc.)
- Level II variable information that will be available for a few days post-crash (e.g. the vehicle itself, which may be stored in a recovery-yard, the highway layout at the accident scene, etc.)
- Level III variable information that will be available semi-permanently (e.g. medical notes, questionnaire responses etc.)

A further level is suggested as follows:

- Level IV variable special study information (e.g. in-depth component failure studies, mathematical modelling of individual crashes)

It is proposed that each investigation begins with the capture of Level 0 and Level I data and then proceeds through level II (if time permits). It is imperative that as a minimum, all level I data are collected at each scene.

In most circumstances, it is envisaged that Level II data will be collected by scene re-visits or recovery-yard visits. However, in some circumstances where the scene is 'closed' by the Police, all data up to and including Level II data could be captured provided a parallel notification is not received. Level III data is not normally available at the scene but can be obtained at a later date. Similarly, Level IV data relating to the accident may need to be captured as a separate activity - data capture at this level will not be made at the time of the initial accident scene visit.

Due to the different accident circumstances that teams will confront at different accidents, it is difficult to produce a sequencing of events that will apply at all accident scenes. Therefore

the sequencing should not restrict freethinking and improvisation by investigators during scene examinations. It is envisaged that common sense will determine the order of priority.

4.11. On-the-Scene Sequencing

As a minimum requirement, a team actually attending accident scenes should comprise three persons. The functions that should be performed at the scene are as follows:

- Accident Investigation and data collection
- Photography and video data-capture
- Police Officer duties.

The sequence of events on-the-scene is critical if the loss of 'volatile' information from the scene before capture is to be avoided. It is for that reason that the following order of priority should apply:

- all level 0 accident data (outlined on form)
- pedestrian level I data
- cyclist level I data
- highways level I data
- cycle level I data
- motor-cyclist level I data
- motorcycle level I data
- M1 and N1 level I car/van and occupants
- bus level I data and occupants
- HGV level I data and occupants
- any necessary level II data as time permits
- any necessary level III data as time permits

This sequencing is the recommended sequencing. However, it is acknowledged that the circumstances of accidents differ greatly. Therefore, this sequence should be adopted as a guideline and if circumstances determine that an alternative sequencing would result in a more efficient data capture process for that particular accident, then that sequence should be used in preference. This will be at the discretion of the investigation team.

Figure 1 illustrates the recommended sequence of events for a team that attend the scene of accidents. This should not be seen as a rigid model but a guideline.

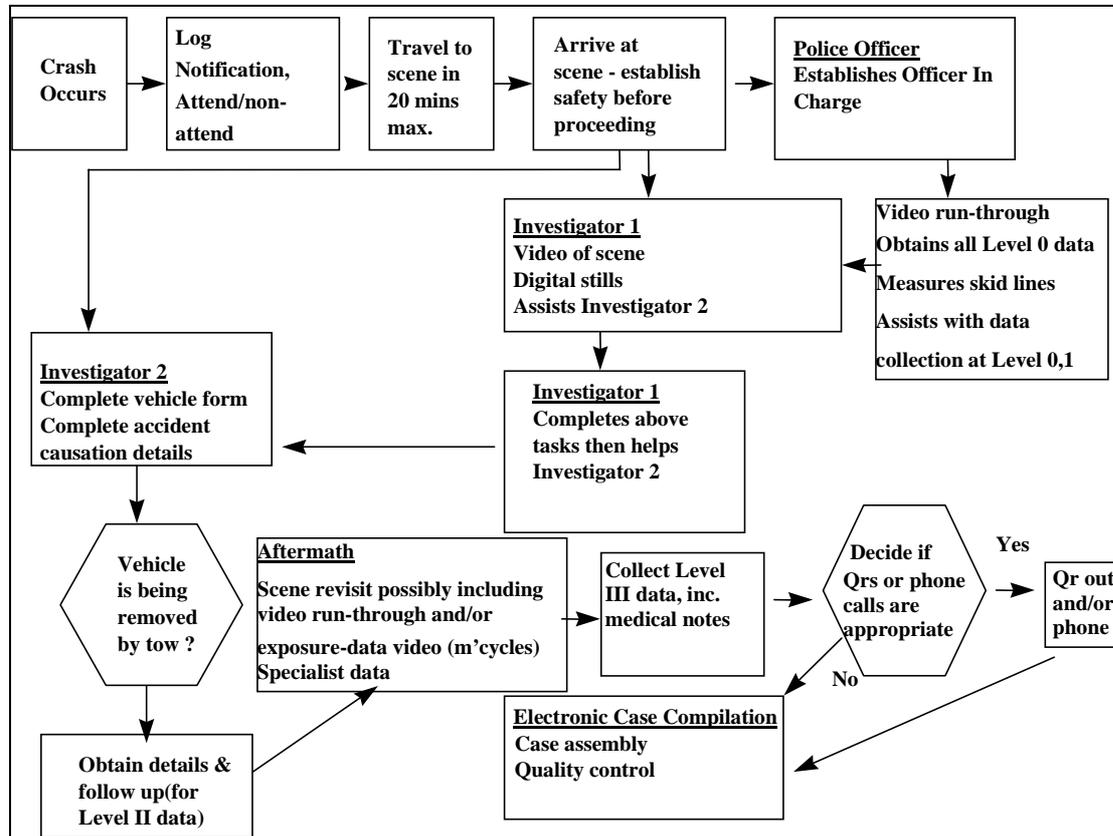


Figure 1: Data Collection Sequencing

4.12. Level II Data Required From Vehicles Removed Out Of Sample Area

There will be numerous occasions when vehicles involved in accidents will be removed or driven by the owners out of the sample area before all level II data can be captured. It should be at the team’s discretion whether to follow these cases up. It is suggested that if vehicles are removed further than 50 miles away from the study team’s headquarters, then a follow-up inspection should not be attempted. However, the team should use discretion in this respect in cases of particular interest. This can be reviewed periodically as the study progresses.

4.13. Special Requirements at Pedestrian, Cycle and Motorcycle Crash Scenes

Experience has demonstrated that Police Officers have unique access to information at crash scenes and until the study-team becomes established in their respective sample areas they may not have the same access. It is recommended that particularly in cases of pedestrian, cycle and motorcycle accidents, the Police Officer should collect data regarding the clothing and helmet details worn by these road-users. In many cases, when the team reach the accident scene, these road-users will already be receiving treatment in the ambulance. The Police

Officer will have routine access to the ambulance whereas study team members may encounter some difficulties (this is reflected in the data-collection forms at Level 0).

4.14. OECD Motorcycle Accident Data Collection

Forms have been developed in-line with the OECD motorcycle accident data collection protocol described by McCarthy and Chinn (1999). This specifies a relatively extensive set of data to be collected by an OTS project including accident exposure data (see page 42). The OECD report also describes a very detailed protocol for obtaining exposure data and a Specialist Level of data collection (essentially involving detailed examination of helmets) which have not been included in the current OTS protocol. It is suggested that an additional OTS module should be commissioned from at least one research centre if that specialist data is required from a new OTS project (see also page 49).

4.15. Accident Reconstruction - Calculation of Speeds

Measurements will need to be taken for each accident for the purposes of accident reconstruction. If several groups are collecting data as part of the OTS study, there should be agreed procedures for any collision severity sampling that may be considered appropriate, to ensure consistency. It is anticipated that the accident reconstruction will form a significant part of the overall case composition.

Teams should be familiar with accident reconstruction procedures. It is intended that the essential procedures will be outlined in a glossary written to accompany the case forms. However, the details specified in the glossary should not necessarily be viewed as a comprehensive guide to accident reconstruction since it is expected that each team will have in-house skills.

(i) M1/N1 Cars & Vans

Where appropriate, it will be necessary to calculate energy transformations and speed changes at impact (ΔV) based on stiffness coefficients, masses and damage sustained by the vehicles. A reconstruction should be undertaken using a suitable CRASH-type computer programme sold for use on a PC running MS Windows. It is recommended that the same software product should be adopted across teams working on a new OTS project. WinSmash is the programme currently used by NHTSA in the USA. Given that CCIS in the UK has now chosen WinSmash to replace CRASH3 from early in 2000, it is recommended that a new OTS project should also use the WinSmash programme.

Measurement of vehicles for CRASH-type computer calculations is classified as level II data and should be collected as a priority. However, where the data is not collected at scene because of removal of the vehicle or vehicles by a tow-operator, a follow-up visit to the storage site of the crash-damaged vehicle may be necessary for this type of accident reconstruction. The storage location of all vehicles involved in the accident (e.g. recovery-yard, garage, owner's address) will be recorded by the investigators at the scene to facilitate a follow-up visit if it becomes necessary. CRASH measurements should generally be taken from HGVs and buses at the scene, if appropriate, because these vehicles will often be driven away and out of the research area.

Crash energy and delta-V results will often supplement other calculations to determine vehicle speeds and positions using a range of evidence gathered at the scene such as, for example, tyre marks on the road surface. Individual teams may wish to make use of features within the above mentioned software to assist with a variety of calculations. The possible use of further software products to assist with this type of calculation will be at the discretion of individual research teams, but the fundamental methodologies must be consistent across the project.

(ii) Pedestrians, Cyclists and Motor-cyclists

'Pedestrian' throw is a technique that can be applied to estimate a range of speeds for the striking vehicle in a pedestrian, cycle or motorcycle accident, 'pedestrian' being a generic term. Pedestrian throw utilises the concept of momentum transfer between the vehicle and the pedestrian, cyclists or motorcyclist.

4.16. Front Profiles of Vehicles in Pedestrian/Cycle Crashes

In the event of a pedestrian/cycle crash, the front profiles of vehicles should be measured in accordance with the standard procedure to be set out in a glossary. If inspection of the vehicle is not possible, then a similar model should be used, although measurement should be made at the scene wherever possible.

4.17. Contact Points On and In Vehicles

Injury contact points identified by the investigators should be recorded on the appropriate forms. If contact points are found on the ground in the event of a pedestrian crash, they should be recorded on the Car/LGV pedestrian contact page. A glossary will list details of the procedure for recording contact sites.

4.18. Defects and failures

Where possible, identification of any faults or defects will be made during the vehicle examination. This will be achieved using the data collection forms in the appendix. In all cases, reference should be made to the police investigation of defects and failures in the accident.

4.19. Data Capture Methodology

One or more of the following methods will normally be used for data capture:

- Tape-recording (Dictaphone)
- Hand-written data collection forms
- Data entry into a lap-top or pen-based computer
- Video and digital camera images
- Scene revisits in daylight, where appropriate
- Indirectly via Police Accident Investigation Officers

Trials on-the-scene have revealed that data disappears very rapidly from the scene and the accident investigation team will need to work very quickly to capture the 'volatile' information. Experiments have been performed by VSRC with different methods of data collection. The use of dictating machines is strongly recommended provided that the requisite data can be captured adequately. (Note: digital dictating machines are not appropriate if tapes are to be stored and possibly disclosed as legal evidence at a later time). The use of data checklists (which may be summaries of the main data collection forms) has been found to be the most effective manner of helping each investigator to check whether all necessary data has been captured. VSRC trials with such checklists have been very successful. Tape recordings should be made in cases where the information is particularly volatile. However, teams may find other means of data capture more appropriate.

In addition to these methods of data capture, it is envisaged that photogrammetrical techniques will be investigated and possibly introduced and developed into the project as the project proceeds.

4.20. What To Do In The Case of a Parallel Notification

Periodically during the study, it is probable that the on-the-scene team will be investigating an accident when a parallel notification is received over the Police radio system. This should normally be followed up as soon as possible, but after Level I data for the current accident has been collected. In some circumstances, it may be necessary to revisit the scene of the original accident to complete the data collection and normally revisits should be made on the same day.

4.21. On-the-Scene Equipment and Instrumentation

It is suggested that the following is a list of essential equipment routinely required at the scene of crashes:

Item

For investigation

- Vehicle (Police livery, blue lights, in-car communications equipment, stem lights etc.)
- Police spec. high-8 video camera system, permanently fitted into vehicle
- At least one portable digital video camera (including floodlight attachment)
- Digital camera
- Mobile telephones
- 2-way radios
- Light meter
- Laser measuring device (optional)
- Tape measures, 50m, 30m and 5m
- Measuring wheel
- Scaled tape for photographic purposes
- Stick-on arrows for photographic purposes
- Anemometer
- Thermometers, probe and whirling hydrometers

Torches
Portable computer and printer (optional)
Road chalk (Note: general usage and colour of chalk should be chosen avoiding conflict with local Police AI teams)
Tape-recording facility (1 Dictaphone per team member)
Road cones
Sled and load-cell for measuring co-efficient of friction
Spring balance for weighing pedal cycles
Digital spirit level
Inclinometer
Compass
Profilometers
Tyre pressure and depth gauges

For Team Offices

Digital video editing suite
Personal computers
Laser printer
Large format ink-jet printer for scene plans (optional)
CD writer
Tape transcription machines
Lockable filing cabinets

For Safety

Waterproof fluorescent jackets (conforming to EN417 Class 3)
Fluorescent vests
Safety shoes/boots
Safety glasses
Helmet
Disposable gloves
First aid kit
Fire extinguisher

Furthermore, specialist accident investigators (e.g. motorcycle crash investigators) may have specialised equipment requirements.

4.22. On-Scene Etiquette and Code of Conduct

It is essential that investigators follow a code of conduct whilst attending the scene of crashes:

- Members of the investigation team should adhere to the dress code described below;
- Members of the investigation team must remain impartial at all times and should not appear to support any of the parties involved in the crash in terms of apportioning blame. In this respect, members of the on-the-scene team should refer any approaches for information about the accident to the Officer-In-Charge and should not divulge any information to any third-party;
- Under no circumstances should investigators alter the positioning of any switches or controls as this may interfere with police investigation work;
- Under no circumstances should investigators impede or restrict the work of the Emergency services;
- Intrusive photography or video capture of any injured person or persons is not permitted;
- In general, no part of the on-the-scene team's work will be allowed to interfere with any Police operation at the scene nor should the work of the team delay the re-opening of the road to the normal flow of traffic;
- Members of the on-the-scene team should retain the right to decide whether to proceed with an accident investigation depending on the circumstances. If the team-leader and/or team-assistant do not wish to proceed on the grounds of risk to personal health and safety, the case should be abandoned. Furthermore, if the circumstances of the case are such that they may cause undue stress to a member or members of the on-the-scene team, the case should, likewise be abandoned.

4.23. Accident Investigation Dress-code

Members of the on-the-scene team attending an accident team should wear appropriate clothing for an on-the-scene investigation. Normally, this will involve wearing a yellow or green fluorescent jacket or other high visibility upper garment to enhance conspicuity and aid identification (marked on the back with 'Crash Research'). Such a garment should conform to the standard EN417 Class 3. Safety shoes and overalls should also be worn routinely. Padded and insulated water-proof leggings should be used where appropriate. Safety spectacles are to be used when lifting or inspecting vehicle glazing. Industrial gloves must be

worn when lifting glazing or debris. Rubber gloves should be worn whilst inspecting within the vehicle for contact marks to avoid contact with blood, etc.

4.24. Rest Positions

Investigators should make good use of road chalk to mark locations of casualties and vehicles that may be quickly moved in the accident. A sketch will be made of the rest position of all vehicles as found by the investigators. However, it should be remembered that the collision scenario will not always be established by the final rest position or the damage to the vehicles. Evidence should be corroborated with the information that is determined by the Officer-In-Charge at the crash together with subsequent evaluation of all other evidence, including witness statements.

Measurements should be taken of the rest positions of the vehicles relative to the road environment (using tape measures or measuring wheels).

In the case of fatal crashes, near-fatal crashes or other crashes of special police interest, exact scene measurements (using surveying equipment) will be made by investigating officers from the respective Accident Investigation Section of the Police Force. Ideally, these measurements will be available to members of the on-the-scene investigation team, and arrangements should be made for results to be obtained for routine inclusion in the case file.

4.25. Medical Data Collection

In addition to the vehicle and highways data collected on-the-scene, there is an obvious requirement to collect data about the road-user. There may be a requirement to develop specific studies of crash injuries and these could be identified as the OTS study proceeds (e.g. injury impairment, injury causation to specific road users etc).

Whilst a methodology exists for the collection of data concerning car occupants who have been involved in crashes which form part of the CCIS study, it is envisaged that the level of information that will be collected as part of the on-the-scene project may be more in-depth. For example, reference to the ambulance notes can provide information about treatment administered on-the-scene based on initial paramedic diagnosis. Of particular interest in this

respect are items such as initial assessment of Glasgow Coma Scale (GCS), level of consciousness on-the-scene, CPR etc.

However, it is anticipated that only a limited amount of medical data will be available on-the-scene as professional medical diagnoses at Accident and Emergency Departments are nearly always required for each injured person. Ambulance Service medical notes will ideally be available to any team undertaking on-the-scene investigations, and these should be routinely obtained.

Where possible, on-the-scene team members should record details of any 'surface' or other obvious injuries to casualties and should attempt to identify likely contact sources at the scene as this may help in the determination of injury causation once a clinical diagnosis of the injury has been made.

The on-the-scene study will not accept self-report of injuries by participants if an injury of AIS 2 or above is claimed in a questionnaire response (see below).

The protocol determines that injury information for each casualty is collected from the hospital attended. This task should preferably be undertaken by staff who have prior experience of Accident & Emergency Department administration procedures. The protocol also determines that injuries should be coded to the most up-to-date version of the Association for the Advancement of Automotive Medicine (AAAM) injury coding scale (currently AIS 90 - 1998 Update). One member of the team who is trained and experienced (to maintain consistency) should also only undertake this task. It is imperative that the version of the AIS coding manual used in the on-the-scene study is at all times consistent with the version used in the CCIS study so that there is compatibility between the two studies.

4.26. Accident/Injury Causation, and Confidence Ratings

One advantage of an on-the-scene study is that a clear understanding of accident causation and injury causation can be attained. Usually at each accident, the Officer-in-Charge will be responsible for determining the cause of the accident. Investigators should liaise with the Officer-in-Charge to establish the accident causation and use all other evidence that may be available at the scene to complete the accident causation and driver behaviour form. It is

acknowledged that the accident causation details may sometimes be uncertain. Therefore a confidence rating of 1 to 4 should be applied to each factor judged to have played a role in the accident (Definite = 1, Probable = 2, Possible = 3, None/Not-applicable = 4).

The causes of injuries will be assigned by determining likely people-kinematics in crashes, which in turn will be based on the direction of force (DoF) of the vehicle, pre-crash and post-crash motions and contact marks encountered during examination of the damage within the vehicle. A confidence scale of between 1 and 4 will be allocated for each contact source/injury correlation, as described above.

4.27. Road User Questionnaires

In order to gain further insight into road-user behaviour in accidents, there is a need for some degree of co-operation by the road-users involved in the accident. Questionnaires are the chosen method of attaining this data. The questionnaire is aimed at obtaining that information from crash participants that cannot be obtained directly from an on-scene investigation. The questionnaires (see Appendix A) should be administered to crash participants within one week of the crash although participants and witnesses (see Witness Information below) will be supplied with an introductory/advisory handout document at the scene which describes the intention of the follow-up questionnaire. This leaflet gives a brief outline of the study and its objectives. It is not expected that a 100% questionnaire response will be achieved. However, the information received from questionnaires should be transcribed onto the anonymous forms also to be found in Appendix A **Error! Reference source not found.**

4.28. Witness Information

Whilst collecting witness information is seen as a specialist module (see page 50), there is a requirement for basic witness information on-the-scene and this should be collected by a team investigator (as opposed to Police Officer) using the form in Appendix A, section 18 **Error! Reference source not found.**

Investigators should use their judgement about who to approach at accident scenes.

Each chosen witness should be asked about his or her willingness to co-operate further in the study. As outlined above, each chosen witness should also be given an advisory handout document explaining that a telephone follow-up may be made (see Appendix A, section 17 **Error! Reference source not found.**). Following the scene visit, the team should reach a consensus about the information that each witness can provide which is additional to data already gathered from the scene. If it is deemed that some witnesses will not offer any further useful information, they should not be followed up. Witnesses should be followed up within

48-hours of the crash. No more than ten questions should be asked of each witness who is followed up. However, at least three questions should validate that the witness concerned accurately recalled basic details about the crash (e.g. the colour of the cars concerned).

The success of witness interviews should be reviewed as the study progresses and this would ideally form part of the specialist module that was referred to above.

4.29. On-the-Scene Photography and Video sequencing

Image capture on-the-scene should be made using a both a high resolution digital camera and a digital video camera. The video camera should always be used first since still images can be taken from the video if the information disappears rapidly, whereas the converse does not apply.

A procedural approach to digital camera and video data capture is proposed and this should be adopted as follows:

(i) Video and Photographic Capture of the Scene

a) The scene

The scene should be videoed during investigations, on the day of the accident, but it is not appropriate to recommend a structure to the procedure since each scene will differ in its complexity. The scene video should therefore be made at the discretion of the video operative. The following evidence should be collected where possible:

- Physical evidence - skids, scrape marks, debris patterns, fire;
- Crash participants (especially cyclists, motorcyclists and pedestrians): discreet recording to show details of position, clothing and injuries, if appropriate, after liaising with the Officer in Charge.
- Roadway environment, contamination, obstacles, defects;
- Any traffic control, signage or services (temporary or permanent);
- Good quality images are required to show details;

b) Approach videos

The approach to the accident scene should be recorded using a video camera mounted in the police vehicle (see equipment list, page 28) “running through” to the point of impact. This procedure must be carried out to indicate road and traffic conditions at the time of collision if at all possible.

Each road-user perspective should be recorded and the video recording should begin within approximately 30-seconds of arrival at the scene (depending on the crash) so as to record similar traffic conditions to those at the time of impact. Alternatively, investigators may decide to record approach videos one week later, at the same time of day, if traffic conditions can be replicated. This may be particularly convenient for motorcycle accident investigations, because video recordings must also be carried out to gather exposure data one week after impact, as described on page 42.

(ii) Video and Photographic Capture of M1 and N1 Cars and Vans

For each M1 and N1 vehicle involved in the accident, the starting point for video-data capture should be the front left-hand corner of the vehicle. The video capture should then proceed in an anti-clockwise direction around the vehicle such that the front area of the vehicle is the last external area to be videoed.

The operative should then video the following where applicable:

- The central damage location;
- The windscreen
- Any obvious faults or defects (e.g. flat-tyre, missing head-light);
- Any obvious occupant ejection route.

The engine-bay region should then be photographed and particular attention should be focused on the following:

- The location of any ignition source of a vehicle fire;
- Any rupture or breakage of fuel or brake-pipes;
- Any failure of engine mountings;
- Any pedestrian or cyclist contact points;

The operative should then capture damage to the interior. Particular attention should be focused on the following where applicable:

- Contact marks, including skin, blood, hair, clothing scuff marks, shoes etc; (all contact marks should be indicated using 'stick-on' arrows before the video-capture is made if there is sufficient time to allow this - these must be removed after use);
- Positioning of seats and head restraints;
- Damage to seat-backs, seat bases and seat mountings;
- Damage to steering wheels and steering columns;
- Position of controls and pedals;
- Restraint systems, including driver and passenger front and side airbags.

- Evidence of loading by luggage to interior surfaces
- Evidence of damage to the loading-bay area.

Up to twelve individual photographs of each vehicle exterior should be taken from points on the vehicle exterior which match the face of a clock (e.g. head-on = 12 o'clock, rear shot = 6 o'clock etc). The starting point should be the 11 o'clock region of the vehicle (i.e. front left corner of the vehicle). The photographer should then work around the vehicle and should finish at the front of the vehicle. Photographs should then be taken of both the exterior and interior items listed in video data capture above.

(iii) Video and Photographic Capture of M2/M3 and N2/N3 Trucks and Buses

For each M2/M3 and N2/N3 vehicle involved in the accident, the starting point for video-data capture should be the front left-hand corner of the vehicle. The video capture should then proceed in an anti-clockwise direction around the vehicle such that the front area of the vehicle is the last external area to be videoed.

The operative should then video the following where applicable:

- The central damage location;
- The windscreen;
- Any obvious faults or defects (e.g. flat-tyre, missing head-light);
- Any obvious occupant ejection route.

Particular attention should be focused on the following:

- The location of any ignition source of a vehicle fire;
- Any rupture or breakage of fuel, brake-pipes and air-lines;
- Any pedestrian or cyclist contact evidence.

The operative should then capture damage to the interior. Particular attention should be focused on the following where applicable:

- Contact marks, including skin, blood, hair, clothing scuff marks, shoes etc; (all contact marks should be indicated using 'stick-on' arrows before the video-capture is made if there is sufficient time to allow this – stickers must then be removed);
- Damage to seat-backs, seat bases and seat mountings;
- Damage to steering wheels and steering columns;

- Position of controls and pedals;
- Restraint systems, including driver and passenger front and side airbags.
- Evidence of loading by luggage to interior surfaces;
- Evidence of load movement, spillage and load-restraint type.

Up to twelve individual photographs of each vehicle exterior should be taken from points on the vehicle exterior which match the face of a clock (e.g. head-on = 12 o'clock, rear shot = 6 o'clock etc). The starting point should be the 11 o'clock region of the vehicle (i.e. front left corner of the vehicle). The photographer should then work around the vehicle and should finish at the front of the vehicle. Photographs should then be taken of both the exterior and interior items listed in video data capture above.

(iv) Video and Photographic Capture of Cycles and Motorcycles

Video capture of the cycle and motorcycle should begin with images of the vehicle in situ after the accident (where possible, and with permission from the Officer in Charge). The vehicle should then be stood, where possible, and the video-operative should video around the vehicle in an anti-clockwise direction beginning at the front left of the vehicle and finishing at the front area.

The following information should be captured:

- instrumentation array;
- close-ups of tyres including tread detail, side-wall markings, skid-patches and puncture evidence;
- close-up of engine, transmission, suspension and brake system (if applicable);
- all areas of collision contact and damage;
- all injury contact areas observed during the inspection.

If possible, the operative should film from directly above the cycle or motorcycle and directly below, showing the complete undercarriage.

The above information should also be captured using a digital camera. Instead of a complete 'sweep' of the cycle or motorcycle, a 'basic eight' photographs should be taken as follows:

- 1 from head-on and 1 from directly behind

- 1 from 90-degrees on each side
- 2 from 45-degrees on each side

(v) Crash Participants

It is not deemed appropriate to propose a protocol for video and photographic capture of crash participants since the circumstances of individual crashes are so unique. However **discrete** capture of the following are suggested where possible, providing consent has been given by the police:

- Details of any clothing worn by crash participants, especially clothing worn by pedestrians, cyclists and motor-cyclists;
- Any obvious surface injuries that may indicate the presence and location of more serious under-lying injury (e.g. Fracture, haemorrhage);
- Personal effects/accessories e.g. Walking stick, umbrella, personal stereo etc;
- Location and orientation at scene;
- Location and orientation in vehicles, including details of entrapment.

4.30. Photogrammetry

Use of photogrammetry equipment for data capture on-the-scene has been considered. This is a technique that potentially offers considerable time-saving benefits for investigators at the scene, and allows a variety of measurements to be taken at a later stage using computer processing of the images. At present, photogrammetry equipment is relatively expensive to purchase and involves a relatively extensive training period. It is recommended that the use of such equipment should be considered as the project develops. However, at the outset, it is not recommended that photogrammetry techniques should be adopted. It should also be recognised that photogrammetry is an expensive technique and if this technique is adopted, the cost should be considered at the commencement of the project.

4.31. Follow-up Investigations

(Including Scenes, Vehicles, Motorcycle Accident Exposure , Medical, Questionnaires, Witness & Police Data)

It is acknowledged that in the majority of cases, there will be a requirement for further information to be gathered “post-scene”, including several of the following:

- level II data capture of all vehicle information in recovery-yards, garages, home addresses or other location (where this cannot be achieved at the scene because of time pressures)
- level II data capture of highways information (where this cannot be achieved at the scene because of time pressures)
- scene-approach video recordings for accidents involving all types of casualty or vehicle (see page 35)
- for motorcycle accidents only, the recording of exposure data to meet basic OECD RS9 requirements as set out by McCarthy and Chinn (1999)
- medical information (including coding)
- questionnaire information (from casualties and other vehicle occupants)
- witness information (bystanders)
- accident reconstruction
- injury causation
- case assembly
- database update and database management.
- preparation of summary sheets for all accidents

These post-scene requirements are further discussed below.

Vehicle Data

If the vehicle is removed before the information contained in the data collection forms can be completed, a follow-up may be necessary to finalise the investigation procedure. This will normally be to capture level II and above data where this has not been collected on-the-scene. Furthermore, if an M1 or N1 vehicle(s) involved is/are less than seven years old and meets with the CCIS sampling criteria, an appropriate notification system should be developed. This will ensure that members of the CCIS team are routinely informed that an on-the-scene investigation has been made so that duplication of effort does not occur. Also see page 23.

Scene Data

In some circumstances, it may be necessary to re-visit the scenes of accidents to capture level II data that are listed on the Highways protocol although there may be circumstances where

this can be captured during the scene visit. It is also recommended that some scene-approach video recordings are made during re-visits, as mentioned above (also see page 35).

Medical Data

A trained person shall collect medical information from each hospital attended by the casualty. If a fatality is involved in the accident, the post-mortem examination will be obtained from the respective coroner's office.

Questionnaire Data

Each crash participant will be sent a questionnaire, which will assist in determination of the possible causes of both the accident, and the injury sustained. However, questionnaires should not be sent to relatives of fatally injured persons who may have been involved in the crash, persons with serious head injuries and persons who are aged 75 and above. This procedure is described on page 33.

Police Records

Police record of each accident will be obtained to determine possible defects and failures on the vehicle that may have contributed to the crash.

Exposure Data Relating to Motorcycle Accidents

There is a requirement that motorcycle data gathered for a new OTS project should meet the requirements of the OECD RS9 accident investigation protocol. The following procedure has been developed with that objective in mind. A form entitled "Traffic Flow Exposure Data" corresponding to the protocol set out below may be found in Appendix A **Error! Reference source not found.**

A video of the crash scene must be taken using high quality video cameras, if possible try and use more than one camera and mark on the scene plan exactly where the cameras were

positioned and the angle of shot. The video should be taken one week later on the same day and run continuously for ½ an hour before the time of the crash until ½ an hour after.

A traffic count and vehicle census must be obtained and the results entered on the appropriate form. It is suggested that this should be carried out retrospectively, with reference to the video recordings. The siting of the cameras is, therefore, particularly crucial.

Care must be taken that the presence of the OTS team and vehicle do not influence results. For example, remember that a conspicuous police-vehicle or video camera will most likely influence driver behaviour and, therefore, affect traffic flow rates.

Note that the exposure video procedure described above is required for all motorcycle impacts in addition to approach videos. Approach videos are required for all OTS investigations, as described on page 35.

When all the data relating to the accident have been obtained, the case can proceed to the case assembly stage.

Witness Information

A procedure for obtaining witness information is described on page 33.

4.32. Case Assembly

A case assembly will comprise the following;

- an accident summary sheet which contains the salient accident details, injury details, the accident causation details and the potential accident countermeasures;
- injury forms for all crash participants (but excluding witnesses), which include injury information, personal details, etc;
- forms for all vehicles involved in the accident, including both level I and II data including the accident reconstruction information and outline sketches of damage and contact evidence;
- anonymous forms containing questionnaire data received from each crash participant;
- highways data at levels I and II;
- motorcycle accident exposure data.

Crash investigation forms and questionnaires may be found in Appendix A **Error! Reference source not found.** together with a list of contents. Outlines for sketches are to be found in Appendix B **Error! Reference source not found.**

The following should also be included in the final case assembly (where appropriate);

- Calculation of delta-V and EBS (see page 25);
- Calculation of closing speed by accident reconstruction using vehicle skid-lines, etc.;
- The Police reconstruction of the accident in fatal crashes and near-fatal crashes (usually undertaken using surveying equipment);
- The Police report of any defects and failures to any vehicle involved in the crash;
- Correlation of injuries to vehicle contacts within or exterior to the vehicle coded with confidence ratings (see page 33)
- Coding of injuries to the appropriate coding convention (generally the most up to date version of the Association for the Advancement of Automotive Medicine injury coding scale);
- Questionnaire information transcribed to anonymous forms (where appropriate)
- An edited scene-video, scene-approach video (to be distributed on VHS tapes) and edited digital still-images of the scene and the crash participants (JPEG computer files).

4.33. Data Storage

It is suggested that the electronic database must be developed once the project has commenced. State-of-the-art software options should be appraised and the most appropriate system used.

All cases will be stored on a database that can be accessed conveniently by a variety of authorized users including project sponsors.. It is anticipated that periodic releases of data will be available on CD, although Internet options may possibly be explored as the project develops. The method of data storage should be constructed such that the relevant clauses of the Data Protection Act are complied with and this entails that names and addresses of casualties and witnesses are not stored on computer systems and any associated paperwork is filed in lockable storage systems. There should be no reference to names, addresses or vehicle registration numbers in completed cases. All data (regardless of type) should be kept securely and stored for a minimum of period of time as agreed locally. The CPS and local police should be consulted and agreements reached to ensure that all parties are content that OTS data storage protocols meet with requirements with regard to disclosure of evidence.

4.34. Support to Staff Undertaking On-the-scene Data Collection

It is anticipated that members of an on-the-scene team may encounter distressing and shocking sights in some circumstances. Screening and recruitment of staff should take this into account when forming a team to undertake on-the-scene investigations. A de-briefing session to experienced counsellors should be available at all times to all members of the on-the-scene team.

5. OTS Protocol - Discussion and Recommendations

This study has been undertaken to develop a protocol for on-the-scene accident investigations. The literature concerning previous accident investigations, which have used an on-the-scene methodology, reveals that such investigations are the only means of obtaining 'volatile' data for research purposes. The main advantage of the 'on-the-scene' methodology would appear to be that the quality and accuracy of data collected from the scene is frequently superior to data that is collected using other methodologies. On-the-scene methodology also allows the possibility of accident reconstruction at a more in-depth level than retrospective investigations permit due to the presence of skid-marks on the road surface and the fact that the vehicles themselves are usually 'in-situ' when the scene is reached. Such data can be used for the purposes of determining accident causation, injury causation and effective remedial measures.

It is proposed that the performance of secondary safety systems can be more accurately assessed at the scene rather than retrospectively because the vehicles are not interfered with by recovery crews and rescue damage can usually be clearly identified.

It is clear that a successful on-the-scene project requires both a good notification system and a means of rapidly reaching the scene. The preferred way of achieving this is to base an on-the-scene team with members of the UK emergency services (either the police, fire or ambulance service) who themselves rely on an excellent notification procedure and are permitted to use a siren and blue lights to reach the scene. Pilot studies at VSRC and discussion with DETR have established the police to be the most appropriate emergency service for assisting with the present requirements of an OTS research project.

It would not be possible for an on-the-scene team to collect all the desirable information from the scene of a crash and the protocol has been constructed to reflect this. Information has been identified that is likely to be most volatile and sequencing developed accordingly. 'Volatile' material should be collected first during any on-the-scene investigation in order to maximise the effectiveness of such a study. It is accepted that a certain amount of follow-up will be necessary in such a study and this is permitted by the protocol. It is suggested, therefore, that investigators collect certain in-depth information about the vehicle (e.g. damage deformation),

the road user (e.g. injury information) and the highway (e.g. road surface condition) some time after the accident. This is so that the time spent at the scene can be utilised as efficiently as possible for collecting the volatile data.

A further important consideration is the approach taken to data capture. There is an opportunity within the framework of a future on-the-scene project to use state-of-the-art technology for data capture, accident reconstruction, data-storage and data dissemination. Good systems for data capture will also help to ensure that the time spent at the scene of a crash is utilised as productively as possible.

Statistical sampling is an important consideration of an on-the-scene study. Any team participating in an on-the-scene investigation study should be capable of identifying the likely pool and distribution of accessible accidents in the chosen study area. Furthermore, the study team should be capable of specifying weighting factors that can be utilized where appropriate in order to estimate UK national statistics. An additional work module might be required to adequately manage and co-ordinate sampling statistics, this important issue is further outlined below.

5.1. Modular Approach

In addition to core activities included in the main data collection protocol, there may be a requirement for additional team members to undertake specialist modules and short-term projects meeting additional research needs. While a number of additional modules might be considered, the Authors would like to make three suggestions below:

- ***Statistical Sampling Issues:*** A sound statistical sampling plan will be essential for statistical validity and to ensure the overall usefulness of OTS data. A short-term research module is therefore recommended that will investigate essential sampling issues, develop a co-ordinated methodology, and make recommendations for continued monitoring of statistical sampling integrity.
- ***Specialist Motorcycle Data:*** It is suggested that an additional OTS module should be commissioned from at least one research centre to obtain “Specialist Level” motorcycle data as specified by McCarthy and Chinn (1999) for the OECD motorcycle accident data

collection protocol. Additional staff and equipment would have to be involved. Such a module would essentially involve detailed examination of helmets and would enable an OTS project to obtain the full set of data stipulated in the OECD protocol (also see page 25).

- ***In-depth Witness Study:*** The protocol regarding witnesses requires further research. It is not clear whether witness testimony can be taken as a true representation of the circumstances of the accident and this applies to both crash participants and innocent bystanders. It is recommended that the protocol for witness information be both enhanced and validated in a special study that should be conducted in parallel with the main on-the-scene project as recommended by Hill et al. (1999a). Potentially, detailed witness testimonies and validated protocols can be built into the main on-the-scene protocol at some future stage. One researcher would be usefully employed developing and evaluating the feasibility of methodology for an in-depth witness information appraisal (to be based with one team only, but working in conjunction with other teams).

5.2. Maintaining Case and Protocol Integrity

OTS cases will be of a diverse and complex nature. Case reports should aim to evaluate causes of accidents/injuries, and evaluate effectiveness of safety features/technologies. Methods should be explored for consistently maximising the technical quality and detail available from OTS case reports. A varied pool of experts should remain closely involved with the project.

Meetings and discussion are to be encouraged, on an on-going basis, involving all teams employed to carry out these protocols. The implications of this protocol need to be discussed in-depth, and there may be a requirement for amendments to the protocol either at the onset or during the early months of a new study. Cross-team case reviews are also recommended for a variety of important reasons including enhancement of investigation techniques, maintaining compatibility and identifying training requirements as a new project develops.

5.3. Further Recommendations

A variety of skills and training will be required of personnel involved in this project. A number of further recommendations are made concerning personnel, training and other issues.

- It is recommended that teams undertaking an on-the-scene project undertake a period of training that involves some investigations actually on-the-scene. Experience has shown that exposure to accident investigation at the scene is an essential component of investigation skills acquisition. This training can be held at one or other of the organisations that intend to participate in the study or at each of the centres in turn. A training infrastructure exists, for example, involving VSRC and the Nottinghamshire Police. It is suggested that the minimum training period necessary is two weeks. Different skill areas can be learnt during this training period including the following:
 - highways data identification
 - accident reconstruction in pedestrian crashes
 - accident reconstruction in vehicle crashes (delta-V/EBS, skid-marks, tachographs)
 - general familiarisation with accident scene and personal-safety considerations.

- Experience has shown that the motorway is an extremely dangerous place to conduct an on-the-scene investigation. Whilst it is acknowledged that there is a necessity to sample all types of crashes on all road types, the wisdom of collecting information on crashes of a minor nature in such a hazardous environment is questioned. A more appropriate compromise would be for the collection of information from motorway crashes where there are serious and potentially life-threatening injuries. In such crashes, there is an enhanced degree of protection offered by the Police and there may even be closing of individual carriageways of the motorway in such circumstances. Local police forces should be consulted about their policy regarding researchers attending the scene of motorway accidents. Both police and research teams must be comfortable about the safety issues involved. Specific training should be obtained for research personnel operating on motorways.

- Trials with this protocol have been fairly limited to date. Some less common situations will not have arisen during the recent pilot study at VSRC. It is acknowledged that there may be a requirement for fine-tuning of both the methodology and the data collection

procedure. A longer trial period is recommended for this where training can also be given to teams wishing to undertake an on-the-scene study. As a minimum requirement, two months trial/piloting of this protocol is recommended.

- Experience has shown that it can be helpful if a member of staff from each hospital in the study area performs some duties on behalf of the team, although it is preferable if most of the data are collected by an OTS team member. In particular, if there is a requirement for anthropometrical data from the road-users, it is important that this information is collected at the earliest convenient opportunity. There may be a requirement for suitable arrangements to be made for collection of this data. Reliance on the road-users themselves to provide this information is not recommended. This issue should be discussed before a system is developed.

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