

Scottish Executive

COMPANION Stage 1  
Final Report

April 2000



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# Executive Summary

COMPANION is a roadside hazard warning and information system, based on electronic guide markers, with the objective of warning drivers of any kind of unexpected events ahead. In Scotland, COMPANION covers a 4 Km stretch of the M90 Southbound between junctions 3 and 1.

The impact of the system at the M90 site has been monitored, through field trials and an ongoing analysis of accident data, since its implementation in January 1998. System usage has been monitored since September 1998.

The system has been well received by the Fife Police Constabulary, who are responsible for activating the system in response to incidents at the COMPANION site, to the extent that it now forms the first line response to incidents occurring at the COMPANION site.

The long term objective is to develop a specification for a beacon-based hazard warning system, such as COMPANION which might be rolled out at other sites in Scotland.

The lowest number of incidents addressed at the site, during any one month was 1, in October 1999 and the highest was 20, during February 2000. On average, there were 8 incidents addressed per month with the activation of COMPANION.

The plan intended for use during periods of congestion has been the most used plan in response to incidents, representing 41% of all COMPANION activation. This is followed by the plan developed for incidents on the hard shoulder, representing 28% and the "errant driver" plan at 20%. Overall, 85% of settings were during daylight hours.

A comparison of Personal Injury Accident statistics for the COMPANION Site and for a number of other, control sites, also within Fife, has shown that the largest reduction in accident numbers, rates and severity occurred at the COMPANION site. The accident rate at the COMPANION site reduced from 0.10 to 0.06 Personal Injury Accidents per Million Vehicle Kilometres.

The aims of the forthcoming programme of research and development at the M90 site are to:

- Trial and evaluate loop, microwave and CCTV based incident detection technologies, to identify the most suitable approach for future applications in Scotland;
- Trial and evaluate the impact of pictogram variable messages in conjunction with COMPANION use;
- Develop a system specification which can be used to procure future installations, of a similar hazard warning system, at appropriate sites throughout Scotland;
- Develop a cost / likely benefit analysis for Scotland, where best value will be gained from system implementation; and
- Identify potential sites in Scotland for future application of the technology.



# 1 Introduction

## 1.1 Background

This report summarises the work which has been undertaken by Oscar Faber, on behalf of the Scottish Executive, to monitor and assess the impact of the COMPANION hazard warning system in Scotland. System usage has been monitored since September 1998, following the last major update in software. The impact of the system has been monitored, through field trials and an ongoing analysis of accident data, since its implementation in January 1998.

The COMPANION system has been progressively developed and enhanced by BMW over a period of ten years. It was originally installed and trialled in Germany and later in Scotland, as part of the 3<sup>rd</sup> Framework LLAMD Project (Germany only) and the 4<sup>th</sup> Framework TABASCO project (Germany and Scotland) and in Italy, as part of the 4<sup>th</sup> Framework INFOTEN project. The objective of the field trials undertaken in these projects was to demonstrate COMPANION's capability as a roadside incident management system.

The COMPANION research and development programme in Scotland, as part of TABASCO and beyond has been well received by the Fife Police Constabulary, who are responsible for activating the system in response to incidents at the COMPANION site. As stated in the following Tayside Press article (Figure 1.1), they are pleased with the way the system is working, to the extent that it now forms the first line response to incidents occurring at the COMPANION site.

## Hazard warning system developed

**THE FUTURE** of road safety north of the Forth Road Bridge is looking brighter thanks to a new companion hazard warning system.

Motorists on the M90 will no doubt have noticed the newly completed lighting poles which are designed to give drivers advance notice of problems ahead.

The Companion system has been developed by BMW and was trialled in Fife by the Scottish Office as part of a research and development programme backed by European funding to improve safety on busy motorways.

It is controlled from Fife Constabulary's operations room and there Inspector Brian Winton explained that the system used electronic roadside posts, 50 metres apart, which emit yellow or orange signals to advise motorists of potential problems.

"The aim has been to improve road safety by quickly alerting motorists and the trial showed that the system can produce significant reductions in speed and has the potential to prevent both primary and secondary incidents," he added.

Companion's test site lies on a four kilometre stretch of the M90 south of the Halbeath interchange and complements existing hazard warning and variable message sign systems.

"With the arrival of the darker nights it has obviously become much more prominent and noticeable but there might still be some road users unaware of its existence or indeed, its potential," added the inspector. Fife police monitor the area using CCTV and activate the system whenever necessary to warn motorists of incidents or hazardous conditions.

The only other sites in Europe designated to test Companion are Munich and Verona.

"Fife Constabulary were delighted to be one of these three and we are pleased with the way it is working. It is now our hope that road users will quickly get used to its presence, take in the message signals and respond to whatever is required of them.

"Companion has the potential to make the roads safer but a lot does still depend upon the reactions and co-operation of the drivers themselves," Inspector Winton said.

Article from Tayside Press - Nov 1998

Figure 1.1 Article from Tayside Press

The positive feedback received from those who operate the system, together with the encouraging results derived from an analysis of accident data, pre and post COMPANION implementation and work being undertaken in Germany and Italy, to develop and implement automatic incident detection algorithms within COMPANION, are seen as reasoned justification for further research and development of the system in Scotland.

The long term objective is to develop a specification for a beacon-based hazard warning system, such as COMPANION which might be rolled out at other sites in Scotland.

## 1.2 Structure of the Report

The remainder of this report is structured as follows:

- **Section 2** describes the COMPANION system;
- **Section 3** summarise system usage for the monitoring period September 1998 to February 2000, inclusive;
- **Section 4** presents an analysis of accident data, pre and post implementation, at the COMPANION site and a number of other control sites; and
- **Section 5** presents a proposed programme for future development of the system in Scotland.

## 2 The COMPANION Hazard Warning System

COMPANION is a roadside hazard warning and information system, based on electronic guide markers, with the objective of warning drivers of any kind of unexpected events ahead which constitute potential danger for approaching vehicles, eg. tailbacks, stationary vehicles or roadworks.

In Scotland, COMPANION covers a 4 Km stretch of the M90 Southbound between junctions 3 and 1. By using flashing lights contained in the posts, which are installed on the roadside verge (see Figure 2.1), COMPANION warns drivers of hazards ahead. When activated, the purpose of the system is to alter driver behaviour to make them more attentive to conditions ahead, thus improving road safety and also traffic flows.



Figure 2.1 The M90 COMPANION Site in Scotland

A set of standard 'plans' has been developed, to ease the process of setting the guide markers and, as a consequence, minimise the time between an incident occurring and the system being activated.

COMPANION can be activated differently according to the nature of the incident. At present, there are eleven "plans" in place, each activating the lights over differing lengths, with differing light patterns and at different frequencies, with different colours according to day or night.

The operator sets one of these plans manually, according to the nature of the incident, via COMPANION's map-based, graphical man machine interface. The COMPANION Control hardware and associated software is installed, as a stand alone system, at the Fife Police Head Quarters.

To ensure that the full potential benefits of the system can be achieved, it is important that, when an incident occurs, the time taken to activate the COMPANION guide markers, in response to that incident, is as short as possible.

It is envisaged, therefore, that the current use of CCTV, Police patrols and calls from the general public, via roadside emergency telephones or personal mobile phones, for the detection and reporting of incidents, will be improved upon in the future, by the introduction of semi-automatic and automatic, real-time detection procedures.

### 3 Summary of System Usage

#### 3.1 COMPANION Activation

Figure 3.1 shows the total number of incidents addressed per month, between September 1998 and February 2000. During the past eighteen months, the lowest number of incidents addressed during any one month was 1, in October 1999 and the highest was 20, during February 2000. On average, there were 8 incidents addressed per month with the activation of COMPANION.

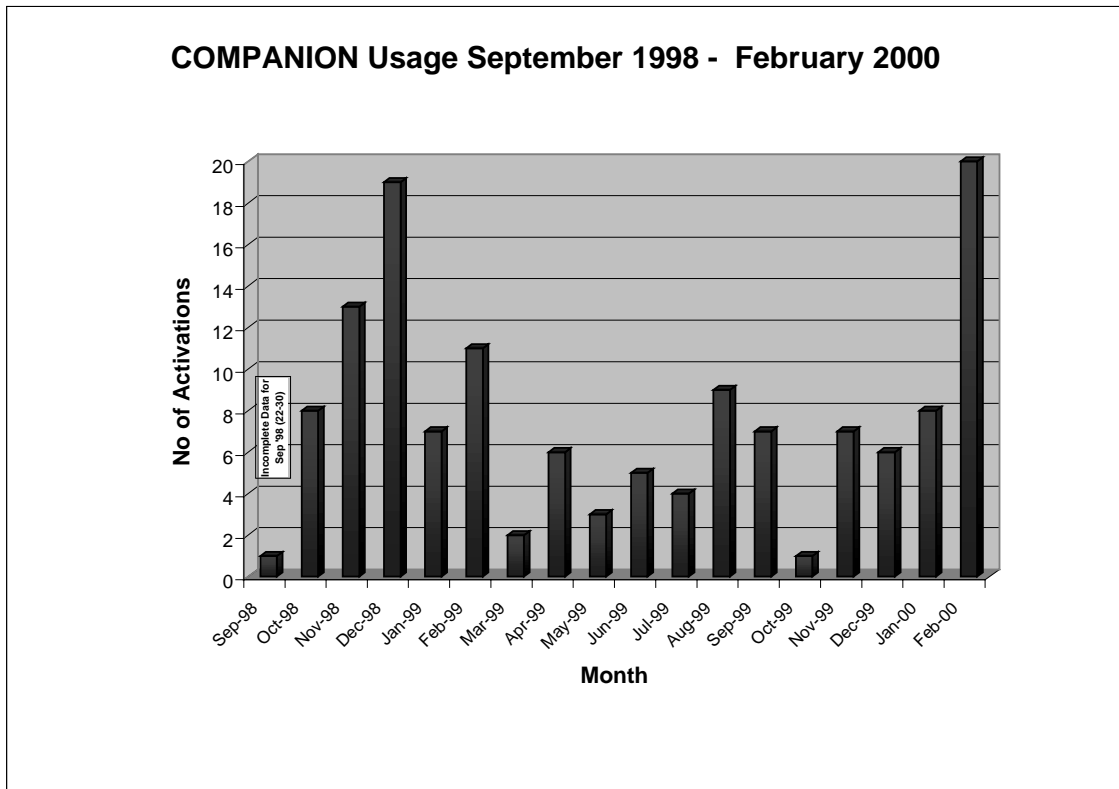


Figure 3.1 COMPANION Activation September 1998 – February 2000

#### 3.2 Plan Types Used

Cumulatively, over the past eighteen months, the plan intended for use during periods of congestion has been the most used plan in response to incidents, representing 41% of all COMPANION activation. This is followed by the plan developed for incidents on the hard shoulder, representing 28% and the “errant driver” plan at 20%. The remaining activation can be broken down into plans developed for a complete road closure (“all lanes blocked”) representing 6%, a single lane blocked, representing 4% and “funnelling”, representing 1%.

Overall, 85% of settings were during daylight hours.

A full breakdown of the plans used in the activation of COMPANION, covering the past eighteen months, is presented in Figure 3.2.

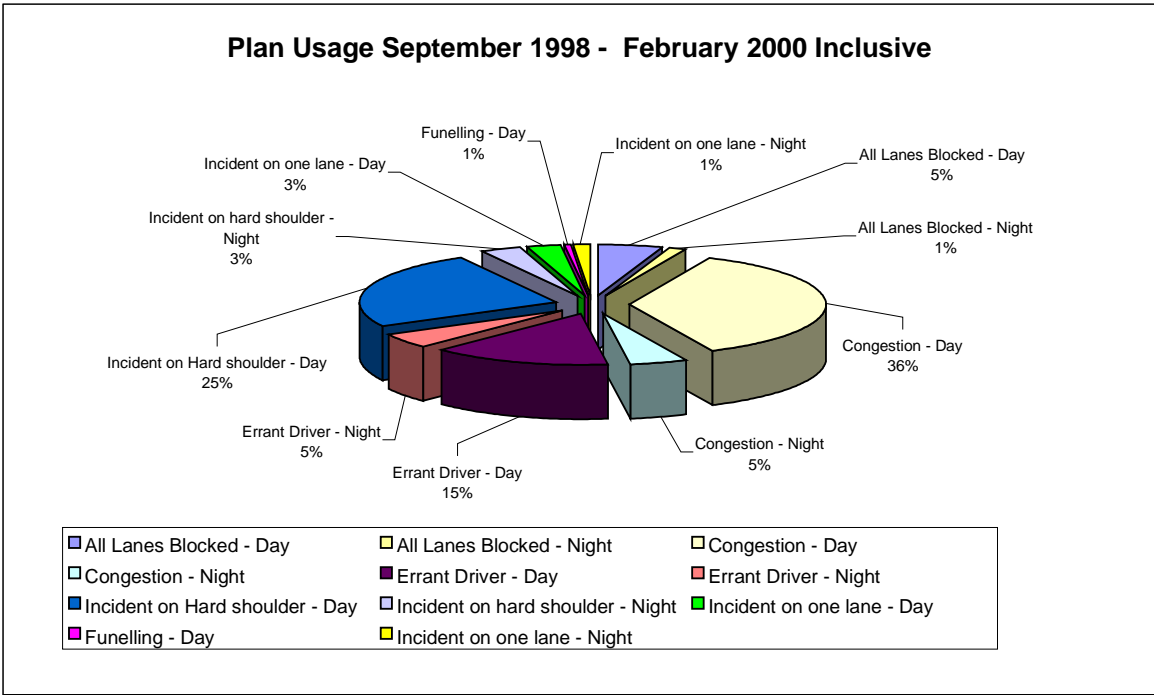


Figure 3.2 Plan Usage Details

## 4 Accident Data Analysis

### 4.1 Comparative Analysis of Accident Data

A comparison of Personal Injury Accident (PIA) statistics for the COMPANION Site and for a number of other, control sites, also within Fife was, used as the basis of an evaluation of the impact of COMPANION in reducing accident numbers and severity.

The data, which were provided by the Scottish Executive, cover the periods:

- three years 1995 to 1997, inclusive, pre COMPANION implementation; and
- sixteen months from January 1998 to April 1999, post COMPANION Introduction.

There is currently no accident data available beyond April 1999.

The sites for which accident data were analysed are as follows;

**COMPANION site:**

M90 Junction 3 to Junction 1 Southbound;

**Control sites:**

M90 Junction 3 to Junction 1 Northbound;

M90 Junction 10 to Junction 3 Southbound;

M90 Junction 10 to Junction 3 Northbound;

A92 Halbeath to Glenrothes Southbound;

A92 Halbeath to Glenrothes Northbound.

The objective of including the control sites was to assess whether any impact at the COMPANION site was due to the use of the system or merely a reflection of an underlying trend in accident rates.

The number of injury accidents occurring, per year at each site, pre and post COMPANION implementation is shown in Figure 4.1. This shows a reduction in the number and severity of accidents at the COMPANION site post implementation.

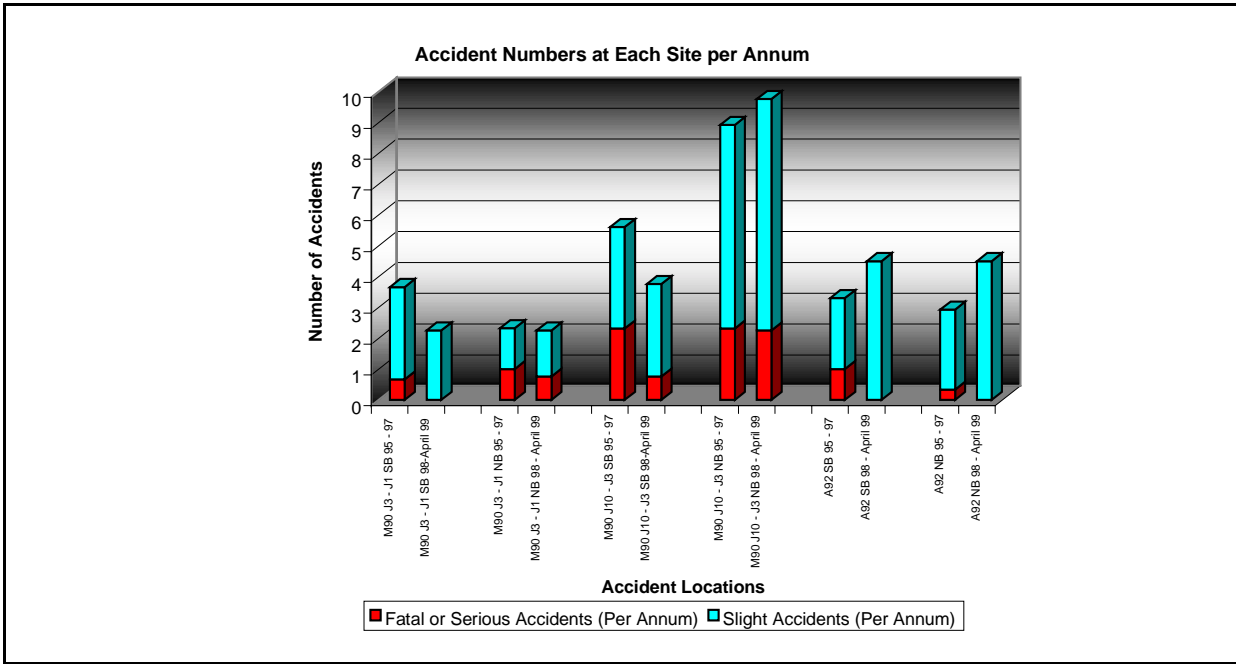


Figure 4.1 Accident Numbers per Annum by Severity

In order to assess the significance of this reduction, accident rates at each site have also been expressed as the number of personal injury accidents occurring at the site per million vehicle km (MVKm). This ratio takes into account the length of each site, traffic flows, the number of accidents and the data collection period.

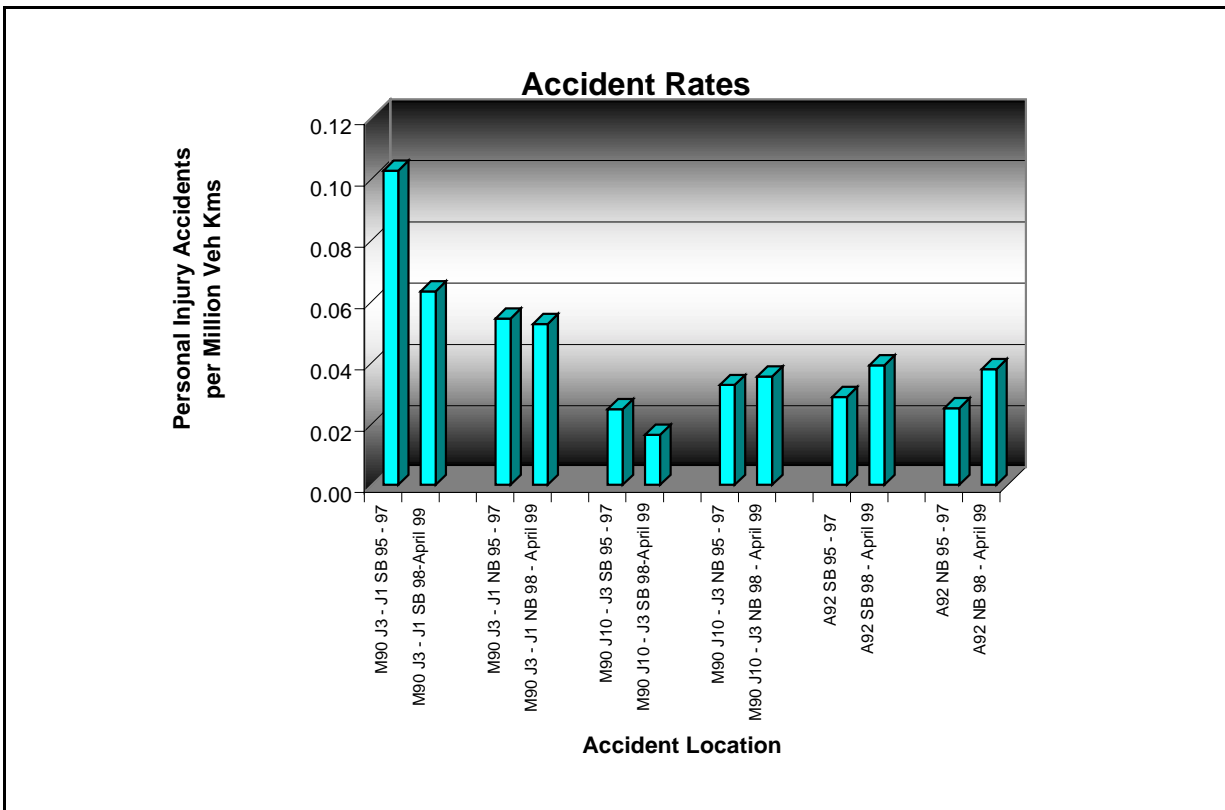


Figure 4.2 Accident rates (PIA per MVkm) Pre and Post COMPANION Implementation.

The number of accidents per MVKm is derived from the following equation:

$$\frac{\text{Number of Accidents} * 1,000,000}{\text{Number of Vehicles per day} * \text{study period in days} * \text{length of study link in Km}}$$

Accident rates, in PIAs per MVKm are shown in Figure 4.2. The accident rate at the COMPANION site, pre implementation, was 0.10 PIAs per MVKm. The current rate is estimated to be 0.06.

#### 4.2 Conclusions From Accident Data Analysis

Taken together, Figures 4.1 and 4.2 indicate that the largest reduction in accident numbers and severity, relative to the length of site and the traffic using the road occurred at the COMPANION site. This is confirmed by the analysis in Table 4.1 below, which summarises percentage reductions in accidents, by injury accident type, for each site, for the post implementation period.

Percentage Change in Accidents Post COMPANION Implementation	M90 J3-J1 Southbound (COMPANION Site)	M90 J3-J1 Northbound	M90 J10-J3 Southbound	M90 J10-J3 Northbound	A92 Halbeath to Glenrothes Southbound	A92 Halbeath to Glenrothes Northbound
Severe Accidents	-100%	-75%	-68%	-3%	-100%	-100%
Slight Accidents	-25%	+12%	-10%	+11%	+49%	+42%
All Injury Accidents	-38%	-3%	-33%	+9%	+36%	+50%

Table 4.1 Percentage Changes in Accident Numbers

The COMPANION site shows the greatest percentage reduction in PIAs compared with the other, control sites. Severe accidents have decreased for every site, but by varying amounts. The COMPANION site represents the largest reduction, along with the A92 North and Southbound. Slight injuries have reduced more significantly for the COMPANION site than for any other, control site.

Overall, the analysis undertaken to date suggests that COMPANION is having some positive effect on reducing both accident numbers and their severity.

However, it is clear that further assessment into the merits of COMPANION would be beneficial, particularly given the low absolute number of accidents included in the analysis, and a post implementation period of at least 3 years is recommended to fully validate the above conclusions.

## 5 Future Aims for COMPANION in Scotland

Based on the experiences of COMPANION to date at the M90 site and at similar sites in Germany and Italy, it is recommended that the next stage of the project for the development of COMPANION should address the following aims:

### Aim 1

**Trial and evaluate loop, microwave and CCTV based incident detection technologies on the existing COMPANION site and identify the most suitable approach for future applications in Scotland.**

The objective would be to investigate as wide a range as possible of alternative procedures for the operation of COMPANION, including manual and automatic activation, with a range of different Automatic Incident Detection approaches.

A key issue in evaluating the benefits of any detection technology, incorporated within COMPANION, is the assessment of its actual and achievable impact on reducing incident detection time and thereby system activation times, with the aim of ultimately reducing accident rates. Use of the existing COMPANION installation by RUETZ Technologies, who manufacture and distribute COMPANION on behalf of BMW, for the purposes of testing and evaluating alternative loop and microwave automatic incident technologies, will be encouraged.

The clear, likely benefit through the integration of COMPANION with CCTV, loop and microwave technology is the reduction in detection time of incidents. This will reduce the number of incidents that would otherwise occur in the time between detection of congestion and disposition and activation of the system.

Table 5.1 gives the assumed scope of the next stage of research taking account of developments across all COMPANION sites. It is envisaged that, if proceeded with, the trials planned for England would add to the range of technologies and operational procedures to be evaluated. However, the English site is unlikely to be installed in time to participate fully within the study proposed for the Executive.

Trial Application	Technology Used	Scotland	Germany	Italy	England
Manual Operation – Detection Technologies Not Integrated	CCTV	T	T	T	T?
	Loops	T	T		T?
	Environmental Monitors		T		T?
Manual Operation – Detection Technologies Integrated	Microwave @ 500m	T	T		
	Loops	T	T		T?
	CCTV		T		T?
Automatic Operation – Detection Technologies Integrated	Microwave @ 500m	T	T		
	Loops	T	T		T?
	CCTV		T?		T?
	Environmental Monitors			T?	
Telephone Alerts in Addition to the Above	Mobile and Emergency Phones	T	T	T	T
Pictograms in Addition to the Above	VMS	T		T	

Table 5.1 Potential Scope of Trials Across All Sites

## **Aim 2**

**Trial and evaluate the impact of pictogram variable messages in conjunction with COMPANION use.**

There are similar, parallel trials being held at the German and Italian COMPANION sites into the additional benefits of providing drivers with a pictogram of the nature of the incident ahead, the results from which have been delayed.

However, the Italian trials have assessed the interaction between the warnings delivered by COMPANION and those delivered through a traditional VMS system. This was combined with questionnaires assessing the drivers' attitudes and reactions towards COMPANION.

Clarification is needed as to the status of these trials, together with the Automatic Incident Detection trials that have been held in Italy, as well as those held in Germany, before detailed plans for these additional trials in Scotland can be developed.

## **Aim 3**

**Develop a system specification which can be used to procure future installations of a similar hazard warning system at appropriate sites throughout Scotland.**

A system specification would be established, following trials and evaluation of the incident detection technologies and pictogram variable message signs used in conjunction with COMPANION. Data from Scottish, German and Italian trials would be collated to establish appropriate system components, technical specification and performance criteria for a beacon based hazard warning system for Scotland, similar to COMPANION.

## **Aim 4**

**Identify potential sites in Scotland for future application of the technology.**

Finally a cost / likely benefit analysis would be developed, which could be used to establish, for Scotland, where best value will be gained from system implementation. Thereafter, potential sites for system implementation would be identified within Scotland.