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Incident Management Workshop - Framework for Developing Incident Management Systems

National Highway Institute

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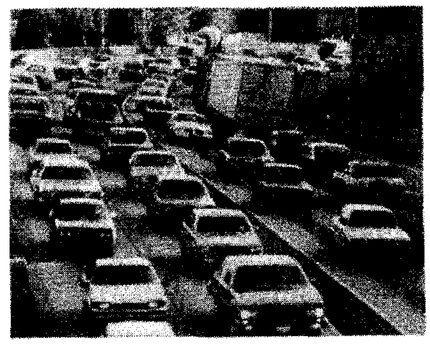


This document describes a procedure for developing an effective incident management system. It discusses the issues that must be addressed as a management system is developed, and describes the types of decisions and actions that must be considered to create a smoothly functioning management process. It describes the specific management measures and techniques that may be included as part of an incident management system. It also discusses potential benefits from specific types of incident management, as well as the costs and administrative burdens that those management measures impose, and provides "how to" guidance for creating or improving existing incident management systems.

INTRODUCTION

Even without formal incident management programs, in every urban area agencies already perform some type of incident response. That is, someone responds to incidents that occur. Thus, the goal of an incident management system is not to create a response, but rather to create a *more effective* response for all cooperating agencies.

Often, if an agency already has significant responsibilities for incident management, a formal "management system" may actually decrease the resources used to react to incidents by decreasing overtime and excess staff requirements. While resources within the organization may be allocated differently than before the formal system had been adopted, resources saved by a formal incident management system usually result in increased resources (personnel and/or funding) for non-incident response tasks.

This guide is intended to aid in the development, implementation, and enhancement of formal incident management systems. It provides agencies involved with incident management the basic information needed to evaluate alternative management techniques and a framework for using and evaluating those techniques to establish or refine incident management systems. The report is intended both for agencies that are interested in creating a formal incident management process and for agencies that already have a formal management process in place and are looking to enhance its effectiveness.

Thus, this guide is designed to be used in two ways. For agencies that do not have, but are planning to instigate, a formal incident management system, this guide provides the necessary background to understand the scope of the task ahead, defines the technical alternatives, provides instructions on creating a system, and describes barriers and problems that are likely to occur as the incident management system is developed and deployed.

For agencies that already have a formal incident management system in place, the technical chapters of the guide provide a useful summary of alternative management strategies used throughout the country. The summary includes the strengths, weaknesses, cost structures, and benefits associated with each of the alternatives. Also described are implementation issues for each alternative (the implications of implementing a particular strategy in terms of budgets, field personnel, staffing levels, training, inter-jurisdictional relations, operations, and legal issues). Wherever possible, the guide provides references to reports that describe evaluations or the operation of specific management techniques and names of agencies that use those techniques. With this information, an agency wishing additional information on that strategy has an initial contact point. These summaries should make identification and selection of new response techniques easier and less time consuming.

Finally, the background and introductory sections of this guide can be used as a primer for personnel new to incident management and response. The guide can be used to better understand the issues surrounding incident management and the types of problems and barriers likely to be met as response measures are implemented.

GUIDE ORGANIZATION

Below is a brief overview of the remainder of the guide.

- Section I contains an introduction to incident response and the issues and techniques for creating and implementing a formal incident management system.
- Section II describes the technical details of specific incident management measures.
- Section III contains step-by-step guidelines for selecting response techniques, as well as reference material.

The remainder of this chapter includes a brief introduction to incident prevention and management. It describes the categories of incident response actions that are used throughout the guide and provides a useful introduction to incident response for personnel new to this area of work.

The second chapter of Section I, "Systems Approach to Problem Solving," describes a successful approach to developing a formal incident management process. It describes a strong, rational approach to approaching the complex issues inherent in incident management and outlines the steps that must be taken to develop such a system.

The third chapter of Section I, "Major Issues In Selecting Alternatives and/or Developing a System," is essentially a primer for managers and administrators interested in setting up an incident management system. It also serves as an important source of background material for personnel entering the field or taking on new responsibilities for overseeing incident management actions.

Section II of this notebook, "Management Actions to Consider," provides the technical details of the majority of incident management actions employed in the United States. This section should be used to develop lists of alternative actions to be investigated as part of the development or enhancement of an incident response system.

The first chapter of Section III summarizes the information provided in Section I in a format designed to help lead an agency through the development process. "Framework for Creating a System" provides a series of short worksheets, lists, tables, figures, and questionnaires that will help an agency determine whether it has addressed the major concerns described throughout this guide. These worksheets are not designed as a formula to make the decision on incident management. Instead they are designed to help an agency collect and integrate the information it needs so it can make an informed decision about the actions and responses it and cooperating agencies should take as part of a planned, efficient incident management process.

This section ends with a discussion of ways to quantify the benefits obtained from implemented incident management techniques and provides contact lists and references to help agencies select from the available incident response options.

INCIDENT PREVENTION

Focusing on ways to improve the management of incidents makes little sense without also considering ways to prevent incidents from occuring. Incident prevention means minimizing incident occurence in the first place. Conventional incident prevention methods have included improvements in roadway geometrics, right-of-way obstruction removal (i.e., light poles, trees), and material changes to improve skid resistance. New technologies are beginning to focus on incident prevention as well. These new technologies include Advanced

Vehicle Control Systems (AVCS) and Automated Truck Warning Sytems (ATWS).

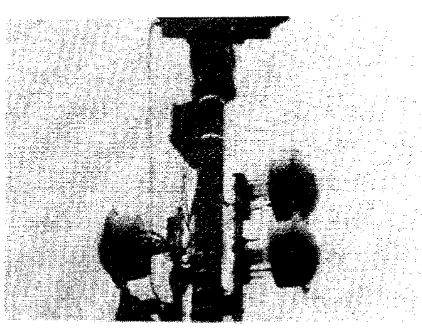
Table 1.1 lists options for incident prevention.

INCIDENT MANAGEMENT

Incident management systems encompass five basic tasks. Even in the absence of a formal incident management process, these five functions still take place. However, they take place less effectively and more slowly than if they had been conducted as part of a well planned procedure. These tasks include the following:

- incident detection and verification,
- incident response,
- incident site management,
- incident clearance, and
- motorist information.

These functions often occur simultaneously and are often performed in an iterative fashion. That is, the response to the incident may begin with preliminary information about the incident and then change as the incident is understood more clearly. (For example, the initial response to all incidents may be the same: send a police officer. On the basis of the results of that response, the needs identified for various incidents will differ, and any additional response for the incidents will be based directly on those needs.)



Incident Detection and Verification

Incident detection is the process that brings an incident to the attention of the agency or agencies responsible for maintaining traffic flow and safe operation on a facility. Generally, the speed with which an incident is detected affects the speed with which it is cleared and the amount of disruption it causes the remainder of the traffic stream. Thus, fast, accurate detection often results in greatly reduced traffic disruption and the large savings reduced disruption can produce. However, false detection of incidents can result in wasted response resources. Consequently, many incident management measures are aimed at improving the methods for detecting incidents.

Incident detection can be improved with a variety of methods, including

- electronic traffic monitoring devices (e.g., loops),
- video cameras,

Table 1.1 Options for Improving Prevention

Type of Program	Potential Benefits	Potential Costs	Comments
Advanced Vehicle Control	👍👍👍👍	💰💰💰💰	Can prevent incidents, as well as improve response and clearance.
Automated Truck Warning Systems	👍👍👍	💰💰⇨💰💰💰	Requires the identification of locations with high rates of truck-involved incidents before implementation.

👍 = Minor benefits

👍👍 = Moderate benefits

👍👍👍 = Substantial benefits

👍👍👍👍 = Very substantial benefits

⇨ = Indicates a range of benefit/cost levels

💰 = Minor costs

💰💰 = Moderate costs

💰💰💰 = Substantial costs

💰💰💰💰 = Very substantial costs

- CB radios, and
- visual observation (e.g., by uniformed law enforcement personnel at the scene).

Table 1.2 lists options for reducing detection times that may be evaluated for possible inclusion in an incident management system.

Incident Response

Once an incident has been detected, response depends on understanding the cause of the incident and the steps and/or resources that are necessary to return the facility to normal conditions. These steps may entail (among other items) requesting assistance or services from other agencies or contractors, requesting special equipment and/or personnel, and the deployment of specific traffic control plans.

As with detection, the appropriate identification of needs at an incident significantly decreases the time required to clear it. However, unlike incident detection, proper identification of needs at an incident site is more a function of training and knowledge of the available response resources than a function of technology. Because incidents can be cleared with many techniques and pieces of equipment, persons who initially respond to (or investigate) an incident location must have adequate training to select the best response. They must be able to judge the scope of the problem and know the resources that are available for responding to that type of incident, at that time, and at that location.

Table 1.2 Options for Reducing Detection and Verification Time

Type of Program	Potential Benefits	Potential Costs	Comments
Peak Period Motorcycle Patrols	👍👍👍👍	💰💰⇨💰💰💰	Roving motorcycle patrols can provide added surveillance along high incident segments of freeway.
Dedicated Freeway/Service Patrols	👍👍⇨👍👍👍👍	💰💰⇨💰💰💰💰	Roving patrols along high incident segments of the freeway can serve to reduce incident detection times.
Motorist Aid Call Boxes/Telephones	👍👍	💰💰💰	May incur added costs or complications because of required utility work.
Incident Phone Lines	👍	💰💰	Requires an initial publicity effort and continued cooperation with media agencies.
Cellular Telephones	👍👍👍👍	💰	Information should be distributed to cellular phone users describing proper incident reporting techniques.
Citizen Band (CB) Radio Monitoring	👍👍	💰	Information should be distributed to CB radio operators describing proper incident reporting techniques.
Volunteer Watch	👍	💰	Training efforts may be wasted on short-term or non-dedicated volunteers.
Ties with Transit/Taxi Companies	👍👍👍	💰	Can be expensive to cover all routes or limited to only those who travel on the freeway or other high incident areas.
Aircraft Patrol	👍⇨👍👍👍👍	💰⇨💰💰💰💰	May be limited by noise or density restrictions.
Electronic Loop Detection	👍👍	💰💰💰💰	Can also serve other operations functions, but may give false calls in incident detection.
Video and Closed Circuit TV	👍👍👍👍	💰💰💰💰	Can also serve many other operations functions such as volume, speed, and vehicle classification data collection.
Automatic Vehicle Identification	👍👍👍	💰💰💰💰	Motorists may be resistant to instrumenting their vehicles with electronic tags.
Cellular Telephone Monitoring	👍👍	💰💰	Still emerging as a technology and may suffer from unreliability and lack of support when problems arise.
Video Imaging	👍👍👍	💰💰💰💰	Still emerging as a technology and may suffer from unreliability and lack of support when problems arise.
Central Information Processing and Control Site	👍👍👍	💰💰💰	Centralization of information allows for better verification of incidents.

An incident management system is not limited to a single action or program. Instead, it is a combination of actions that allow the responding agency to tailor its response to the given conditions within that agency's resource limitations. Some response actions are designed to decrease the time an agency needs to transport equipment to an incident location. Other response actions are designed to provide specialized equipment or personnel for speeding incident removal or clearance. The most successful management systems provide a range of response actions that offer some combination of both quick response and strong clearance capabilities.

Table 1.3 shows many of the response actions that improve an agency's ability to transport equipment and personnel to an incident site, and thus decrease response time. Decreasing the time required for personnel and equipment to reach a site decreases the time required to clear an incident, which in turn decreases both the personnel cost associated with that incident management and the cost to motorists of incident related delay. Management methods that are specifically intended to speed the clearance of a site once the personnel and equipment have arrived are discussed below.

Incident Site Management

Once the selected personnel and equipment have begun to arrive at the incident scene, the effectiveness of the response is a function of both how well suited the response technique is to that incident and how well the personnel at the scene manage the incident site. A well managed response that uses an "inferior" technique may be more effective at clearing an incident than a "superior" technique that is not well managed.

When a single agency responds to an incident, management at the site entails ensuring that the personnel working at the scene understand their duties and are appropriately trained and led. However, when

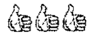
Key to Table 1.2

= Minor benefits	= Minor costs
= Moderate benefits	= Moderate costs
= Substantial benefits	= Substantial costs
= Very substantial benefits	= Very substantial costs
⇨ = Indicates a range of benefit/cost levels	

Table 1.3 Options for Improving Response Time

Type of Program	Potential Benefits	Potential Costs	Comments
Personnel Resource List	👍👍👍	💰	Can save time in locating specially trained personnel if list is comprehensive (involving all responding agencies) and frequently updated.
Equipment and Materials Resource List	👍👍👍	💰	Can save time in locating special equipment or personnel if list is comprehensive (involving all responding agencies) and frequently updated.
Incident Response Database	👍👍	💰💰	Provides consistent and comprehensive incident information for improved resource allocation and cost recovery.
Peak Period Motor Cycle Patrols	👍👍👍👍	💰💰⇨💰💰💰	Motorcycle patrols can provide a direct communications link to request additional response assistance.
Dedicated Freeway/Service Patrols	👍👍⇨👍👍👍👍	💰💰⇨💰💰💰💰	Roving patrols can reduce the response times required by response vehicles departing from a location removed from the freeway.
Personnel Training Program	👍👍👍	💰💰	An emphasis on personnel training through knowledge and repetition of tasks can reduce required response times.
Tow Truck/Removal Crane Contracts	👍👍	💰	Provides faster access to equipment, but may create dissention with other capable private agencies.
Improved Interagency Radio Communication	👍👍👍	💰⇨💰💰	Adequate communication between the various responding agencies, can help to insure that the closest response vehicle is called to the incident scene.
Ordinances Governing Travel on Shoulder	👍	💰	Can provide additional travel lane for response vehicles during emergencies but may be severely limited by space constraints.
Emergency Vehicle Access	👍👍	💰💰	Requires identification of those freeway links which suffer from poor access.
Advanced Vehicle Control	👍👍👍👍	💰💰💰💰	Can prevent incidents, as well as improve response and clearance.
Alternative Route Planning	👍👍	💰	If properly planned, can allow quicker access to incident site by response vehicles.
Equipment Storage Sites	👍👍	💰⇨💰💰	Provides faster access to equipment or materials.
Administrative Traffic Management Teams	👍	💰	Provides a forum to discuss and provide funding for area incident management programs aimed at improving response times.
Public Education Program	👍👍👍	💰	Can educate drivers regarding disabled vehicle removal policies and can resolve many incidents without the need for an actual response.
Automatic Vehicle Location	👍👍👍	💰💰💰	Can improve dispatching and response times if system is detailed and accurate.
Geographic Information Systems	👍👍👍	💰💰💰	Can improve both safety at the scene, by identifying infrastructure resources and utilities, and response to the scene if used with AVL.

Table 1.3 Continued

Type of Program	Potential Benefits	Potential Costs	Comments
Central Information Processing and Control Site			Provides a single location for monitoring incidents, so that data from multiple sources can be used to more quickly determine the appropriate response action.
Closely Spaced Milepost Markers			Always fast, accurate, easy location of incidents, which improves the speed with which response actions can be brought to bear.

 = Minor benefits

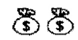
 = Moderate benefits

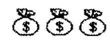
 = Substantial benefits

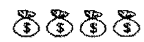
 = Very substantial benefits

 = Indicates a range of benefit/cost levels

 = Minor costs

 = Moderate costs

 = Substantial costs

 = Very substantial costs

multiple agencies respond to an incident, managerial difficulty takes a quantum jump. Not only must each agency understand its own responsibilities and train its staff, but some means of coordination and control must exist among the responding agencies. This process becomes more complicated as the size of the incident grows and the number of agencies involved increases.

The success of these coordination efforts directly impacts the success of the incident response process, especially for larger incidents. Whether coordination is successful often relates directly to the attitude of upper management and its desire to compromise and find solutions to problems that cross jurisdictional boundaries. Techniques that are useful in improving the management of personnel and equipment at an incident site are shown in Table 1.4.

Incident Clearance

Each technique for clearing an incident site has strengths and weaknesses. For example, a truck has overturned on the freeway. The truck could be set back on its wheels by several conventional tow trucks, one large incident response crane, or one or more inflatable air bag systems designed specifically for this task. None of these "solutions" would be necessarily better than the others. The air bag system might only be applicable for certain types of trucks, or personnel responding to the incident site might not have access to, or the necessary training to use, an air bag system. The large crane might work more quickly than conventional cranes or multiple tow trucks, but a large crane might need more time to reach the incident site. Several conventional tow trucks might be able to reach the site quickly and could act as small cranes. However, the drivers of those vehicles might not be familiar with working together to upright a large vehicle, and the use of these vehicles might take more time than calling in a specialized piece of equipment.

Table 1.5 shows a number of management techniques that can help to clear incidents quickly. This table also provides a brief description of these techniques. As part of developing an incident management system, an agency should select the actions that best fit its organizational needs and capabilities.

Most incident management systems employ a number of these responses in order to efficiently match the actions of the agency to the needs of specific incidents. With multiple management capabilities, once an incident has been identified, selection among the available response alternatives becomes a function of the needs identification process described earlier in this guide.

Motorist Information

The final aspect to an incident management system is the notification of motorists about the traffic conditions. Motorist information systems perform many functions, including reducing the traffic congestion caused by an incident, reducing the traffic hazards near the incident location, and providing motorists with information about the cause of their delay to reduce their level of frustration with the road system. Table 1.6 shows various options for providing increased levels of incident information to motorists.

Adequately informing motorists of the incident location and the scope of the incident can help reduce traffic volumes that pass the site, spread the traffic mitigation measures over a greater geographic area, and reduce vehicle speeds approaching the site (or at least heighten drivers' awareness of upcoming conditions). All of these items benefit both the agencies, who try to reduce congestion levels and improve the safety of work crews, and the motorists, who need to use the congested facilities.

The five parts of incident management are discussed more fully in the chapter, "Incident Management Options To Consider For Implementation."

Table 1.4 Options for Improving Site Management

Type of Program	Potential Benefits	Potential Costs	Comments
Incident Response Teams	👍👍⇨👍👍👍👍	💰⇨💰💰💰	Highly trained, coordinated response teams can greatly reduce site management delays and can reduce interagency conflicts.
Personnel Training Programs	👍👍👍	💰💰	Highly trained personnel can speed the management process as well as reduce the number of interagency conflicts that may arise.
Peak Period Motorcycle Patrols	👍👍👍👍	💰💰⇨💰💰💰	Motorcycle patrols have more maneuverability in highly congested areas and carry out tasks vital to the incident management process (i.e., traffic control).
Improved Interagency Radio Communication	👍👍👍	💰⇨💰💰	Direct communication between the various responding agencies can reduce repetitious commands and improve interagency relationships.
Command Posts	👍👍	💰	Allows information and instruction to disseminate from a single, central location, improving efficiency and reliability of information.
Identification Arm Bands	👍	💰	Allows quick differentiation between respondents and public or media personnel who may also be present.
Properly Defined Traffic Control Techniques	👍👍👍	💰	Provides greater safety for motoring public, as well as improving the safety of the respondents.
Properly Defined Parking for Response Vehicles	👍👍	💰	Ensures that excess lanes are not blocked by response vehicles and smooth operation of incident management processes are not impeded.
Flashing Lights Policy	👍	💰	Need to consider safety of respondents, liability and impacts on normal traffic flow.
Administrative Traffic Management Team	👍	💰	Provides a forum to discuss and provide funding for area incident management programs aimed at improving site management efforts.
Central Information Processing and Control Site	👍👍👍	💰💰💰	Central collection and analysis of incident information allows for more coordinated response to incidents.
Alternative Route Planning	👍👍	💰	Serves to improve both response and clearance efforts.
Incident Response Manual	👍👍👍	💰	Predetermined chain of command and responses can facilitate decision-making, communications, and site management.
Incident Response Database	👍👍	💰💰	Provides consistent and comprehensive incident information for improved resource allocation and cost recovery.
Automatic Cargo Identification	👍👍👍	💰💰💰	Provides a safeguard when a potentially hazardous cargo is unidentifiable. Still requires confirmation from other HAZMAT references.

Key to Table 1.4

= Minor benefits

= Moderate benefits

= Substantial benefits

= Very substantial benefits

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= Substantial costs

= Very substantial costs

Table 1.5 Options for Reducing Clearance Time

Type of Program	Potential Benefits	Potential Costs	Comments
Policy Requiring Fast Vehicle Removal	👍👍👍👍	💰	Serves to quickly restore the capacity of the roadway,but may require passage of an ordinance to be used.
Accident Investigation Sites	👍👍	💰💰⇨💰💰💰	Serves to improve the safety of the motoring public, as well as improving the safety of the respondents, by removing the incident from the roadway.
Dedicated Freeway/Service Patrol	👍👍⇨👍👍👍👍	💰💰⇨💰💰💰💰	Specially equipped freeway/service patrol vehicles can clear most minor incidents without the assistance of other response vehicles.
Push Bumpers	👍👍	💰	Allows minor incidents to be cleared quickly.
Automated Debris Recovery System	👍👍	💰💰💰	Improves respondent safety, but response times may be too lengthy to reduce incident impacts.
Inflatable Air Bag Systems	👍👍	💰💰	Improves clearance times for incidents usually involving overturned trucks; however, use is severely limited by the truck trailer type involved.
Responsive Traffic Control Systems	👍👍	💰💰💰💰	Can improve clearance efforts by limiting congestion in the immediate area.
Advanced Vehicle Control	👍👍👍👍	💰💰💰💰	Can prevent incidents, as well as improve response and clearance.
Variable Lane Closure	👍👍	💰	Can speed clearance efforts by allowing the interruption of flowing traffic; may require a change in existing policy.
Ordinances Governing Shoulder Travel	👍	💰	Can provide additional travel lane for removing disabled vehicles but may be severely limited by space constraints.
Emergency Vehicle Access	👍👍	💰💰	Requires identification of those freeway links which suffer from poor access.
Alternative Route Planning	👍👍	💰	If implemented simultaneously with motorist information programs, can serve to reduce congestion and improve mobility at the incident site by rerouting uninvolved vehicles.
Identification of Fire Hydrant Locations	👍👍	💰	Can greatly speed clearance efforts by allowing the quick location of utilities in incidents involving fire.
Incident Response Teams	👍👍⇨👍👍👍👍	💰⇨💰💰💰	Coordinated response teams should be trained in a variety of equipment use to provide greatest clearance capabilities.
Personnel Training Programs	👍👍👍	💰💰	An emphasis of personnel training through knowledge and repetition of tasks can reduce required clearance times.
Incident Response Manual	👍👍👍	💰	Once developed, should be included in regular training procedures to further clearance efforts.
Hazardous Materials Manual	👍👍👍	💰	Once developed, should be included in regular training procedures to further benefit clearance efforts.

Table 1.5 continued

Type of Program	Potential Benefits	Potential Costs	Comments
Administrative Traffic Management Teams	👍	💰	Provides a forum to discuss and provide funding for area incident management programs aimed at improving clearance times.
Public Education Program	👍👍👍	💰	Can educate drivers regarding disabled vehicle removal policies and can result in the immediate clearance of disabled vehicles off the roadway.
Total Station Surveying Equipment	👍👍👍👍	💰	Can reduce the time required for accident investigation by nearly half.

👍 = Minor benefits

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💰💰💰💰 = Very substantial costs

Table 1.6 Options for Improving Motorist Information

Type of Program	Potential Benefits	Potential Costs	Comments
Improved Media Ties	👍👍	💰	Information disseminated by the media must be effective and accurate and must therefore come from a single and central dissemination point.
Highway Advisory Radio	👍⇨👍👍	💰⇨💰💰	Variations include mobile and truck mounted, but in each case must be kept current and accurate to be utilized by the motoring public.
Variable Message Signs	👍👍	💰⇨💰💰	Variations include flap, matrix, drum, permanent and portable, but in each case must be kept current and accurate to be utilized by the motoring public.
Radio Data Systems (RDS)	👍👍👍	💰💰💰💰	Provides information to motorists when they want it, but is still in the early implementation stage.
Externally Linked Route Guidance (ELRG) Systems	👍👍👍👍	💰💰💰💰	Provides the most comprehensive information concerning traffic situations, but is still in development stage.
Central Information Processing and Control Site	👍👍👍	💰💰💰	A central location which can collect data from multiple sources will be able to provide a more accurate picture of existing traffic conditions.
Advanced Traveler Information Systems	👍👍	💰⇨💰💰💰	Relies on motorists to change their driving behavior, which may not happen.

👍 = Minor benefits

👍👍 = Moderate benefits

👍👍👍 = Substantial benefits

👍👍👍👍 = Very substantial benefits

⇨ = Indicates a range of benefit/cost levels

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Systems Approach to Problem Solving

The approach suggested in this guide for creating an incident management system is patterned after a classic "systems" approach to program development. It is intended to create a logical series of steps that will help the agency staff responsible for program development identify

- the issues and problems to be resolved,
- alternative ways to solve those problems, and
- the relative merits and disadvantages of the alternatives selected for analysis.

The systems approach also provides a framework for discussing the important issues surrounding the incident response process. Thus, it is important to consider the issues raised in this chapter, regardless of the methodology actually used to develop, evaluate, or select among alternatives for the management program.

The systems approach to program development breaks the decision making process into eight separate tasks. These tasks are as follows:

- define the problem,
- set goals and objectives,
- develop alternatives,
- evaluate alternatives,
- select alternatives,
- implement alternatives,
- re-evaluate alternatives, and
- refine the system

Even if an agency already has a formal incident management process in place, it can follow this same series of tasks to refine that system. The only difference is in the amount of work required and in the number of alternatives that need to be analyzed.

DEFINE THE PROBLEM

The first step in developing a formal incident management process is to understand the problems that are occurring, including the causes of incidents, the impacts those incidents have on traffic flow, and the types of improvements that might alleviate those impacts. Once the problems have been understood, then the agency can advance to the task of developing and selecting among the alternatives that address those problems. It is particularly important to understand the cause(s) of the problems being examined, not just the symptoms that an agency or area might be experiencing. Identification of the true cause(s) of the problems helps set the scope for the incident management process being developed. It also prevents the implementation of a management process that will not measurably improve the incident situation because it will not impact the real cause of the incident problem.

Generally, incidents fall into several sizes or severities. Some incidents require a great deal of effort on the part of responding agencies and others require relatively little effort. By understanding the incidents that are occurring, an efficient agency can tailor its management actions to the needs of each incident. That is, large numbers of personnel and equipment will not respond to small incidents, but these resources can be quickly brought to bear on larger incidents.

Determining the size or severity of specific incidents is part of understanding the problems an incident management process is intended to solve. To do this, an agency must review where incidents occur, what causes them, the impacts those incidents have on traffic flow and public perception, and how management of incidents may impact the agency's mission. With this understanding, the agency can then balance the cost of specific incident management measures against available resources and the benefits that will be gained by implementing those measures.

The severity of an incident can be defined both in terms of the incident conditions (whether a fatality is involved, whether hazardous materials are involved) and in terms of the impacts the incident will have on traffic flow. For example, a stalled car may be considered a minor incident and may require a relatively low level of incident response. However, if that stalled car is on a narrow bridge in heavy rush hour traffic, the congestion caused by that stalled vehicle may elevate the incident to a "severity" level that warrants a greater level of response. Thus, the scope of the problems addressed by an incident management process must be viewed in relation to the types of incidents, their geographic area of influence, and how these factors change the priority of the incident response.

The process of collecting information regarding incidents, which is key to problem definition, can be classified into three categories: 1) incident occurrence, 2) incident duration and 3) traffic impacts.

In collecting data related to incident occurrence, the following information has been shown to be useful:

- frequency of occurrence by location,
- frequency of occurrence by month,
- frequency of occurrence by season of the year,
- frequency of occurrence in rain vs non-rain,
- frequency of occurrence by day of week,
- frequency of occurrence by hour of day, and
- frequency of occurrence during special events (sporting events, etc.).

Data found to be important in determining incident duration problems include the following:

- time required to detect incidents,
- time from the incident report to response arrival at the scene,
- time required to clear incidents after response arrival,
- presence of special events,
- traffic conditions (flow) at the time of the incident,
- number of injuries/fatalities,
- number of lanes blocked, and
- number of vehicles involved.

Finally, while data on incident occurrence and duration are generally available from accident and police dispatch reports, the traffic related impacts of an incident are more difficult to measure. While video monitoring and loop detectors may assist in this regard, the use of a traffic simulation model may also be of value. The use of such a simulation model will allow the traffic impacts to be determined by the incidents' location, extent (number of lanes blocked), duration, and time of day.

SET GOALS AND OBJECTIVES

The second part of developing a successful incident management process is to carefully define the achievements that should result from that management system. These goals and objectives should relate both to the specific problems that have been identified and to broader public needs and demands. It is particularly important to consider the public perception of the incident management system being developed and the need to justify both the initial management system and the continuing operation of that system to local public officials and (sometimes) state legislators.

A significant part of setting these goals and objectives is determining the priorities of the various goals and objectives, and by inference, the priorities of solving the various problems identified earlier. This information is crucial to the process of selecting among alternatives when an agency balances the capabilities of specific alternatives against the costs of performing those measures.

These priorities should reflect the impetus for the implementation of the incident management system. Several important questions should be asked.

- Are there particularly sensitive areas that should receive attention early in the development and implementation of the incident management system?
- What are the factors driving the investigation of improved incident response?
- Are political forces requesting increased action?
- Are incidents frequently hampering the normal operation of the system?
- Does the current response process create problems within the agency that the new process is intended to solve?
- Is the need for better incident management a matter of major public concern?

The answers to these types of questions are important in the selection of goals and objectives, and consequently in the selection of alternative management measures.

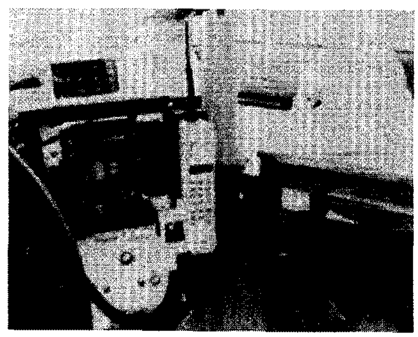
When an agency develops goals and objectives, it is also important that it selects goals and objectives whose success or failure can be measured. That is, some of the goals and objectives must be numerically quantifiable. Measurement allows a realistic assessment of the success or failure of the management procedures implemented and can be of significant benefit for both political and operational purposes. For example, one objective might be to reduce congestion caused by incidents. The selection of such an objective should entail provisions for measuring congestion related to incidents. Usually data on the impacts of programs must be provided to justify the existence of the programs, and selecting objectives that can be readily measured makes that analysis easier and more useful.

Furthermore, developing objectives that can be measured provides impetus to collect data on the delay caused by incidents before the incident management process has started. These data become baseline traffic performance information for comparison with similar information after the incident system has been implemented. Often, funding for baseline data collection is not considered until after the management system implementation has begun, and little "proof" is available to show the impacts of the new system. This lack of validation information decreases an agency's ability to demonstrate the success of a project and may hamper that agency's ability to add new management measures or to further increase the management system's capabilities.

DEVELOP ALTERNATIVES

Once the intentions of the incident management system have been established, an agency may to begin looking at specific incident management alternatives. Section II provides a large number of management techniques to consider. These alternatives cover all of the basic categories of incident management. In addition, the information on each of these techniques includes many options an agency can consider to mold each management technique into it own operational process. Using the techniques described in Section II as a starting point, an agency should begin to develop a variety of alternatives that respond to the problems it has identified. Then it will compare these alternatives' abilities to meet the stated goals and objectives, given their costs.

The types of management techniques selected as alternatives will depend on the incident management needs to be addressed. If refinement to an existing system is being considered, all of the selected alternatives may address one particular need, for example, the need to improve response time to a specific part of a city. In this case, the details of the techniques (e.g., the number of tow trucks employed) may differ rather than the response procedures being significantly different (tow trucks versus incident management teams).



If no formal management process exists, the alternatives an agency considers will be more varied. For new incident management systems, an agency should consider including measures that address all five areas of incident response actions: incident detection, incident response, site management, incident clearance, and motorist information. Explicitly incorporating all of these functions into the incident management system provides a balanced incident management system and helps prevent failures of the system as a result of limitations in any one critical area.

As part of developing the alternatives, the agency should ensure that the costs, benefits, and operational implications of each candidate management technique are well defined. The next chapter describes the many different types of impacts each alternative may generate. This list of impacts is summarized in Table 1.7.

Finally, as part of developing the alternatives, an agency should consider how each alternative will impact motorists, including their costs and benefits. As part of this analysis, an agency should also consider whether

Table 1.7 Information Needed for Each Alternative

Information Needed	Impacted Areas*					
	Jurisdiction	Geographic Constraints	Available Resources	Operational Procedures	Training	Administration
The number of staff needed	○	○	●	○	○	○
Whose staff are needed (which agency, and which sub-group within that agency)	●	◒	◒	○	○	◒
The union rules that pertain to those staff	◒	○	●	●	○	○
The availability of overtime for those staff	○	○	◒	◒	○	●
Their ability to respond on short notice	○	◒	◒	●	○	◒
Who selects the crews to respond to an incident (both internally and externally, i.e., who calls them to the scene and which specific people in the agency are called out that day.)	●	○	◒	◒	◒	◒
The equipment needed	○	○	●	○	◒	○
Which agency (private business) owns/operates the equipment needed	●	◒	○	◒	○	◒
The cost of that alternative	○	○	●	○	○	○
The source of revenue for that alternative	●	○	●	○	○	◒
Whether the source of revenue matches the agency experiencing the costs	●	○	○	○	○	◒
The time frame needed to set-up (i.e., arrange institutionally) and call-out (i.e., on a daily basis) that alternative	◒	◒	◒	●	◒	◒
The potential benefits from the alternative	●	◒	◒	◒	○	◒
The distribution of those benefits between agencies and the general public. (reduced overtime because you are already paying overtime for that function?)	●	○	◒	○	○	◒
Operational difficulties	○	○	○	●	●	◒
Implementation difficulties	◒	◒	◒	●	◒	◒
The need for inter-agency agreements	◒	○	◒	◒		
Who are the lead and any supporting agencies that will participate in that alternative						

* Key to Impact Areas:

○ = No significant impact ◒ = Minor impact ● = Major impact

- the impacts from the system will be visible to the public,
- the system's performance will generate public support simply through its visibility, and
- whether the system will visibly respond to the causes of public frustration with traffic congestion.

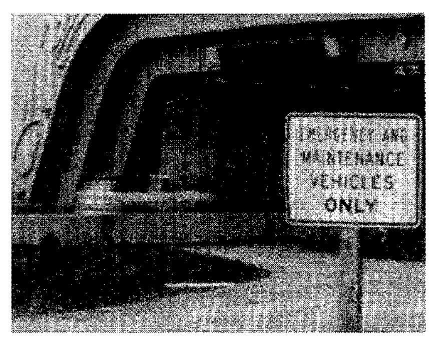
These considerations should be included in the description of the pros and cons of each alternative and in the evaluation and selection phases discussed below.

To help define the impacts of alternative management strategies, and to ease the comparison of alternatives, Table 1.7 documents most of the more important aspects of each alternative.

EVALUATE ALTERNATIVES

Once the list of alternatives for implementation has been developed, each alternative must be evaluated with respect to the other alternatives and with respect to available resources and agency jurisdictional limitations. To make these comparisons, the participating agencies must select evaluation techniques and develop evaluation criteria. It is important that the evaluation criteria have been developed before the evaluation process begins. As a guide to this evaluation process, key elements can be classified as personnel related, equipment related, financial concerns, and other. These are listed in Table 1.8.

The evaluation criteria can be formal or informal. Less formal decision making is often appropriate for selecting among incident management techniques that are reasonably similar (or extremely dissimilar) and where only one agency is impacted by the management action. More formal evaluation techniques are needed when the differences among alternatives are more complex.



This guide can not cover all of the possible evaluation techniques, both formal and informal, that are useful for comparing alternatives. The evaluation and selection process used for incident management should be similar to the procedures the participating agencies normally use. Particularly when the management techniques to be evaluated require the cooperation of multiple agencies, the evaluation technique chosen should also consider the impacts of, and the likelihood of, getting that cooperation and coordination.

Finally, the evaluation process should also account for the benefits and costs to be accrued by the public. Because motorist costs and benefits may be very different than the costs and benefits accrued to the various agencies, the way that the costs and benefits motorists will experience are weighed against the costs and benefits for the implementing agencies will very often drive the the selection of alternatives.

Table 1.8
Guidelines for Alternative Evaluation

EVALUATION CRITERIA	SPECIFIC CONCERNS
Personnel	• the number of staff needed • type of staff needed (job specialties) • training required • agencies providing staff • union rules • availability for overtime • short notice availability • dispatching of personnel to the incident scene
Equipment	• type and quantity of equipment needed • who will operate/own the equipment
Financial	• cost of alternative • revenue sources
Other	• time required to set-up alternative • potential benefits • distribution of benefits among agencies (e.g., overtime reductions, etc.) • operational problems • need for interagency agreements • general implementation difficulties

SELECT ALTERNATIVES

When an agency selects from the alternatives developed above, it should remember that an incident management system is made up of many smaller management capabilities. Therefore, to form a true "system," a variety of alternatives should be selected and implemented. To create a complete incident management system, a number of factors must be considered, including jurisdictional issues, geographical constraints, available resources, operational procedures, training requirements, and administrative coordination.

It is also important that the synergy of projects be considered when alternatives are selected and prioritized as part of the evaluation process. Two small projects may have a large impact if both are implemented but only a small impact if only one of the two is implemented. Also, the incident management system can (will) be constructed in a piecemeal fashion. That is, the design and functioning of the system can be adjusted over time to reflect changing conditions (funding, political, and jurisdictional). Thus, the system design should be flexible and capable of being adjusted to meet changing circumstances.

Finally, a long-term perspective on the incident management process allows the implementing agency to consider both short-term and long-term solutions to problems. A prioritization system can help in selecting and allocating resources among the alternatives so that the alternatives that provide the most "bang for the buck" can be implemented first, while more risky but perhaps more beneficial management techniques can be nurtured slowly to determine their true benefits and then implemented when the conditions are correct.

IMPLEMENT ALTERNATIVES

Actual implementation of the selected incident management techniques is often the most frustrating of all the tasks. Achieving the "critical mass" necessary to secure funding, change existing operational procedures, and develop strong interagency communication and cooperation can often be extremely difficult.

Discussions with many of the agencies currently involved in incident management indicated that development of a true "system" takes <u>at least</u> one knowledgeable, dynamic, motivated individual who is allocated full time to lead the effort. That is, creation of enough impetus to overcome the natural barriers (turf, the need for funds, or reluctance to release resources) that impede the implementation of an incident management system requires an advocate within the lead agency. That advocate must work within his/her agency and with other agencies to build the administrative support and cooperation required for incident management to be successful.

Support from upper management for this individual must be strong. This support includes secure funding for project implementation, the provision of authority to create solutions to problems that occur, the flexibility to adjust management measures as a result of feedback, and political support for creating the system both within the agency and between the agency and other cooperating agencies.

The lead person developing the incident response system should expect to encounter difficulties in all of the areas covered by Table 1.7. More specifically, the topics of concern include the following:

- development of the necessary interagency agreements,
- funding of management measures (both within and among agencies),
- jurisdictional disputes (use of one agency's staff/equipment in some other agency's territory),
- response boundaries (the geographic boundaries within which each agency or dispatch office can respond),
- field crew response guidelines (who will respond, how the field crews are called, and how call-out impacts the crew's regular or other duties),
- field crew training,
- communications among agency personnel both before and after arrival at a site, and
- the command structure at an incident site.

The person in charge of implementing the incident management system must be given the freedom to develop solutions to these problems and receive quick approval or comment from upper management. This person must also be aware of the need to maintain good relations within both his/her own agency and any cooperating agency. It is also useful if at least one person helping with the implementation process is intimately familiar with the field procedures of the lead agency and can handle the interagency relations at the field personnel level, where much of the resistance to interagency cooperation may become apparent.

Once the appropriate lead personnel have been designated, the agency should concentrate on obtaining secure funding for the desired system. Secure funding is important, not only from the managerial perspective ("I don't want to bring in and train staff if they are going to disappear next year."), but also from the interagency perspective. (When agency "A" allocates a specific size incident response budget, it helps define how committed it is to the incident management effort, which will partly drive other agencies' willingness to support the system.)

The availability of secure funding also increases the number of management actions that can be considered for implementation. It allows an agency to consider the funding of another agency's incident management actions (if those actions can be shown to be more cost effective than other alternatives for performing that same task) and raises the level of confidence of agency staff working in incident management by showing their agency's commitment to the management task.

The next step in incident management system implementation is to develop any necessary interagency agreements. These agreements can be both formal and informal and can cover any or all of the following items, depending on the specific needs/operating environment of the local area:

- fund disbursement,
- jurisdictional disputes (use of available staff/equipment in someone else's territory) and setting of response boundaries (where each agency responds),
- different "goals" or perspectives of response agencies,
- training,
- review of agency perspectives at the field level, and
- communications.

These agreements are designed to reduce the problems associated with turf fights, personnel problems, budget problems, communications among agency personnel both before and after arrival at a site, and command structure at an incident.

Finally, the implementing agency needs to determine the operational procedures for each selected management technique. These are listed in Table 1.9.

Table 1.9
Necessary Operational Procedures

- Identify who will respond to the incident.
- Provide operation guidelines for field crews (usually in manual form).
- Provide adequate field crew training.
- Ensure adequate communication among crews.

RE-EVALUATE ALTERNATIVES

As noted earlier in this guide, it is important to re-evaluate the system being implemented (the initial evaluation having been undertaken before implementation). This review allows the value of the incident management system to be proved or disproved. For example, it is valuable to measure the number of assists a new service patrol has made to indicate how many motorists have benefitted from the system. It is even more useful to be able to determine how many times the service patrol has identified and cleared an incident that had yet to be reported through some other source, saving both detection and response time, as well as providing a valuable service to individual motorists and the general driving public. Furthermore, demonstrating the benefits a new system has achieved provides feedback to the people who supported the implementation of the program and aids in both retaining the system that has been installed and expanding it if such expansion is warranted.

To accurately evaluate an incident management system, some data must usually have been collected before the implementation of the test system. The collection of these data is necessary to demonstrate changes in the traffic flow that have resulted from the implementation of the new system. After the management measures have been implemented, additional data collection and analysis must be funded to calculate those changes.

It is important that the desired data collection and analysis are carefully planned because of the expense involved in collecting, storing, and manipulating sufficient traffic data to perform an adequate system evaluation. Data that can be used in these analyses include the following:

- the time required to detect incidents,
- the time required to reach the incident site,
- the time required to clear the incident,
- the delay caused by the incident (vehicle volumes, traffic performance, and reduction in system capacity during the incident), and
- the cost of response system operation.

Because of the complexity of collecting this these types of data, it is often better to develop and fund an ongoing monitoring system rather than to perform a "one-time" evaluation. Ongoing monitoring means that the response agency sets up a routine incident tracking database that can be used to provide continued evaluation of the incident response process. Such a system provides the data needed to make decisions about expanding, reducing or otherwise changing the management system. It also provides answers to questions about system performance that will be asked by upper level administrators and elected officials.

While such a system provides important benefits, the system requires careful planning and design. The collection, storage, and manipulation of these data require trade-offs among resource availability, resource needs, personnel time commitments, the realities of field operations, limitations in automated traffic monitoring devices, and the need for computer systems and software for maintaining and using the collected data.

REFINE THE SYSTEM

Because traffic conditions and political impressions change, every incident management system will need to be refined over time. New incident response measures will have to be undertaken. Arrangements between agencies and/or contractors will have to be modified. Special needs will develop because of new technologies, evolving land use patterns, and growing congestion problems. The need for new or additional incident management techniques can often be determined from an ongoing evaluation process, as mentioned in the preceding section.

As a result of the great potential for change in traffic conditions, an effective incident management system must maintain an effective feedback system that informs managers when changes are required. These changes can be signaled by analyses that are part of an ongoing monitoring effort, as described above. The need for change or system refinement is even more likely to be noticed by members of the response teams who are in the field or are working with incident management daily.

To accommodate the valuable information that can be provided by these personnel, a feedback mechanism should exist for both the upper management/political levels of participating agencies and for the field crews who apply the incident techniques. The feedback provided through upper management and political channels will ensure that the incident management process continues to address the issues that are important to the political decision makers both inside each agency and within the larger political system. These personnel are also most likely to understand the interaction of resource availability, public perception, and interagency relations.

Feedback from the field personnel should help identify specific operating problems or opportunities. This part of the feedback loop allows continued improvement in the operation of the system on a day-to-day basis. These improvements may include discarding the systems and procedures that do not work or are unsafe, or facilitating the development and implementation of new ideas that may work better.

Systems Approach to Problem Solving

The end result should be a constantly evolving management system that continues to improve the incident management process; continues to adapt to the changing needs of the local area; and continues to meet the needs of the participating agencies, the affected jurisdictions, and the motoring public.

Major Issues in Selecting Incident Management Alternatives

This chapter's intent is to describe differences in agency attitudes towards incidents and how those attitudes are reflected in the actions of personnel responding to incidents. The chapter discusses the various issues and problems that engineers may encounter when designing and operating an incident management system within an urban area. Because the responsibilities of operating, political, and law enforcement agencies change from state to state, this chapter describes the more common practices and problems the project team found in its review of the state-of-the-art. Of course, the specific problems and issues related to setting up and operating a specific incident management system will be highly dependent on local conditions.

An important consideration is how each of the factors discussed in this chapter will be applied in the system being developed. Furthermore, the key to successful operation of an incident management system is the cooperation among and understanding of personnel within all levels of the involved agencies. This cooperation requires constant communication among the various agencies and training of all of the personnel involved, both at the administrative and field levels. It is also important for all personnel involved in incident management to understand the goals that other agencies are trying to accomplish so that conflicts are minimized and results for everyone are maximized.

To cover all of the major issues in developing an incident management system, this chapter is divided into six parts (see Figure 1.1):

- jurisdiction,
- geographical constraints,
- operational procedures,
- available resources,
- training, and
- administration.

These categories are somewhat arbitrary, and many specific problems and issues can be placed under several categories. To ease the task of locating subjects, sub-headings are used liberally within this chapter to segregate topics.

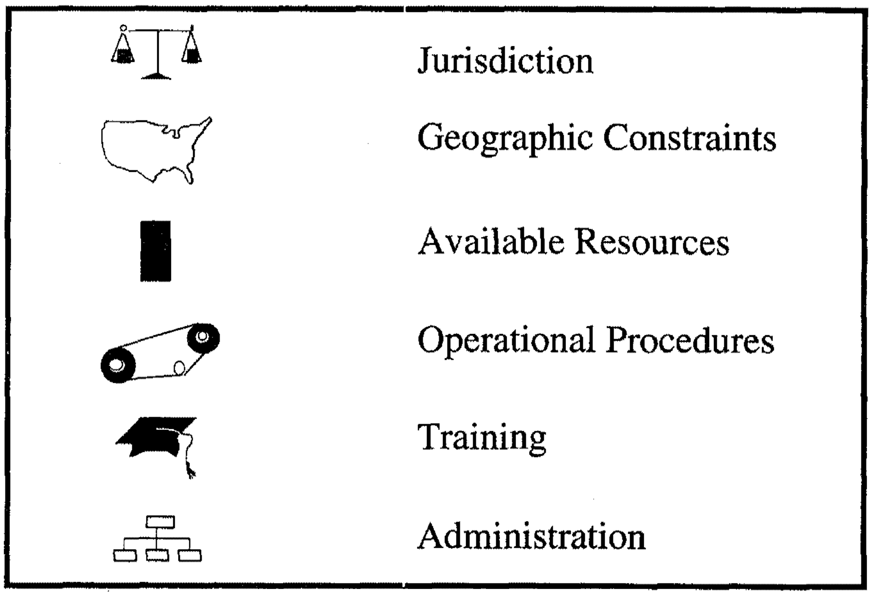


Figure 1.1 Six Basic Concerns

JURISDICTON

Good incident management usually requires the cooperation of several agencies and operating authorities. Even for simple incidents, two agencies, a police authority and the highway agency (city, county or state), are often involved in the management process. Jurisdictional issues occur when two or more agencies must respond to an incident and the responsibilities of those agencies are unclear, or the immediate objectives of the field personnel from those agencies conflict. Figure 1.2 lists the seven key areas from which jurisdictional problems can arise. The following subsections describe these problem areas and show where the need for cooperation and coordination among agencies is most important and apparent.

Site Management

A major part of setting up the incident management process is included in the designation of each agency's responsibilities. Often the most difficult decision in this area is which agency has the overall responsibility for directing and controlling the management of any given incident. For incidents that involve multiple agencies, one agency should have overall control of the incident scene to provide consistent, planned, management actions. In other words, when more than one agency responds to an incident site, the following questions must be addressed:

1.	Defining Site Management Responsibilities
2.	Understanding Agency Perspectives and Responsibilities
3.	Establishing Interagency Field Communications
4.	Developing Administrative Coordination Among Agencies
5.	Considering Legal Ramifications
6.	Forming Consensus Among Agencies
7.	Accounting for Political Sensitivity

Figure 1.2 Key Jurisdictional Problem Areas

Major Issues in Selecting Incident Management Alternatives

- Which agency has responsibility for the actions performed at the site?
- What control over personnel from other agencies does that lead agency maintain?
- Does the lead person change with the scope of the incident? (For example, at a simple traffic accident, the police officer first responding to the incident may have the responsibility for the site, while at a hazardous material spill, overall control of the site may be in the hands of the fire department or other agency responsible for material clean-up.)

By meeting with each other, the agencies can identify beforehand the responsibilities of each agency under specific conditions (e.g., presence of hazardous materials, fatalities, etc.). These conditions must be clearly defined to the field personnel who respond to the incidents. It is also important to examine the legal responsibilities of the various agencies, their political pressures, and the perceptions of the other participating agencies towards vesting control in other agencies.

Another important task is to define the decision making process so that personnel in the field can quickly identify the field leaders and determine their own duties under all circumstances. This definition includes situations that are not directly covered by existing plans. The incident management guidelines should be sufficiently clear and flexible so that operations in the field run smoothly and successfully even during unexpected situations. To achieve this smooth operation, field personnel should be trained both in the developed procedures and the rationale behind those procedures so that persons responding to an incident understand who is in charge, what everyone's roles are, and which decisions are their's to make.

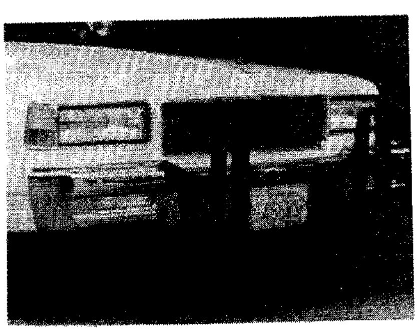
The process of designating agencies to perform specific tasks should reflect the charges and capabilities of the agencies cooperating in the incident management process. Developing the necessary consensus on these issues may take large amounts of effort, political savvy, and tact on the part of the agency organizing the incident management process. It may also require political incentives to convince some agencies to improve their participation in the incident management effort. It is helpful if each participating agency understands that it will benefit politically from participating in the management effort.

Agency Perspectives and Responsibilities

Jurisdictional disputes also occur when two responding agencies have different priorities. Police, highway, and fire agencies usually have fundamentally different perspectives on the intent of incident management. The highway agency's function is to operate the highway, maintain capacity, and ensure a safe operating environment. Under pressure from the public and political organizations to reduce congestion and motorist delay, the highway agency tends to stress restoring the facility to maximum capacity as quickly as possible while ensuring the safety of personnel.

Police agencies are likely to have the same basic intentions as the highway agency (plus law enforcement duties), but their emphasis tends to be different from the highway agency. For example, the primary concern of many highway patrol officers is securing the incident site, collecting any necessary evidence, and reducing the chances of secondary accidents at a site. While restoring the facility to normal operating conditions is a consideration for them, it is often not a priority and thus may not be performed as quickly as the highway agency would like.

Fire crews (and emergency medical crews) have another set of priorities. These priorities tend to center on the safety of fire crews; the application of medical treatment to any injured persons at the scene; and the general ease, speed, and completeness with which they can perform their duties, often to the detriment of traffic flow on that facility.



All these sets of priorities simultaneously present at one incident location may lead to tension and conflict among the agencies and personnel unless all participating groups understand the needs of and political pressures on the other groups. It is important that the people responding to an incident understand the needs of each of these groups and that the response teams plan the actions that will take place given different incident situations to achieve as many of the conflicting goals as possible.

Safety of personnel at the incident site is probably the foremost thought of each of these agencies. However, the agencies may differ on the steps required to achieve that safety. For example, highway agency personnel are often aware that opening the facility to traffic as quickly as possible to reduce queues and eliminate the potential for secondary incidents may often result in a safer environment for both motorists and response crews than closing the facility. On the other hand, fire crews are often trained to close the facility to ensure the maximum safety to the people directly involved with fighting a fire or otherwise responding to that incident. While this approach usually makes the immediate incident site more safe, it often increases the risk of serious secondary accidents at the back of traffic queues created by the reduced capacity at the incident site.

Often a compromise is the best solution to traffic control at a site, but to achieve such a compromise, the crews (highway, police and fire) must understand when, where, and how traffic control actions should be undertaken. For example, at a car fire, the agencies must clarify who is in charge of traffic control at the site, the fire department, the police, or the highway agency. Personnel at the scene need to know when the fire department should be allowed to close the road entirely and when the highway agency should be allowed to keep one or more lanes open. The crews should also know how to use the appropriate traffic control devices to close lanes, provide tapers, and warn motorists of the traffic revisions in place.

Furthermore, all levels of the responding organizations should participate in the consensus for incident site management. Little good is achieved through an agreement with the Chief of Police unless the officers in the field are convinced that the application of that agreement is to their benefit and they are adequately trained in the appropriate procedures.

Interagency Field Communications

In addition to coordinating site management and personnel responsibilities, coordination among agencies must establish both how the agencies' personnel will communicate with each other (first to request assistance and later after personnel have arrived at the scene) and which agencies are responsible for specific tasks at the incident site. Equipment and procedures must be developed to ensure that <u>all</u> incident management personnel remain in close contact with each other and that information available to one agency's personnel is shared with other agencies at the site. More about this subject is discussed under the Operational section of this chapter.

Administrative Coordination Among Agencies

Administrative coordination must occur both among agencies and within each agency. Administrative coordination among agencies is necessary to eliminate jurisdictional issues, determine who should control the management of the response to an incident, and provide for the shared use of equipment and staff whenever possible.

All agencies involved in incident management must dedicate time and resources to maintaining good relations, both among upper management and among field personnel, because it is very easy to fall into an "us and them" atmosphere. An adversarial relationship can hinder the management process and lead to further degradation of jurisdictional relations.

It is important for the participating agencies to meet regularly to discuss the functioning of the incident management system. These meetings should be used to review the operation of the incident management system, resolve problems occurring in the incident management process, and identify areas in which the system can be improved or expanded.

Meetings at the managerial level are necessary to create an understanding of the needs for, and benefits from, an incident management system. Upper management can then identify the needs for and design of the necessary agreements for equipment sharing, fund allocation and distribution, and personnel allocation to make the system work properly.

Upper level managers are also the people most likely be aware of the political support for the incident management. Knowing the public's opinion of the need for incident management, administrative personnel can design the incident management process to address the most visible needs of the public early in the process. This will help ensure the continued public support of the funds necessary to maintain the system.

Formal and informal communication is also necessary among field personnel, both within an agency and among agencies. Open communication among field personnel is the best way to

- identify operational problems that need to be addressed,
- foster cooperation among personnel of different agencies, and
- provide ideas on improving the management process from the people most likely to be able to identify such improvements.

While management personnel can serve as a conduit for ideas and feelings among field personnel of different agencies, it is often advantageous if a senior field supervisor from one agency meets with incident management field personnel from another agency in an informal setting. These meetings allow the field personnel to ask questions of the "visiting" field supervisor, or to make suggestions about particular functions directly to that person. The "visiting" field supervisor can then describe why his/her agency follows procedures the way it does, or ask the necessary questions to clarify a particular point or suggestion. This process provides instantaneous feedback on ideas and helps dispel myths and misconceptions about other agencies' operating procedures.

In the end, providing direct communication among the field personnel of cooperating agencies can help foster a better attitude of cooperation between field staff. As field personnel become more familiar with each other and each other's agencies, the personnel involved with incident management come to view other incident management personnel as more "us" and less "them." These types of relationships smooth the management process and create a better system.

Legal Ramifications

Many laws may direct how portions of an incident management system can function. These laws may

- identify the responsibilities of each agency participating in the management process,
- limit the incident management roles an agency's personnel can perform,
- restrict the methods that can be used to clear an accident, or
- determine the financial liability of agencies, agency personnel, and the public with respect to incidents and incident management.

As a result, it is important to explore the legal ramifications of working with (or not working with) specific jurisdictions and agencies and the consequences of using specific management techniques.

This subsection discusses the legal issues arising from working with other jurisdictions. The Operational Issues section of this chapter discusses the legal issues that impact the day to day operations and procedures of the management system. Important legal jurisdictional issues that need to be resolved include the following:

- Which agency's personnel are allowed to handle hazardous material?
- Do regulations exist for governing who may close a road and for how long that road may remain closed?
- What are the laws governing the financial responsibility of persons involved in accidents? (Does a state have the right to charge a motorist for the time and equipment required to respond to an incident?)

- What are the laws governing the actions public agencies may take as part of their incident management actions? Do these laws change the financial responsibility of persons involved in the incident?

The consequences of the actions the agency intends to implement as part of the incident management process are important. Forming an understanding of these consequences early in the process of designing the management measures leads to a more effective, more efficient and less costly response system.

Forming Consensus

The conflicts inherent in a multi-jurisdictional process such as incident management underscore the need for cooperation and consensus building among participating agencies and jurisdictions. Reaching a consensus about the actions to take, the agencies responsible for taking those actions, and the manner in which each agency's personnel will act helps create a smoothly functioning incident management system.

In addition to a consensus about how to perform incident management, a successful incident management system must be supported by a consensus on the goals the incident management system is supposed to achieve. (Remember that agencies define success within their own context.) When these agencies work together and are able to contribute their ideas about the objectives that are important, as well as how to accomplish them, a consensus on an entire management process is more easily developed. Individual jurisdictions may not like specific aspects of the management system (or would prefer other alternatives to the selected options), but they may willingly accept those aspects when given a complete understanding of the context of the procedures within the scope of the entire incident management process and the benefits that will accrue from that system.

Consensus takes many forms, and formal and informal agreements can be helpful for almost every part of incident management. Provided below are some of the more important areas that require consensus building and interagency cooperation to make the incident management process work smoothly. As part of designing an incident management process, the following issues should be agreed upon or at least investigated:

- Who is responsible for directing the response to an incident, and under what conditions does that authority change (e.g., does the responsibility change if hazardous materials are present)?
- Who is responsible for which actions at a site?

- What actions can/should the respective agencies take independently and under what conditions should they take them? (For example, under what conditions must a facility be closed, and under what conditions may a facility be kept open or partially open?)
- Is it possible to develop some type of inter-jurisdictional agreement, training or new legislation to eliminate legal or other restrictions to desirable incident management actions? (For example, can highway personnel be trained to handle hazardous waste or assist emergency crews?)
- Which agency pays for specific incident management actions and/or equipment?
- Can "deals" between agencies to promote the incident management process be created? (For example, "We'll buy you an extra 10 radio sets for incident management communications, if you will let the interagency incident response teams use your on-site communications radio frequency when responding to incidents.")
- What are the geographic areas of operation and in what manner is management handled within those boundaries during specific times of day or at specific types of incidents?
- What political stimuli does the incident management process need to address?

Political Sensitivity

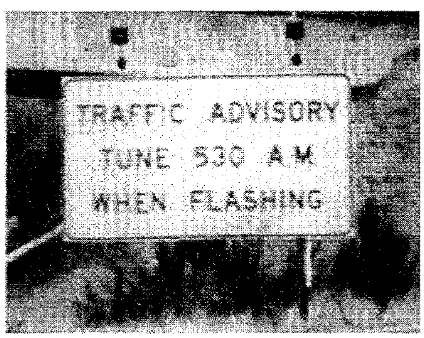
When administrators create an incident management system, they must keep in mind the political context of the system and the agencies that will be working within that system. For example, an effective management system (i.e., one that reduces the delay associated with incidents while maintaining or improving the safety of response crews and the public) that is politically viewed as being too expensive or not responsive to the needs of local areas may be shut down, despite its "success." A continuing part of the incident management process should be the reevaluation of the political realities facing the jurisdictions impacted by the incident management process.

Political influences may also cause an incident management system to be evaluated with different criteria than were used to design the system. For example, the management process may be designed to maximize traffic flow. To achieve this objective, traffic rerouting around incidents may be instituted. If the total traffic flow around incident sites increases as a result of the system, the incident management measures should be considered successful. However, the jurisdiction whose streets absorb this rerouted traffic may view the management system negatively (i.e., "They are causing more congestion on our streets!") and may apply pressure to stop or change the incident management process.

Again, the point of this section is that the creation of an incident management process, and the selection of specific incident management procedures for implementation, must include consideration of the politics of the urban area. Specifically, persons designing the management system should be aware of who will be impacted by the management techniques selected and how those techniques may manifest themselves politically.

GEOGRAPHIC CONSTRAINTS

Another factor that impacts the functioning of the incident management process is the territorial nature of jurisdictional responsibility. That is, each jurisdiction's geographic boundaries of responsibility are usually clear (Agency A operates and controls this set of arterials; Agency B operates and controls the freeways; Agency C responds to fires within these boundaries), but the impacts of incidents are usually oblivious to those political boundaries. Thus, all jurisdictions benefit if the incident management process allows freedom to respond (within limits) across geographic boundaries, even though this response crosses traditional political boundaries.



An important part of the design of an incident management system is the definition of the rules for working in and around these geographic boundaries and the rules for requesting staff and equipment from different agencies. Important to establish are rules concerning the following issues:

- Who can respond in a given geographic area?
- Which police agency has authority for that area?
- When should the police authority in the neighboring geographic area be notified of an incident, and who should make that notification?
- Can personnel cross these boundaries to assist in incident management to prevent congestion from crossing those boundaries?
- Under what conditions can the personnel or equipment from one jurisdiction be used in another jurisdiction (both on an emergency basis and on a regular basis)?
- What additional actions can be taken if the congestion caused by an accident crosses a political boundary?
- Do jurisdictional disputes exist among agencies in the response areas that might restrict potential management measures? (e.g., "We won't respond to incidents over that border, because they won't contribute to our costs.")

The geographic constraints of crews and equipment can cause management systems to develop intricate guidelines on when and where specific agencies and equipment can be requested. These restrictions may lead to additional training requirements, additional jurisdictional conflicts, and larger administrative workloads. However, they are a necessity in incident management and must therefore be considered carefully.

An important consideration of including geographic reality in the incident management design process is that geographic limits must be set to the incident management system. That is, agencies must determine how large of an area the system should cover and whether the area that is covered must be subdivided for administrative purposes.

The scope of the geographic area covered by the management system has several implications. Usually, the larger the area is that needs coverage with incident management, the more complex are the administrative and operating structures needed to adequately perform that management process. Questions that should be answered during an examination of the geographic scope of the management system include the following:

- Are different sets of guidelines needed for urban and rural areas?
- Are different sets of administrative oversight committees needed for different geographic stratifications of the incident management area?
- Which jurisdictions should be included in the administrative information and training aspects of the incident management system?
- What resources exist within the geographic areas that can be used as part of the incident management system?
- Do finances limit the size of the area the incident management system can cover?
- What will the incident management process be outside of the "covered" incident management system?

The answers to these basic questions will help define logical boundaries for the management process. For example, if the geographic area that must be covered is large, several incident response teams or coverage areas may be necessary so that the resources required for incident management are available within a reasonably short distance from anywhere within the covered area.

Similarly, in large areas, regular meetings of smaller groups of geographically related agencies ensures both the necessary lines of communication and the continued support and participation of the agencies in the management system.

$ AVAILABLE RESOURCES

This section describes many of the issues surrounding methods for obtaining equipment, staff, and funding for incident management. The availability of resources, and the allocation of those resources both within and among agencies, play a significant role in the selection and implementation of incident management strategies. While some agencies are able to allocate sufficient resources to create a strong incident management process, other agencies have limits in staff or equipment that hinder the application of the selected management actions.

This section describes some of the ways that resources can be used or shared to alleviate these limitations. In addition, this section describes the pitfalls agencies must avoid if these techniques are to be used.

Equipment, Staffing and Funding

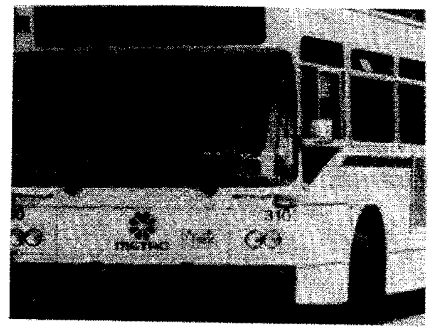
Often the creation, operation, and staffing of an incident management system causes difficulties in the areas of equipment utilization, staff availability, and funding. Similarly, known limitations in these areas can forestall the implementation of desired incident management techniques. For example, an agency with available funding but a lack of staff will be more inclined to select incident detection strategies that rely on capital investment and minimize the need for staff. Agencies with available staff but little available funding to purchase equipment are more likely to select detection procedures that utilize staffing and existing equipment and limit the need for additional capital acquisition.

The other option for providing additional incident management services is to create new funding sources. Traditionally, new funding has come from increased authorizations from the major funding agencies. For example, the state highway agency may provide additional funds for incident response. However, an increasingly popular technique is to charge the motorists being assisted for the services provided. These funds are then used to offset the cost of additional incident response services. Urban areas have charged for providing gasoline, towing services, and other minor response assistance. Other agencies have encouraged private companies to provide incident clean-up services to trucking firms involved in accidents, thus making private what has normally been a public effort.

Any number of similar mechanisms exist for providing at least some form of revenue towards the cost of incident management. Those selected for implementation should be the ones that provide the most revenue while being the most politically palatable.

Resource Sharing Agreements

Timely incident management requires the availability of equipment, staff, and funds, and they are often not available within the "correct" organizations. In most large U.S. cities the equipment is available to handle almost all types of incidents. However, that equipment may not be in the hands of (or readily available to) the agencies responsible for responding to incidents. Some of the equipment may be owned by private companies. Some may be owned by cities or counties outside of the immediate location of the incident. These resources need to be identified, and the rules for their use and the procedures for accessing them must be documented.



Through the use of interagency working agreements, limitations in some of these areas can sometimes be alleviated. For example, a local city may own a crane that is occasionally needed for incident response, while the state highway agency has the necessary staff and funding but no access to a similar crane. The ideal situation would be to allow the highway agency crews to use the city crane on short notice. While sensible, such a plan could easily create liability problems, not to mention turf issues ("It's our crane, they don't know how to operate it.") and boundary problems ("Why should we contribute a crane to clean up an accident on someone else's highway?"). The difficulty in setting up a good incident management system is in reaching consensus on when and where such resources can be shared and the benefits each of the participating agencies may gain from that sharing. (For example, the highway agency may pay a fee for use of the crane, thus sharing the city's annual maintenance cost for that piece of equipment. This reduces the cost of that equipment to other users within the city.)

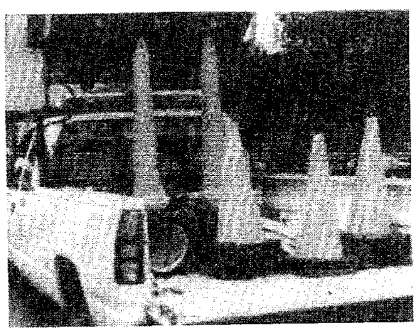
In some instances one agency may be able to help fund another agency's incident management system. This is a scenario in which both agencies often benefit. For example, the highway agency may pay for the addition of push bumpers to police cars when the highway agency has available funds and the police agency doesn't. Such an expenditure provides the police with an incident management capability they might not otherwise have, while also providing the highway agency with a better, faster method for clearing minor accidents and stalled vehicles. Both agencies then win through the sharing of available resources.

Because resource sharing is the most cost-effective way to provide incident management, cooperation among agencies and the development of mutual assistance agreements take on added importance. When these agreements are designed, the following should be determined:

- the resources required by the desired incident management technique(s),

- whether sufficient resources are readily available to the participating agencies to perform this technique,
- how those resources should be allocated among agencies,
- whether those resources can be used on short notice to manage incidents,
- whether sufficient (cash) funds exist to make use of those resources,
- whether a mechanism exists to provide access to those resources (i.e., whether the incident response team from the highway agency can call the city and borrow its crane), and
- whether procedures can be developed or identified to bring the appropriate resources to bear on incidents within the desired response period (i.e., if the highway agency has money for incident response, whether there is a mechanism it can use to reimburse the city for the use of that crane).

When resource sharing makes sense, agreements should be drawn up among agencies to clarify the resources to be shared. These agreements should spell out the following:



- the conditions under which specific equipment should be called to an incident site,
- how that equipment should be requested,
- who should operate the equipment,
- who should pay for the use of that equipment,
- special procedures for making those payments, and
- the legal ramifications of using that equipment.

Successfully arranging to share specialized equipment can result in substantial cost savings for both the incident management system and the owner of the equipment. These financial benefits also allow most areas to provide better incident management than they would be able to do without resource sharing.

OPERATIONAL PROCEDURES

A major part of developing an incident management system involves creating the day-to-day procedures the field crews will follow as they respond to incidents. Many of the incident management measures listed in this guide are based on the simple redeployment of existing resources in a more effective manner. In other words, the operating procedures an agency uses <u>are</u> the incident management measures.

Operating procedures deal with the functioning of the system after administrative, jurisdictional, geographic, and resource availability questions have been answered. Two agencies may agree to allow one agency to request another's personnel support in responding to an incident. However, this support will not be possible unless a specific procedure has been developed to facilitate that action (i.e., a supervisor with agency A should call a designated number at agency B and give the agreed upon information).

Operational procedures must account for the nature of the incident, the training available to (or required of) crews, the types of equipment the crews have available, the work rules that apply to those personnel, the interagency agreements developed for incident management, and the geographic boundaries of the system. Table 1.10 lists the primary operational issues that must be resolved to optimize the functioning of the incident management system.

Communications Among Agencies (Operations)

Communication among cooperating incident management agencies takes two basic forms: (1) higher level communication among the managerial levels of the agencies, and (2) field communications among the personnel responding to incidents. The first of these was discussed under jurisdictional issues. Field communications are discussed below.

Communications in the Field

The need for communication in the field at incident sites is tremendous. Communications are particularly important for the person directing the management action, who must understand the actions being taken (regardless of whose personnel are taking them), how those actions are progressing, and the opinions the participating field personnel have of the situation. In addition, when the person in charge has made a decision, it is important for him/her to be able to communicate quickly and effectively with the people who can implement that decision.

Table 1.10 Primary Operational Issues

- Communications Among Agencies (Operations)
- Communications in the Field
- Legal Ramifications to Operational Decisions

Unfortunately, field communications among agencies are often complex and difficult, despite what appears to be the obvious ease of radio communications. In many cities, police, fire, and highway personnel are equipped with radio equipment that can not communicate with the other agencies' radios (i.e., police radios can not communicate with highway agency radios and vice versa). Purchase of radios that can communicate on all of the necessary bands is often expensive and/or not physically possible, although it appears to be the best solution to this problem if the funds exist for such a purchase.

Where additional radios can not be purchased, a variety of alternatives have been developed. In one instance, simple scanners were provided to the field personnel so that each agency "talked" on its own radio frequency while the other agencies used the scanners to listen in on those other frequencies. While convoluted, this arrangement does allow direct communication among field personnel and, thus, a higher level of interaction among the people responding to an incident.

Other solutions to the field communications problems include the following:

- providing one or more agencies with radios capable of using all necessary broadcast frequencies,
- providing CB radios to all agencies and designating specific channels for interagency communication,
- providing special short range, on-site field radios (OSCAR),
- providing cellular telephone or other cellular technology communications to field personnel, and
- providing some kind of "radio room" protocol, in which each field person uses his/her own radio frequencies, and the central radio facility for each agency rebroadcasts that message on the appropriate cooperating agency's radio system.

Selection among these (or other) techniques for field communications depends on the funding available, the number of agencies involved in the incident management process, and the number and variety of radio frequencies used by those agencies.

Legal Ramifications To Operational Decisions

Many laws may restrict the selection of particular incident techniques, or at least limit the extent to which specific techniques can be implemented. From an operational standpoint, these restrictions may take the form of limitations on the use of personnel (both through union rules and through federal or state safety restrictions), the methods that can be used to clear an accident or other incident, the types of equipment that must be used to handle incidents, and the persons or agencies charged with responding to and clearing specific types of incidents. Some legislative statistics may prevent use of specific response options. These "fatal flaws" can eliminate otherwise promising response strategies.

Consequently, it is important to explore the ramifications of working within the legal framework of a specified geographic area. Some questions that must be answered to avoid legal problems include the following:

- Who is allowed to handle hazardous material?
- What constitutes hazardous material?
- How is hazardous material disposed of after it has been collected at an incident site?
- Are particular steps required when someone first reaches an incident that contains (or might contain) hazardous material?
- What legal requirements must be met in the response to specific types of incidents, and do those required legal steps change how the management process should take place? (For example, most states have different procedural requirements for fatal accidents than for non-fatal accidents, but many also have different requirements for serious injury accidents versus "non-serious injury" accidents.)
- Do regulations exist for governing who may close a road and for how long that road may remain closed?
- What are the laws governing the financial responsibility of persons involved in accidents?
- What are the laws governing the actions public agencies may take as part of their incident management systems? Do these laws change the financial responsibility of persons involved in the incident?
- When should the scene and/or approach to the scene be photographed?
- When should special attention be paid to road surface conditions?

Sometimes specific management measures contain actions that raise legal questions. For example, a truck overturns on a freeway and blocks traffic. Can the incident response team be held responsible for additional damage caused to that truck if it is damaged further as the team moves it to clear the lane? Is an agency more likely to be financially responsible for damage to a vehicle involved in an incident if it takes an aggressive approach to opening the lane (e.g., using another large truck to quickly shove the damaged truck off to the side, causing considerably more damage to the vehicle) than if the agency's crews take a slower, but more gentle approach to moving the truck (e.g., calling several cranes and/or tow trucks to right the vehicle before removing it from the lane)?

Because of questions like these understanding the consequences of the operational procedures an agency intends to implement as part of the incident management process is important. Forming this understanding early in the process of designing the management measures leads to a more effective, better managed, and less costly response system.

TRAINING

Training of field personnel is obviously important in incident management. Training personnel in their own management tasks should include not only how to perform their jobs safely and quickly, but their options when responding to an incident situation and how to select among those options. In addition, they should have at least an introduction to the incident management duties of cooperating agency's personnel and be made aware of the need to be cooperative with other agencies and to be sensitive to the requirements of those agencies. Training should take place not only for the tasks that those personnel are supposed to perform but should also include instruction on the following subjects:

- tasks other agencies should perform,
- the incident management perspectives of other agencies,
- the availability of additional assistance when responding to an incident (for example, additional equipment, additional traffic control, and hazardous waste crews),
- communications procedures, and
- decisions: who should make them and when?

Given the dangers inherent in incident management, training in such items as traffic control, hazardous material handling, and on-site safety are vital to the safety of incident response crews. Training in other areas such as on-site communications, methods for calling in additional resources, and the appropriate times to call in other agencies provides each staff member with a better understanding of the management system as a whole. This understanding should translate into better job performance.

Training is especially important for people who must assess the incident site and select the appropriate response techniques to be applied. Training of field supervisors needs to be an on-going process in which the various supervisors meet periodically to determine which management measures work well, which ones need to be revised, and how the training for supervisors and crews needs to be changed and updated.

To assist in this training process and to assist in the actual incident management process, some type of training/resource guide for incident management personnel is usually a good idea. Such a guide may have dual purposes, such as training and on-site information. Background information and complete documentation of each agency's responsibilities provide an excellent resource for quickly orienting new personnel. Concise resource availability information in the document serves not only to instruct personnel in where and how they can request additional resources for an incident, but that same resource can be used at the site of an incident to provide those personnel with the necessary information (phone numbers and radio calls) to identify and physically request necessary equipment and personnel.

ADMINISTRATION

This section of this chapter discusses the issues and problems that occur within an agency performing incident management. It deals primarily with issues relating to administrative cooperation and coordination among divisions within an agency. Issues relating to specific use of staff and equipment are dealt with under Operational Issues earlier in this chapter.

Administrative Coordination

Coordination within an agency is necessary because the needs of incident response crews often cross internal administrative boundaries. For example, highway maintenance crews and equipment are often required to help restore an incident site to normal operating conditions, although these tasks are somewhat incidental to their "normal" duties. The jobs of highway operations staff are most impacted by the loss of highway capacity that occurs during an incident, but these staff often lack the equipment necessary to respond to incidents. Thus, the maintenance function often sees itself as subsidizing the operations function. Therefore, these perceptions at the administrative level must be handled within each agency to ensure that credit and resources are given to all those who participate appropriately in the process.

Internal Agency Perspectives

Different perspectives may exist within an agency, as well as between agencies. These differences often result from disagreement over the funding and control of the incident management system. The creation of an incident management system may create internal "turf" battles over the funding, staffing, equipment, and operational requirements of the system.

Major Issues in Selecting Incident Management Alternatives

No simple universal solution exists for dealing with these potential arguments over responsibility. They must be resolved through normal agency channels. However, it is important to be aware that the results of these decisions will impact the availability of staff and equipment, which in turn will impact the possible incident management measures that can be selected.

Section

2

Incident

Management

Options

Incident Management Options to Consider for Implementation

This section presents summaries of eacn of the incident prevention and management options identified by the project team during the state-of-the-art review. The incident management measures are divided into sixchapters, each of which corresponds to one of the basic categories of incident prevention and incident management: incident detection and verification, incident response, incident clearance, site management, and motorist information (see Table 2.1).

At the beginning of each of these six chapters, two tables summarize the following information:

- the benefit and cost potential for each of the incident management options described in that chapter, and
- the approximate level of involvement of participating agencies (i.e., transportation, police, and fire) in the majority of current applications of each management technique.

Following these two tables are brief descriptions of each measure that the literature indicated might provide improvements to that aspect of incident prevention or management. The following information is summarized for each technique:

- the proposed actions,
- cities in the U.S. where the action has been used,
- the incident conditions under which the action is most likely to work favorably,
- the primary advantages and disadvantages of the management measure,
- the probable costs of the management measure, separated into capital costs, operating costs, and maintenance costs,
- other "costs" or the potential for "costs" that may be accrued by the implementing agency, including the need for specialized staff training, the potential for increased legal liability, and the need for special legislative approvals,
- the type of agency or agencies (police, fire, transportation, or private firm) that perform that management measure, and
- how that incident management measure is funded.

Incident Management Options to Consider for Implementation

This summary information is designed to provide readers with a brief overview of each incident management technique. Such an overview should allow readers to separate the techniques that are appropriate for their incident situation from those less likely to be useful.

Where variability exists in associated costs, operation, or funding, more complete descriptions about the different management techniques follow the summaries. Unfortunately, in most cases, accurate, detailed cost estimates could not be developed and included in this section. Often, complex procedures are used to fund and/or operate incident management techniques, e.g., the sharing of resources from several agencies or the use of personnel who are also assigned to other duties. The cost of these shared resources are often not well differentiated by operating agencies, and thus comparable costs were not readily available to the research team. Consequently, the costs and benefits (in dollar amounts) for specific management techniques were impossible to determine for a general implementation, and the cost estimates included in this report are only descriptive values.

For more information concerning a specific incident prevention or management technique or the incident management process as a whole, references to published studies have been listed at the end of this guide. Also listed are the names, addresses, and telephone numbers of the persons or agencies that have been directly involved with incident management across the U.S. This list is not intended to be comprehensive but merely to provide an initial contact from which readers can obtain incident management information or direction.

Table 2.1 Areas of Impact for Incident Management Alternatives Examined

Options	Options for Improving Prevention	Options for Reducing Detection Time	Options for Reducing Response Time	Options for Improving Site Managem't	Options for Reducing Clearance Time	Options for Improving Motorist Information
Accident Investigation Sites					✔	
Administrative Traffic Management Teams			✔	✔	✔	
Advancted Traveler Information System						✔
Advanced Vehicle Control	✔		✔		✔	
Aircraft Patrol		✔				
Alternative Route Planning			✔	✔	✔	
Automated Debris Recovery System					✔	
Automated Truck Warning System	✔					
Automatic Cargo Identification				✔		
Automatic Vehicle Identification		✔				
Automatic Vehicle Location			✔			
Cellular Telephone		✔				
Cellular Telephone Monitoring		✔				
Central Information Processing and Control Site		✔	✔	✔		✔
Citizens' Band (CB) Radio Monitoring		✔				
Closely Spaced Milepost Markers			✔			
Command Post				✔		
Dedicated Freeway/Service Patrols		✔	✔		✔	
Electronic Loop Detection		✔				
Emergency Vehicle Access			✔		✔	
Equipment and Materials Resource List			✔			
Equipment Storage Sites			✔			
Externally Linked Route Guidance (ELRG) Systems						✔
Flashing Lights Policy				✔		
Geographic Information Systems			✔			

Table 2.1 continued

Options	Options for Improving Prevention	Options for Reducing Detection Time	Options for Reducing Response Time	Options for Improving Site Managem't	Options for Reducing Clearance Time	Options for Improving Motorist Information
Hazardous Materials Manual					✔	
Highway Advisory Radio						✔
Identification Arm Bands				✔		
Identification of Fire Hydrant Locations					✔	
Improved Interagency Radio Communication			✔	✔		
Improved Media Ties						✔
Incident Phone Lines		✔				
Incident Response Database		✔	✔	✔		
Incident Response Manual				✔	✔	
Incident Response Teams				✔	✔	
Inflatable Air Bag Systems					✔	
Motorist Aid Call Boxes/Telephones		✔				
Ordinances Governing Travel on Shoulder			✔		✔	
Peak Period Motorcycle Patrols		✔	✔	✔		
Personnel Resource List			✔			
Personnel Training Programs			✔			
Policy Requiring Fast Vehicle Removal					✔	
Properly Defined Parking for Response Vehicles				✔		
Properly Defined Traffic Control Techniques				✔		
Public Education Programs			✔		✔	
Push Bumpers					✔	
Radio Data Systems (RDS)						✔
Responsive Traffic Control Systems					✔	
Ties with Transit/Taxi Companies		✔				
Total Station Surveying Equipment					✔	

Table 2.1 continued

Options	Options for Improving Prevention	Options for Reducing Detection Time	Options for Reducing Response Time	Options for Improving Site Managem't	Options for Reducing Clearance Time	Options for Improving Motorist Information
Tow Truck/ Removal Crane Contracts			✔			
Variable Lane Closure					✔	
Variable Message Signs						✔
Video and Closed Circuit TV		✔				
Video Image Processing		✔				
Volunteer Watch		✔				

Table 2.2 Areas Where the Options Are in Use

City (STATE)	Pop.	Accident Investigation Sites	Admin. Traf. Mgt. Teams	Advanced Traveler Info. Sys.	Advanced Vehicle Control	Aircraft Patrol	Alternate Route Planning	Auto. Debris Recov. Sys.	Automated Truck Warning Sys.	Auto. Cargo ID	Auto. Vehicle ID	Auto. Vehicle Loc.	CB Radio Monitoring	Cellular Telephone	Cell. Phone Monitoring	Central Information Processing & Control Site	Closely Spaced Milepost Markers	Command Post	Dedicated Freeway/ Service Patrol	Electronic Loop Detection	Emergency Vehicle Access	Equipment & Materials Resource List	Equipment Storage Sites	Externally Linked Route Guidance Systems	Flashing Lights Policy
New York (NY)	7,322,564			√																√		√			
Los Angeles (CA)	3,485,398		√	√		√	√						√	√		√		√	√	√	√				√
Chicago (IL)	2,783,726	√	√	√		√	√				Δ		√	√		√	√	Δ	√	√	√	√	√	√	√
Houston (TX)	1,630,553		√	√		√	√						√	√					√	√	√				
San Diego (CA)	1,110,549			√										√					√	√					
Detroit (MI)	1,027,974			Δ		√	√						√	√					√	√	√				
Dallas (TX)	1,006,877		√	√			Δ				Δ		Δ	√		Δ			√	√	Δ	√	√	Δ	√
Phoenix (AZ)	983,403	√		√			√	√			Δ			Δ		√			√	√		√	√		
San Antonio (TX)	935,933																		√	√					
San Jose (CA)	782,248		√	√		√	√				Δ			√		√		√	√	√		√	√		√
Baltimore (MD)	736,014		√	√		√	√		√			Δ	√	√		√	√	√	√	√	√	√	√		
Indiannapolis (IN)	731,327	Δ	Δ	Δ			Δ				Δ			√		√	√	√	√						
San Francisco (CA)	723,959		√	√		√	√				√			√		√		√	√	√		√	√		√
Jacksonville (FL)	635,230		√	Δ		√	√						√	√			√	Δ	√		√	√	√		√
Columbus (OH)	632,910			Δ																√					
Milwaukee (WI)	628,088			√												√				√					
Toronto (ON)	599,217	√	√	Δ		√	√				√			√		√	√	√	√	√	√	√	√		
Boston (MA)	574,283	√	Δ			√	Δ				Δ		√	√		√	√	Δ	√	√	√				
Seattle (WA)	516,259			√		√	√						√	√		√	√	√	√	√	√				
El Paso (TX)	515,342	√	√				√				Δ					√	√	√	√	√					
Denver (CO)	467,610		Δ	Δ			Δ				√			√		Δ	√		√	√	√	√	√	Δ	
Ft Worth (TX)	447,619			Δ			√							Δ					√	√					
Portland (OR)	437,319		Δ	Δ			Δ						Δ	√		Δ		Δ	Δ	√		Δ			Δ
St. Louis (MO)	396,685			Δ			Δ							√		Δ	√	Δ	√	Δ		Δ	Δ		Δ
Atlanta (GA)	394,017			√		Δ								√						√					
Pittsburgh (PA)	369,879			Δ			√				Δ			√		Δ			Δ	Δ					
Sacramento (CA)	369,365		√	√			√							√		√	√	√	√	√		√	√		
Minneapolis (MN)	368,383	√	√	√		√	Δ	Δ			Δ			√		√		√	√	√	Δ	√		Δ	√
Cincinnati (OH)	364,040		Δ	√		√							√		√	√	Δ	Δ	√	√	√	Δ	Δ		
Miami (FL)	358,548		√	Δ			√							√						Δ					
Fresno (CA)	354,202			Δ										√						√					
Tampa Bay (FL)	280,015		√	Δ		√	√						√	√			√	√	√	√	√	√	√		√
Newark (NJ)	275,221	Δ	Δ	Δ			Δ				Δ		√	Δ			√		√	Δ	√	√	√		
Anaheim (CA)	266,406			√			√						√						√	√					
Jersey City (NJ)	228,537			√			√									√									
Lexington (KY)	225,366	√	√	√			Δ				Δ		√	√		√	Δ	√		√	√	√	√		√
Raleigh (NC)	207,951		√	√		√	√							√		Δ	Δ	√	√	√	√	√	√		
Richmond (VA)	203,056	√	√	Δ		√	√						√	√			Δ	√	√	√	√	√	√		Δ
Arlington (VA)	170,936	Δ	√	Δ		√	√		√		Δ	Δ	√	√	√	√	Δ	√	√	√	√	√	√		Δ
Orlando (FL)	164,693		√	Δ		√	√						√	√			√	Δ	√	√	√	√	√		√
Providence (RI) †	160,728																		√						
Salt Lake City (UT)	159,936	Δ	√	Δ		√	√							√		Δ	√	Δ	√	√	Δ	Δ	√		√
Ft Lauderdale (FL)	149,377		√																						
Bridgeport (CT)	141,686			√															√	√					
Hartford (CT)	139,739													√					√						
Lansing (MI)	127,321						√							√		√		√			√	√	√		
Lakewood (CO)	126,481					√								Δ						√					
Trenton (NJ)	88,675	Δ	Δ	√			Δ	√			Δ			Δ		√	√	√	√	√		√		√	
Palm Beach (FL)	67,643		√	Δ		√	√						√	√			√	Δ			√	√	√		√
Daytona Beach (FL)	61,921		√	Δ		√	√						√	√			√	Δ			√	√	√		√
New Brunswick (NJ)	41,711			√										√						√					

† = not updated from 1991 √ = implemented Δ = planned

GIS	Hazardous Materials Manual	Highway Advisory Radio	Identification Arm Bands	Identification of Fire Hydrant Locations	Improved Interagency Radio Communication	Improved Media Ties	Incident Phone Lines	Incident Response DB	Incident Response Manual	Incident Response Teams	Inflatable Air Bag Sys.	Motorist Aid Call Boxes/Phones	Ordinances Governing Travel on Shoulder	Peak Period Motorcycle Patrols	Personnel Resource List	Personnel Train. Progs.	Policy Requiring Fast Veh. Rem.	Properly Defined Parking for Response Vehicles	Properly Defined Traffic Control Techniques	Public Education Progs.	Push Bumpers	Radio Data Systems	Responsive Traffic Control Sys.	Ties with Transit/Taxi Co.	Total Station Surv. Eqmt.	Tow Truck/Removal Crane Contracts	Variable Lane Closure	Variable Message Signs	Video and CCTV	Video Imaging	Volunteer Watch
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Information gathered from "Urban Transportation Monitor" and Personal Surveys

Options for Improving Prevention

Focusing on ways to improve the management of incidents makes little sense without also considering ways to prevent incidents from occuring. Incident prevention means minimizing incident occurence in the first place. Conventional incident prevention methods have included improvements in roadway geometrics, right-of-way obstruction removal (i.e., light poles, trees), and material changes to improve skid resistance. New technologies are beginning to focus on incident prevention as well. These new technologies include Advanced Vehicle Control Systems (AVCS) and Automated Truck Warning Sytems (ATWS).

Table 2.3 lists options for incident prevention. Table 2.4 shows alternative ways for agencies to be involved in each prevention technique.

Table 2.3 Options for Improving Prevention

Type of Program	Potential Benefits	Potential Costs	Comments
Advanced Vehicle Control	👍👍👍👍	💰💰💰💰	Can prevent incidents, as well as improve response and clearance.
Automated Truck Warning Systems	👍👍👍	💰💰⇨💰💰💰	Requires the identification of locations with high rates of truck-involved incidents before implementation.

👍 = Minor benefits

👍👍 = Moderate benefits

👍👍👍 = Substantial benefits

👍👍👍👍 = Very substantial benefits

⇨ = Indicates a range of benefit/cost levels

💰 = Minor costs

💰💰 = Moderate costs

💰💰💰 = Substantial costs

💰💰💰💰 = Very substantial costs

Table 2.4 Agency Involvement in Improving Prevention

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Automatic Vehicle Control	A	△					△		
Automated Truck Warning Systems	A	▲							
	B	△					△		

▲ Indicates sole involvement

△ Indicates shared involvement

GENERAL DESCRIPTION

Advanced vehicle control (AVC) systems help prevent incidents rather than improve their management. Advanced vehicle control systems can prevent incidents both in both the longitudinal and lateral directions. Longitudinal direction incidents include head-on and rear-end collisions. Lateral direction incidents include side-swipe or other incidents caused when a vehicle has left its lane. In addition, advanced vehicle control systems allow motorists to be automatically rerouted to avoid congestion.

The advanced vehicle control systems technology is still being developed and is not widely deployed. The implementation of this technology will likely be in stages, the final stage of which will be the fully automated vehicle on a fully instrumented highway.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where incident impacts are major.

Advantages

- ✓ Avoids the incident rather than mitigates the consequences of the incident.
- ✓ Allows for the automatic diversion of motorists around incident sites.
- ✓ May reduce the stress of driving for motorists.
- ✓ Prevents incidents resulting from human error.

Disadvantages

- ✗ Greatest benefits result only when system is fully automated.
- ✗ Fully automated system may experience lengthy implementation times.
- ✗ System is costly.

Costs	Capital	Variable - See Below
	Maintenance	High
	Operating	High
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with an advanced vehicle control system are high. However, some of the cost burden may be assumed by the private sector through public/private partnerships.

Special Equipment Required

The type of equipment required depends upon the level of automation offered through the advanced vehicle control system. Each of the vehicles must be appropriately equipped to allow either for the motorist to be warned of a potential incident or for the vehicle to automatically take control to avoid the incident. In addition, the roadway must be instrumented to allow real-time information to be sent to the vehicle.

Special Training Required

The required training depends on the level of automation offered through the advanced vehicle control system. Public education must take place for the new technology to be accepted and properly used. In addition, the controlling agency must train personnel to operate and maintain the new equipment as part of the system.

Liability

A chance for liability exists if an incident occurs after the implementation of the advanced vehicle control system. However, this chance for liability can be greatly reduced if the limitations of the system are carefully defined.

Operation

Public or Private

An advanced vehicle control system should be a cooperative effort with both public and private agency involvement. The instrumented roadway should be operated by a public agency because of its direct impact on the public agency's facilities and the risk of liability placed upon that agency. The development and implementation of the instrumented vehicle should be the responsibility of the private sector, either automative manufacturers or after-market suppliers.

Operating Agency

An advanced vehicle control system should be cooperatively operated by a transportation agency (Operations division) and private agencies, automative manufacturers, or after-market suppliers. Coordination must occur with other response agencies.

Funding Responsibility

The funding responsibility lies with both operating agencies, namely the transportation and private agencies.

GENERAL DESCRIPTION

Automated truck warning systems help prevent or reduce incidents rather than improve the management of them. Automated truck warning systems can, depending on the technology, prevent or reduce truck-related incidents resulting from misjudged underpass clearances or truck rollovers. With automated truck warning systems, a driver can be warned upstream of a hazard that either the vehicle speed is too fast and could result in a rollover or that the vehicle's height will not clear an upcoming underpass. The information can be provided either through roadside warnings or through in-vehicle warnings. The warning must occur far enough upstream for the driver to adjust either by slowing or rerouting.

Conditions Under Which Appropriate

Appropriate in locations with a high rate of truck-related incidents such as reduced speed ramps or low clearance underpasses.

Advantages

- ✓ Reduces the potential for infrastructure damage, in addition to reducing the impacts from incidents.
- ✓ Prevents incidents resulting from human error.

Disadvantages

- ✘ Requires the cooperation of the vehicle driver to be effective.
- ✘ Requires the identification of locations with high incident rates before implementation.
- ✘ Speed, weight, or height detectors may suffer from poor reliability and vandalism or may be damaged during resurfacing or standard roadway maintenance.

Costs

Capital	Variable - See Below
Maintenance	Medium
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	Variable - See Below
Legislative Requirements	None

Operation

Public or Private	Variable - See Below
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with an automated truck warning system are variable, depending on the technology and how extensively it is used. More automated options, such as in-vehicle warning systems, would be more costly. Less automated options, such as roadside warnings, would be less costly.

Special Equipment Required

The type of equipment required depends upon the level of automation offered through the automated truck warning system. For roadside warnings, the system requires speed, weight, or height detectors along the roadway, a communications link (usually by means of modem) from the detectors to a central observation station, a computer equipped with a software, a calibrated truck rollover algorithm, a roadside warning device, and a communications link (usually by means of modem) from the central observation station to the warning device.

For in-vehicle warnings, the equipment required to implement an automated truck warning system includes an onboard computer in the truck with software and a calibrated truck rollover algorithm and electronic devices (transponders) at critical locations along the roadway that transmit information to a truck's onboard computer. That information is processed and a warning is activated if the truck's weight, speed and cargo cannot safely maneuver the roadway.

Special Training Required

The required training depends on the level of automation offered through the advanced vehicle control system. Education of the trucking industry must take place for the new technology to be accepted and properly used. In addition, the controlling agency must train personnel to operate and maintain the new equipment as part of the system.

Liability

A chance for liability exists if an incident occurs after implementation of the automated truck warning system. The system must be carefully tested and monitored to ensure that the warnings occur at appropriate times.

Operation

Public or Private

An automated truck warning system could be operated solely by a public agency or cooperatively by both public and private agencies. The instrumented roadway with roadside warnings should be operated by a public agency because of its direct impact on the public agency's facilities and the risk of liability placed upon that agency. The development and implementation of the instrumented vehicle and in-vehicle warning systems should be the responsibility of the private sector, either truck manufacturers or after-market suppliers.

Operating Agency

An automated truck warning system could be solely operated by a transportation agency if roadside warnings were used, or cooperatively operated by a transportation agency and private agencies if in-vehicle warnings were used.

Funding Responsibility

If a roadside automated warning system is chosen, the funding responsibility lies with the transportation agencies. The funding responsibility lies with both operating agencies, namely the transportation and private agencies, if in-vehicle warning systems are desired.

Options for Improving Prevention

Options for Reducing Detection and Verification Time

Incident detection and verification are the processes that bring an incident to the attention of the agency or agencies responsible for maintaining traffic flow and safe operation on a facility. They include differentiating incidents from false alarms generated by the detection system. Generally, the speed with which an incident is detected affects the speed with which it can be cleared and the amount of disruption the incident will cause the remainder of the traffic stream. Thus, fast, accurate detection often results in greatly reduced traffic disruption and the large savings that can produce. Consequently, many incident response measures are aimed at improving the methods for detecting incidents.

Incident detection can be improved with a variety of methods, including

- electronic traffic measuring devices (e.g., loops),
- video cameras,
- CB radios, and
- visual observation.

Table 2.5 lists options for reducing detection times that may be evaluated for possible inclusion in an incident management system. Table 2.6 shows alternative ways for agencies to be involved in each management technique.

Table 2.5 Options for Reducing Detection and Verification Time

Type of Program	Potential Benefits	Potential Costs	Comments
Peak Period Motorcycle Patrols	👍👍👍👍	💰💰⇨💰💰💰	Roving motorcycle patrols can provide added surveillance along high incident segments of freeway.
Dedicated Freeway/Service Patrols	👍👍⇨👍👍👍👍	💰💰⇨💰💰💰💰	Roving patrols along high incident segments of the freeway can serve to reduce incident detection times.
Motorist Aid Call Boxes/Telephones	👍👍	💰💰💰	May incur added costs or complications because of required utility work.
Incident Phone Lines	👍	💰💰	Requires an initial publicity effort and continued cooperation with media agencies.
Cellular Telephones	👍👍👍👍	💰	Information should be distributed to cellular phone users describing proper incident reporting techniques.
Citizen Band (CB) Radio Monitoring	👍👍	💰	Information should be distributed to CB radio operators describing proper incident reporting techniques.
Volunteer Watch	👍	💰	Training efforts may be wasted on short-term or non-dedicated volunteers.
Ties with Transit/Taxi Companies	👍👍👍	💰	Can be expensive to cover all routes or limited to only those who travel on the freeway or other high incident areas.
Aircraft Patrol	👍⇨👍👍👍👍	💰⇨💰💰💰💰	May be limited by noise or density restrictions.
Electronic Loop Detection	👍👍	💰💰💰💰	Can also serve other operations functions, but may give false calls in incident detection.
Video and Closed Circuit TV	👍👍👍👍	💰💰💰💰	Can also serve many other operations functions such as volume, speed, and vehicle classification data collection.
Automatic Vehicle Identification	👍👍👍	💰💰💰💰	Motorists may be resistant to instrumenting their vehicles with electronic tags.
Cellular Telephone Monitoring	👍👍	💰💰	Still emerging as a technology and may suffer from unreliability and lack of support when problems arise.
Video Imaging	👍👍👍	💰💰💰💰	Still emerging as a technology and may suffer from unreliability and lack of support when problems arise.
Central Information Processing and Control Site	👍👍👍	💰💰💰	Centralization of information allows for better verification of incidents.

Key for Table 2.5

= Minor benefits

= Moderate benefits

= Substantial benefits

= Very substantial benefits

= Indicates a range of benefit/cost levels

= Minor costs

= Moderate costs

= Substantial costs

= Very substantial costs

Table 2.6 Agency Involvement in Reducing Detection and Verification Time

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Peak Period Motorcycle Patrols	A		▲						
Dedicated Freeway/Service Patrols	A	▲							
	B		▲						
	C						▲		
Motorist Aid Call Boxes	A	▲							
	B		▲						
Incident Phone Lines	A	△						△	
	B		△					△	
Cellular Telephones	A	△						△	
	B		△					△	
Citizen Band Radio Monitoring	A	△						△	
	B		△					△	
Volunteer Watch	A	▲							
	B		▲						
Ties with Transit/Taxi Companies	A	△				△			
	B	△					△		
	C		△			△			
	D		△				△		
Aircraft Patrol	A	▲							
	B		▲						
	C						▲		
Electronic Loop Detection	A	▲							
Video and Closed Circuit TV	A	▲							
Automatic Vehicle Identification	A	▲							
Cellular Telephone Monitoring	A	▲							
Video Imaging	A	▲							
Central Information Processing and Control Site	A	▲							
	B	△	△			△	△	△	
	C						▲		

▲ Indicates sole involvement △ Indicates shared involvement

Example of Sole Involvement
Dedicated freeway/service patrols can be operated by a transportation agency or a police agency or a private agency. Each of these agencies has the potential to operate the patrol program successfully with no required interagency cooperation.

Example of Shared Involvement
Incident Phone Lines can be implemented and operated by either a transportation agency or police agency, but in each case, cooperative effort with the local media is required to ensure adequate public education regarding the use of the service.

PEAK PERIOD MOTORCYCLE PATROLS

GENERAL DESCRIPTION

The establishment of peak period motorcycle patrols may produce numerous incident management improvements for a potentially minimal cost. To obtain the most benefit, the motorcycle patrols should operate in congested areas during the peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures. With well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection time should be reduced.

As a consequence of peak period motorcycle patrols, incident response times should also improve because motorcycles are more maneuverable in congested areas than larger response vehicles and should allow trained personnel to reach and assess the incident site quickly. The appropriate equipment can thus reach the site in less time, reducing the overall impact of the incident.

A third benefit that should result from the establishment of peak period motorcycle patrols is that because motorcycles are small and maneuverable, they can more easily access the incident site than larger response vehicles. This quick access allows traffic control procedures to begin early in the incident management process, decreasing the incident's impact on the motoring public.

This option may be implemented in place of a dedicated freeway/service patrol program or increased regular police patrol units, depending on the incident management needs and available funding.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where larger incident response vehicles have limited access to the incident site.

Advantages

- ✓ In addition to reducing detection times, motorcycle patrols also improve response times and site management efforts.
- ✓ Increase police mobility during peak hours, allowing more rigid enforcement of traffic laws (i.e., speed limits).
- ✓ Can reach and assess the incident quickly and can call for other emergency vehicles to respond if necessary.

Disadvantages

- ✗ Motorcycles lack incident clearing capabilities.
- ✗ Motorcycles do not offer protection for the officer in case of secondary accidents or inclement weather.

Costs

Capital	Variable - See Below
Maintenance	Variable - See Below
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Police Agencies

Funding Responsibility — Police Agencies

DETAILED DESCRIPTION

Costs

Capital

Capital costs may range from low to medium, depending on whether new response patrol vehicles are purchased or existing or reconditioned vehicles are used. If existing or reconditioned vehicles are used, capital costs will remain low. However, capital costs may be higher if new response vehicles are required, and it may be wise to consider other options that can provide better incident clearance and respondent protection for an equal expenditure. Such alternatives may include a small scale dedicated freeway/service patrol program or an investment in special equipment such as push bumpers for existing patrol vehicles.

Maintenance

Maintenance costs may also range from low to medium, depending on the condition of the response vehicles. If capital expenses are relatively high because of the purchase of new motorcycle patrol vehicles, maintenance costs should remain relatively low. The inverse is also true: if reconditioned vehicles are chosen over new vehicles, maintenance costs may run higher.

Special Equipment Required

New response patrol vehicles, equipped with the required electrical and communication systems, may be purchased if an inadequate number of vehicles exist. However, it might be wise to explore other alternatives.

Special Training Required

The required training depends on the background and experience of the responding personnel. However, a well trained motorcycle patrol respondent should be knowledgeable in the following areas:

- Emergency medical training including CPR and first aid
- Radio communication with an emphasis on reporting
- Traffic control
- Public relations
- Surveillance of suspicious activities
- A general knowledge of departmental procedures and policies of each of the responding agencies (transportation, police, fire and rescue).

Obviously, some of these areas will overlap with the existing police agency training requirements, so a unique training program may be needed for motorcycle patrol personnel.

Options for Reducing Detection and Verification Time

GENERAL DESCRIPTION

The establishment of a dedicated freeway/service patrol program may resul in numerous improvements to the incident management effort for a potentially minimal cost. To achieve the greatest benefit, the freeway/service patrols should operate in congested areas during the peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures. With well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection time should decrease.

As a consequence of a dedicated freeway/service patrol, incident response times should also improve because the patrol vehicles are usually physically closer to the incident site than vehicles that depart from a location far from the corridor under surveillance.

A third benefit that may result from the establishment of a dedicated freeway/service patrol is that many minor incidents or disablements can be cleared with the responding patrol vehicle, eliminating the delay caused when a tow truck is needed. The legal implications of this service, as well as the variety of cost levels at which this program can be implemented, are discussed in the Detailed Description.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where efficiency in incident detection is critical.

Advantages

✓ In addition to improving detection times, dedicated freeway/service patrols improve response and clearance times.

✓ Trained personnel can quickly assess incident severity.

✓ Patrol vehicles can often quickly remove minor incidents.

Disadvantages

✗ May conflict with other operating agency budgetary priorities.

✗ Additional personnel may be required.

✗ Quickly becomes ineffective if implemented improperly.

Costs	Capital	Variable - See Below
	Maintenance	Low
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with a dedicated freeway/service patrol vary greatly, depending on the size of the initial program, the aim of the program, and the source of the equipment or supplies. In any case, it is wise to initiate a small scale patrol program that requires minimal capital investment, then expand as the program proves successful. Or, if the program has not proved successful, it may be altered or abandoned for a new program that better meets the incident management needs.

Along with the size of the program, the aim of the program can greatly affect initial capital requirements. For instance, to mitigate the impacts of major incidents that involve numerous vehicles and/or trucks, larger, heavy-duty response vehicles such as wreckers or tow rigs are required. These vehicles have high initial capital funding requirements. However, if the aim of the program is to mitigate minor accidents or vehicle disablements, smaller response vehicles such as pickup trucks or vans can be chosen , greatly reducing the initial capital required.

A third factor that affects the required capital funding is the source of the equipment or supplies. Various methods exist for the initial purchase of the appropriate equipment. One option is for the public operating agency to acquire the new vehicles, but this option requires a large amount of initial funding. A second option is to utilize backup or refurbished vehicles as incident patrol vehicles. This choice greatly reduces the capital funding required. A third option is to obtain privately sponsored vehicles. Many private agencies are willing to assume the cost of purchasing, operating, and maintaining a small number of freeway/service patrol vehicles in return for beneficial public relations and additional advertising. Even though a specified public agency (i.e., a transportation or police agency) must frequently monitor or inspect the patrol program, it does not directly incur any capital costs, making this the lowest cost option.

Special Equipment Required

The type of equipment required depends upon the specific incident management needs, as well as the amount of funding available for the development of the program. Relatively low cost options include using light/medium duty pickup trucks, vans, or patrol cars to mitigate the impacts of minor vehicle accidents or disablements. These vehicles may be purchased new by the public operating agency, refurbished, or sponsored by the private sector in return for advertising and public relations benefits. Each of the vehicles must be appropriately equipped with gasoline, water, tools for minor repair, jumper cables, flares, first aid kits, warning lights, and possibly push bumpers. Auto parts are not recommended, since the goal is to offer the service to the public with negligible associated costs.

For major incidents, larger or specially designed vehicles may be chosen. Tow trucks/rigs, cranes, or wreckers may be used to patrol localized areas that suffer from high incident rates or limited access. In this instance, though response may be relatively infrequent, the decrease in the usually lengthy delays may warrant implementation.

In each of these cases, it is better to begin on a small scale with the purchase of only a few vehicles, prove the program's success, and then increase the response fleet to improve efficiency.

Special Training Required

The required training depends on the background and experience of the responding personnel. However, a well trained freeway/service patrol respondent should be knowledgeable in the following areas:

- Emergency medical training including CPR and first aid
- Radio communication with an emphasis on reporting
- Traffic control
- Public relations
- Surveillance of suspicious activities
- A general knowledge of departmental procedures and policies of each of the responding agencies (transportation, police, and fire and rescue).

Obviously, some of these areas will overlap with the existing public agency training requirements, so a unique training program may be needed for freeway/service patrol personnel.

Liability

A minimal chance for liability exists from damage that the disabled or blocking vehicle may possibly incur. However, this chance for liability can be greatly reduced if an emphasis is placed on training the respondent personnel.

Operation

Public or Private

A dedicated freeway/ service patrol program can be operated by either a public or private agency.

Operating Agency

A dedicated freeway/service patrol program can be operated by a transportation agency (Operations or Maintenance divisions), police agency, or private agency. If a private agency wishes to undertake the operation, some coordination must occur with either the transportation or

police agency to ensure that the vehicles are operated safely and are properly equipped and that patrol respondents are properly trained.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the transportation, police, or private agency involved. However, if operation is undertaken by the transportation agency, freeway/service patrols are eligible for Federal Aid Primary, Urban, and Interstate 4R Funds. These funds are available for the establishment of the service but not the day-to-day operational costs.

GENERAL DESCRIPTION

Motorist aid call box systems consist of a box with a switch or toggle that signals the operating agency via phone line that an incident has occurred. There is no direct communication from the person reporting the incident. A variation of this is the motorist aid telephone system, which includes a handset that allows the person reporting to relay additional information. The latter option is preferred because a sizable reduction in response time occurs if the dispatch personnel has more information about the accident (e.g., whether it is a major/minor accident, fatality, or fire).

Conditions Under Which Appropriate

Appropriate in isolated or limited access areas (i.e., bridges, tunnels, overpasses) that suffer from high incident rates and where detection times are normally lengthy.

Advantages

✓ Incident reporting can be done 24 hours a day.

✓ Citizen acceptance is high.

✓ Citizens can report directly to response agency dispatch office.

Disadvantages

✗ Start-up costs are relatively high.

✗ May be limited by utility locations.

✗ Accrues monthly telephone usage fees.

✗ Creates potential for vandalism.

Costs

Capital	Medium
Maintenance	High
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Special Equipment Required

Motorist Aid Call Boxes or Motorist Aid Telephone devices are required, depending on which option is chosen. Also, depending on location, extra costs may be incurred from required utility work, since both of these options operate via telephone lines. Costs may also be incurred from signing that notifies the public of the existence, location, and use of these devices.

Operation

Operating Agency

Either a transportation or police agency should assume complete control over the operation of this program.

Funding Responsibility

The responsibility of securing funding lies with the operating agency, namely the transportation or police agency involved.

GENERAL DESCRIPTION

Incident phone lines consist of a special telephone line that allows the public to call one number, similar to a 911 number, to illicit emergency response. An initial effort is necessary to inform the public of the number's existence for this option to be successful.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ Motorists are less confused about who to report incidents to.

Disadvantages

✗ Adds to the phone bill.

✗ An initial publicity effort is required.

✗ Roadside signs are required to remind drivers of the incident phone line.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Medium
	Special Equipment Required	None
	Special Training Required	None
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Operation

Operating Agency

Operational responsibilities should lie with either a transportation agency or police agency, but to be successful, media agencies should be strongly involved. The media can make great strides toward informing the general public of the existence and use of this incident phone line.

Funding Responsibility

The funding responsibility for this program should lie with the transportation or police agencies involved.

CELLULAR TELEPHONES

GENERAL DESCRIPTION

The public may use cellular phone systems to report incidents if a traffic report phone number is established to allows drivers to directly contact the dispatch office. Despite the relatively small percentage of cellular telephones on the roadway, ample surveillance should result. However, to ensure that this resource be used to its full potential, information should be distributed to cellular phone users (possibly through cellular telephone companies) that describes the correct procedures for reporting vehicle accidents, breakdowns, or spills (e.g., incident type, location, direction). If possible, a contract should be established with the cellular telephone companies to allow the cellular phone operator to report traffic problems without charge.

Conditions Under Which Appropriate

Appropriate under all circumstances, but will have the greatest impact in less travelled areas where detection times are normally lengthy.

Advantages

- ✓ Can monitored by existing dispatch staff.
- ✓ Requires no training on equipment use by the operating agency.
- ✓ Since more than one report of the incident is usually received, complete and comprehensive information of the incident can be obtained before respondents depart for the scene.

Disadvantages

- ✗ Users are limited to owners of cellular phones.
- ✗ Increases the work loads of dispatch personnel.
- ✗ Users may want to be reimbursed for their time or effort.
- ✗ Roadside signs are required to remind drivers of the dedicated cellular telephone number.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Operation

Operating Agency

Operational responsibilities should lie with either the transportation or police agencies, but to be successful, media agencies should be strongly involved. Without adequate publicity concerning the existence and use of this number, the program cannot be successful.

Funding Responsibility

The responsibility of securing funding lies with the operating agency, namely the transportation or police agencies involved.

CITIZENS' BAND (CB) RADIO MONITORING

GENERAL DESCRIPTION

Citizens' Band (CB) radio monitoring can be accomplished through the establishment of a radio frequency dedicated to incident reporting. Despite the relatively small number of CB radios on the roadway, ample surveillance should result. CB coverage can also be increased by incorporating transit bus drivers, service patrol operators, truckers and delivery operators in the system. To ensure that this resource is used to its full potential, CB radio operators must be educated about the correct procedures for incident reporting, including the types of situations to report and how to report incident type, location, and direction.

Conditions Under Which Appropriate

Appropriate under all circumstances, but will have the greatest benefit on less travelled routes where detection times are normally lengthy.

Advantages

✓ Can be monitored by existing dispatch staff.

✓ Requires no training on equipment use by the operating agency.

✓ Because more than one report of the incident is usually received, complete and comprehensive information of the incident can be obtained before respondents reach the scene.

Disadvantages

✗ Users are limited to owners of CB radios.

✗ Increases the work loads of the dispatch personnel.

✗ Roadside signs are required to remind drivers of the dedicated CB radi frequency.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Operation

Operating Agency

Operational responsibilities should lie with either the transportation or police agencies, but to be successful, media agencies should be strongly involved.

Funding Responsibility

The responsibility of securing funding lies with the operating agency, namely the transportation or police agencies involved.

GENERAL DESCRIPTION

Volunteers can be used to observe the freeways during peak hours from vantage points near high incident locations. Incidents can then be reported to a dispatch office through telephone, cellular telephone, CB radio or other means. For incidents that occur in the areas under surveillance, this program results in instantaneous detection; however, locating such localized areas may be difficult.

Conditions Under Which Appropriate

Appropriate in high incident locations or limited access areas where detection times are vital and where the safety of the observer will not be jeopardized or serve as a distraction to the moving traffic.

Advantages

- ✓ Provides citizens with a specific action for reducing congestion in their community.
- ✓ Provides visual verification of incidents.
- ✓ Provides initial assessment of the severity of the incident.

Disadvantages

- ✗ Volunteers may not be available.
- ✗ Training must be provided for reliable reporting.
- ✗ Incident detection may be "spotty" because volunteers usually would not follow a strict work schedule.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

For this program to operate most efficiently, a brief training session should instruct volunteers in reporting incidents (i.e., the information that is most important, including accident type, location, and direction). Some equipment training may also be required, depending on the background or experience of the volunteers and the type of communications equipment used.

Operation

Operating Agency

Operational responsibilities should lie with either the transportation or police agencies.

Funding Responsibility

The responsibility of securing funding lies with the operating agency, namely the transportation or police agencies involved.

GENERAL DESCRIPTION

Ties with Taxi or Transit companies may improve incident detection efforts, as well as provide other traffic information, by taking advantage of transit or taxi vehicles already equipped with radios. Only initial instruction concerning the proper methods for reporting incidents is required (i.e., incident type, location, direction). This program can be expansive and cover all routes or may be limited to only routes that travel the freeways or other high incident areas.

Conditions Under Which Appropriate

Appropriate in areas where sufficient transit or taxi service exists to provide adequate and frequent coverage of high incident locations.

Advantages

- ✓ Incidents can be reported quickly, given a substantial number of transit/taxi vehicles and a wide geographic spread.
- ✓ Traffic conditions for both freeways and arterials can be reported.
- ✓ Requires no training in equipment use by the operating agency.
- ✓ Incidents can be reported directly to the response agency dispatch office.

Disadvantages

- ✗ Additional personnel may be required.
- ✗ Transit/taxi drivers may be distracted while driving.
- ✗ Transit/taxi drivers may want to be paid for reporting.
- ✗ Transit or private agencies may want to be paid for providing this service.

Costs

Capital ---Low
Maintenance--- Low
Operating---Low
Special Equipment Required--------------------------------None
Special Training Required-------------- Variable - See Below
Liability --None
Legislative Requirements--------------------------------- None

Operation

Public or Private --- Public
Operating Agency------------------------ Variable - See Below

Funding Responsibility

-- Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

For this program to operate most efficiently, a brief training session should instruct transit/taxi drivers in reporting incidents (i.e., the information that is most important, including incident type, location, direction).

Operation

Operating Agency

Operational responsibilities should lie with either the transportation or police agencies, but extensive coordination is necessary with either the private or transit agency involved.

Funding Responsibility

The responsibility of securing funding lies with the operating agency, namely the transportation or police agencies involved. The funding for this program should prove to be minimal.

GENERAL DESCRIPTION

Airplanes or helicopters can be used to detect incidents and provide up-to date traffic information. An initial effort is needed to educate personnel in the proper methods of incident reporting (i.e., the information that is important, including incident type, location and direction). This information can be relayed to the dispatcher and then directly disseminated to the public. This service quickly becomes ineffective if the information is not accurate and timely.

Conditions Under Which Appropriate

Appropriate in areas that do not have noise or density restrictions for aircraft.

Advantages

- ✓ Has potential for monitoring major shifts in route choice.
- ✓ Has potential for photographic analysis of traffic distribution.
- ✓ Can quickly verify potential incidents.

Disadvantages

- ✗ Use is often limited to peak hours.
- ✗ May impede incident management efforts by hovering too closely.

Costs	Capital	Variable - See Below
	Maintenance	Variable - See Below
	Operating	Variable - See Below
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

An aircraft patrol program can be implemented in a wide range of capital cost levels, but in each case, the same benefits will result. The most expensive, and therefore least likely, option is for the public agency to purchase the aircraft and assume the associated maintenance and operational costs. This option is not recommended because the high implementation costs will greatly outweigh the the benefits. A second option is to rent or lease the aircraft. Rental will greatly reduce the initial required expenditure and result in the same improvements toward incident detection efforts.

However, the most feasible option for implementing an aircraft patrol program is to obtain a private sponsor who is willing to assume operation. Private sponsors such as radio or television stations are ideal because they are better equipped for disseminating traffic information to the motoring public. In most cases, private sector sponsors are willing to assume the costs associated with an aircraft patrol program in return for the beneficial publicity and advertising. Even though, for this last alternative, the public agency does not directly incur any costs, the public agency must still interact with or monitor the privately sponsored program to ensure that the motoring public receives the maximum benefits.

Maintenance

Associated maintenance costs for an aircraft patrol program will vary depending on who has assumed operation of the program. If the public agency has opted to either purchase or lease the aircraft, it will be incur relatively high maintenance costs. However, if the aircraft patrol program is established by the private sector sponsor, the public agency will incur no direct maintenance costs.

Operating

Operating costs incurred by the public agency will vary depending on whether the aircraft patrol program is implemented by a public agency or a private sector sponsor. Operating costs will be high if the public agency has established the program. Operating costs will also be high if the program is established by a private sponsor, but the private sponsor must absorb these costs. No operating costs will be incurred by the public agency.

Special Equipment Required

The equipment required for efficient operation of the aircraft patrol program consists mainly of communications equipment. The aircraft operator must be able to report incidents that have been detected from the air directly to the transportation or police agency dispatch personnel, as well as disseminate this information to the motoring public in a direct and efficient manner.

Special Training Required

A brief training session is required to educate the aircraft personnel about the types of situations to report and the best methods for relaying this information to the general public. For example, aircraft personnel become very familiar with the transportation network and may assume, in their reporting, that the motoring public is just as familiar with various routes.

Therefore, for the aircraft patrols to offer beneficial rerouting advice in case of intense congestion or lane blockage, appropriate locational information must accompany the traffic reports (e.g., approximate exits). The standard information describing incident type, location, and direction must also be provided to the dispatcher, as well as to the motoring public.

Operation

Operation

An aircraft patrol program may be operated successfully by either a public or private agency.

Operating Agency

Operational responsibility should lie solely with either a transportation or police agency or a private agency. However, in practice, intense coordination must exist, especially in the area of communication, among all responding agencies.

Funding Responsibility

The funding responsibility for this program lies with the operating agency, namely the transportation, police, or private agency involved.

Options for Reducing Detection and Verification Time

ELECTRONIC LOOP DETECTION

GENERAL DESCRIPTION

Incidents can be detected through electronic loops imbedded in the roadway. Traffic flow information can then be sent, via a communications link, from the loop amplifiers to a central observation station. There, a computer equipped with incident detection software and a calibrated incident detection algorithm can indicate any incident occurrence

Conditions Under Which Appropriate

Appropriate in isolated, high incident locations or limited access areas.

Advantages

- ✓ Provides 24-hour a day surveillance.
- ✓ Can collect traffic data for other uses.
- ✓ Loop information can be represented on a network map.

Disadvantages

- ✗ Incident detection algorithms often produce false calls.
- ✗ Loops are frequently damaged during resurfacing or standard roadway maintenance.

Costs	Capital	Very High
	Maintenance	High
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The special equipment required to implement an electronic loop detection system includes electronic loops imbedded in the roadway, a communications link (usually by means of modem) from the loop amplifiers to a central observation station, a computer equipped with incident detection software, and a calibrated incident detection algorithm.

Special Training Required

Training in the operation and maintenance of the new equipment may be required.

GENERAL DESCRIPTION

A video and closed circuit television system allows visual surveillance of any section of the freeway, provides a quick assessment of incident severity, and allows for appropriate equipment to be sent before response units actually arrive at the scene. Care must be taken to ensure that that cameras are spaced sufficiently close to provide adequate coverage and are not inhibited by vertical curves or obstructions.

Conditions Under Which Appropriate

Appropriate in high incident locations or areas with limited access.

Advantages

- ✓ Incidents can be visually verified.
- ✓ Allows initial assessment of incident severity.
- ✓ Provides a visual record of freeway operations that may be carefully examined at a later time.
- ✓ Volume, speed, and vehicle classification data can be gathered simultaneously.

Disadvantages

- ✗ Cable and equipment are not very reliable.
- ✗ Provides opportunity for vandalism.
- ✗ May be obstructed by vertical curves.
- ✗ Video monitoring is a tedious task, some incidents may go unnoticed.

Costs	Capital	Very High
	Maintenance	Medium High
	Operating	Medium High
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The special equipment required to implement a video and closed circuit television system includes cameras that can be mounted conveniently on existing structures such as overpasses or luminare poles. These cameras must be capable of vertical and rotational movement. Camera movement should be operated through the monitoring center, where screens are set up to observe traffic movements.

Special Training Required

Some training may be required, as with any new equipment, concerning the operation and maintenance of the video cameras and television system.

GENERAL DESCRIPTION

Automatic vehicle identification (AVI) technologies rely on the tracking of a specific vehicle to determine whether an incident has occurred. Automatic vehicle identification requires vehicles to be equipped with an electronic tag unique to each vehicle. Electronic tag readers mounted at set distances along the roadside recognize a particular vehicle's tag when it passes one reader and when it passes a second reader downstream. Traffic information can be sent via a communications link to a central observation station. There, a computer equipped with incident detection software and a calibrated incident detection algorithm can indicate any incident occurrence. Unusually long travel times between readers may indicate that an incident has occurred.

Conditions Under Which Appropriate

Appropriate in isolated, high incident locations or limited access areas.

Advantages

✓ Provides 24-hour a day surveillance.

✓ Can collect traffic data for other uses.

✓ Information can be represented on a network map.

Disadvantages

✗ Vehicle drivers may be resistant to instrumenting their vehicles with electronic tags.

✗ Incident detection algorithms often produce false calls.

✗ Readers and tags may suffer from low reliability and vandalism or may be damaged during resurfacing or standard roadway maintenance.

Costs	Capital	Very High
	Maintenance	High
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required	The special equipment required to implement an automatic vehicle identification system includes electronic tags, tag readers along the roadway, a communications link (usually by means of modem) from the tag readers to a central observation station, a computer equipped with incident detection software, and a calibrated incident detection algorithm.
Special Training Required	Training in the operation and maintenance of the new equipment may be required.

CELLULAR TELEPHONE MONITORING

GENERAL DESCRIPTION

Cellular telephone monitoring technologies rely on the tracking of a specific vehicle to determine whether an incident has occurred. When the cellular phone is turned on but not necessarily in use, triangulation methods using the vehicle's telephone signal and at least two other cellular site signals can locate a particular vehicle This process can be repeated farther downstream. Computer software can be used to easily calculate the vehicle's location and time. Unusually long travel times between the two locations may indicate that an incident has occurred.

Conditions Under Which Appropriate

Appropriate under all circumstances, but requires adequate cellular coverage.

Advantages

- ✓ Provides 24-hour a day surveillance.
- ✓ Can collect traffic data for other uses.
- ✓ Information can be represented on a network map.

Disadvantages

- ✗ Cellular telephone monitoring is still emerging as a technology and may suffer from unreliability, false calls, and a lack of support when system problems arise.

Costs

Capital	Medium
Maintenance	High
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The special equipment required to implement a cellular telephone monitoring system includes a communications link (usually by means of modem) from the cellular sites to a central observation station, a computer equipped with triangulation software, and a calibrated incident detection algorithm.

Special Training Required

Training in the operation and maintenance of the monitoring equipment may be required.

GENERAL DESCRIPTION

Video imaging technologies rely on the tracking of a specific vehicle to determine whether an incident has occurred. Cameras mounted at set distances along the roadside recognize a particular vehicle's location when it passes one camera and when it passes a second camera downstream. Traffic information can be sent via a communications or video link to a central observation station. There, a computer equipped with incident detection software and a calibrated incident detection algorithm can indicate any incident occurrence. Unusually long travel times between cameras may indicate that an incident has occurred.

Conditions Under Which Appropriate

Appropriate in isolated, high incident locations or limited access areas.

Advantages

- ✓ Provides 24-hour a day surveillance.
- ✓ Can collect traffic data for other uses.
- ✓ Information can be represented on a network map.

Disadvantages

- ✘ Incident detection algorithms often produce false calls.
- ✘ Roadside cameras may suffer from low reliability and vandalism.

Costs

Capital	Very High
Maintenance	High
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The special equipment required to implement a video imaging system includes numerous roadside cameras mounted along the roadway, a communications link (usually by means of modem) to a central observation station, a computer equipped with incident detection software, and a calibrated incident detection algorithm.

Special Training Required

Training in the operation and maintenance of the new equipment may be required.

GENERAL DESCRIPTION

A Central Information Processing and Control Site is a control center which collects and analyzes traffic performance, incident, and incident response information from multiple agencies and jurisdictions. It serves as an information resource for agencies responding to incidents by monitoring the status of incidents and related traffic performance.

The intent of the center is to provide a single location which is responsible for the monitoring the need for response actions, and then track the progress of those actions, and their impact on traffic performance. This function takes place over a large urban area and usually encompasses several jurisdictions and operating authorities.

When such a center is developed by private industry, the primary intent is to provide traffic performance information directly to motorists or to news agencies which then provide that information to motorists. When operated by a public agency, the center is usually meant to improve the operational performance of a series of facilities, by providing a more coordinated system of traffic monitoring and response.

An integrated central data processing center provides agencies with an effective method for increasing the control and coordination of their incident response efforts. However, resources are required to provide this level of improved control and coordination, and these resources must be obtained either by selling the information collected, or by increasing the total budget allowed for incident response.

Conditions Under Which Appropriate

A central control center will provide a better level of response for less overall cost in larger urban areas where multiple agencies or jurisdictions collect traffic performance information and/or respond to incidents. Central information processing centers are usually more expensive than the the uncoordinated alternatives, but provide a better overall level of service.

Advantages

- ✓ Provides a single source of information on conditions on facilities, the need for incident response, and the status of response activities, as well as for news media inquiries. This single source produces more reliable and comprehensive information.
- ✓ Provides a better level of incident response through better coordination of response actions and monitoring.
- ✓ Can reduce unnecessary response actions, by eliminating duplication of response actions by different agencies.

Disadvantages

- ✗ Requires agencies to develop systems that automatically share information.
- ✗ Designing and developing such a center carries a high initial cost.
- ✗ Operating a central information processing center requires continuous funding from those agencies or companies which participate in the center, as well as the continued cooperation of those agencies which provide input data to the central system.
- ✗ Funds for development and operation of a multi-jurisdictional center are usually "out-of-pocket" expenditures for participating agencies. As a result, these funds are often hard to secure on an continuing basis.

Costs	Capital	High
	Maintenance	None
	Operating	Variable - See Below
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement a central information processing and control site are high due to the need for large computer and communications resources to collect, store, manipulate and transmit traffic performance and incident information.

Operating

Operating costs vary with the size of the control center, the number of hours per day it operates, and the number of staff required to operate the center. A multi-jurisdictional center usually must obtain funds from multiple sources, which can be politically difficult, while private centers require a large market for the information developed in order to create the revenue necessary to run the system.

Special Equipment Required

At a minimum, the center will need computer resources to accept and process traffic performance and incident information. Communications facilities are also needed to transmit incident and traffic performance data t the end users of that data, whether it be operating agencies, news organizations or motorists. The design of these communications links will vary from simple telephone lines to radio and cellular communications capabilities, depending on the role to be played by the central location.

Special Training Required

Training in operational procedures is required to educate the center staff on how to identify, track incidents and on how to coordinate the appropriate responses to those incidents. This training must be tailored to the specific operating environment developed for each control center and its participating agencies.

Legislative Requirements

Legislative action may be needed to empower the control center agencies to share data. If the control center directs incident responses, it may also need authorizing legislation allowing control center personnel to request the action of agency personnel outside of their direct line of supervision.

Operation

Public or Private

The control center can be operated either as a public or private entity. If the control center operates solely as a clearing house for information on incidents and traffic performance, it can be privately run, although a public agency can also undertake this mission. If the center's personnel actually direct the actions of public agency field personnel, the center must probably be publicly operated.

Operating Agency

A central system requires a cooperative effort between transportation, police, fire and rescue, and other responding agencies.

Funding Responsibility

Ideally, the funding for this program is provided by all participating agencies or private groups. The size of each agency's (or company's) participation should depend on their level of benefit from the system and their ability to pay. A shared funding arrangement requires written agreements between agencies and the creation of these agreements may delay implementation of a program if such an agreement is not easily reached, or if some agencies are not convinced of the merits of the system. A second option is for the agency which will benefit the most from the center to assume responsibility for funding and establish contracts with the other agencies that delineate guidelines for obtaining data and for sharing equipment and personnel.

Options for Reducing Detection and Verification Time

Options for Reducing Response Time

Once an incident has been detected, the next step in the management process is to identify the needed response and speed the arrival of that response to the incident site. Identifying the proper response and getting that response to the site are the two key elements to improving the speed of the response action.

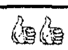
These responses may entail (among other items) requesting assistance or services from other agencies or contractors, requesting special equipment and/or personnel, and the deployment of specific traffic control plans. An incident response system is not limited to a single action or program. Instead, it is a combination of actions that allow the responding agency to tailor its response to the given conditions within that agency's resource limitations.

A variety of incident management techniques that serve to improve response times to the incident site are listed in Table 2.7. Also depicted are the potential costs and benefits that can be associated with each of the options. Table 2.8 shows alternative ways for agencies to be involved in each management technique.

Table 2.7 Options for Reducing Response Time

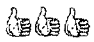
Type of Program	Potential Benefits	Potential Costs	Comments
Personnel Resource List	👍👍👍	💰	Can save time in locating specially trained personnel if list is comprehensive (involving all responding agencies) and frequently updated.
Equipment and Materials Resource List	👍👍👍	💰	Can save time in locating special equipment or personnel if list is comprehensive (involving all responding agencies) and frequently updated.
Incident Response Database	👍👍	💰💰	Provides consistent and comprehensive incident information for improved resource allocation and cost recovery.
Peak Period Motor Cycle Patrols	👍👍👍👍	💰💰⇨💰💰💰	Motorcycle patrols can provide a direct communications link to request additional response assistance.
Dedicated Freeway/Service Patrols	👍👍⇨👍👍👍👍	💰💰⇨💰💰💰💰	Roving patrols can reduce the response times required by response vehicles departing from a location removed from the freeway.
Personnel Training Program	👍👍👍	💰💰	An emphasis on personnel training through knowledge and repetition of tasks can reduce required response times.
Tow Truck/Removal Crane Contracts	👍👍	💰	Provides faster access to equipment, but may create dissention with other capable private agencies.
Improved Interagency Radio Communication	👍👍👍	💰⇨💰💰	Adequate communication between the various responding agencies, can help to insure that the closest response vehicle is called to the incident scene.
Ordinances Governing Travel on Shoulder	👍	💰	Can provide additional travel lane for response vehicles during emergencies but may be severely limited by space constraints.
Emergency Vehicle Access	👍👍	💰💰	Requires identification of those freeway links which suffer from poor access.
Advanced Vehicle Control	👍👍👍👍	💰💰💰💰	Can prevent incidents, as well as improve response and clearance.
Alternative Route Planning	👍👍	💰	If properly planned, can allow quicker access to incident site by response vehicles.
Equipment Storage Sites	👍👍	💰⇨💰💰	Provides faster access to equipment or materials.
Administrative Traffic Management Teams	👍	💰	Provides a forum to discuss and provide funding for area incident management programs aimed at improving response times.
Public Education Program	👍👍👍	💰	Can educate drivers regarding disabled vehicle removal policies and can resolve many incidents without the need for an actual response.
Automatic Vehicle Location	👍👍👍	💰💰💰	Can improve dispatching and response times if system is detailed and accurate.
Geographic Information Systems	👍👍👍	💰💰💰	Can improve both safety at the scene, by identifying infrastructure resources and utilities, and response to the scene if used with AVL.

Table 2.7 Continued

Type of Program	Potential Benefits	Potential Costs	Comments
Central Information Processing and Control Site			Provides a single location for monitoring incidents, so that data from multiple sources can be used to more quickly determine the appropriate response action.
Closely Spaced Milepost Markers			Always fast, accurate, easy location of incidents, which improves the speed with which response actions can be brought to bear.

 = Minor benefits

 = Moderate benefits

 = Substantial benefits

 = Very substantial benefits

 = Indicates a range of benefit/cost levels

 = Minor costs

 = Moderate costs

 = Substantial costs

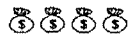
 = Very substantial costs

Table 2.8 Agency Involvement in Reducing Response Time

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Personnel Resource List	A	△	△	△	△	△	△	△	
Equipment and Materials Resource List	A	△	△	△	△	△	△	△	
Incident Response Database	A	▲							
	B		▲						
	C			▲					
Peak Period Motorcycle Patrols	A		▲						
Dedicated Freeway/Service Patrols	A	▲							
	B		▲						
	C						▲		
Personnel Training Program									
Tow Truck/Removal Crane Contracts	A	△						△	
Improved Interagency Radio Communication	A	△	△	△	△	△	△	△	
Ordinances Governing Travel on Shoulder	A	▲							
Emergency Vehicle Access	A	△	△	△			△		
Advanced Vehicle Control	A	△					△		
Alternative Route Planning	A	△	△	△	△		△		
Equipment Storage Sites	A	△	△	△			△		
Administrative Traffic Management Teams	A	△	△	△	△				
Public Education Program	A	▲							
	B		▲						
	C	△	△	△	△	△	△	△	
Automatic Vehicle Location	A	▲							
	B		▲						
	C			▲					
	D	△	△	△			△		

Table 2.8 Continued

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Geographic	A	▲							
Information Systems	B		▲						
	C			▲					
	D	△	△	△			△		
Central Information	A	▲							
Processing and	B	△	△			△	△	△	
Control Site	C						▲		
Closely Spaced Milepost Markers	A		▲						

▲ Indicates sole involvement   △ Indicates shared involvement

<u>Example of Shared Involvement</u>
Administrative Traffic Management Teams require a cooperative effort among transportation, police, fire and rescue, and public works agencies to ensure a complete examination of possible traffic management strategies and a variety of funding alternatives.

Options for Reducing Response Time

PERSONNEL RESOURCE LIST

GENERAL DESCRIPTION

A comprehensive list of available personnel can be compiled for each area or region. Personnel from each of the responding agencies, including transportation, police, fire and rescue, private and media agencies, should be listed. This list should specify who responds in each geographic or jurisdictional area. Radio channels or cellular phone numbers need to be available, as well as off-hour phone numbers. Once it has been completed, this list should be distributed to all appropriate responding agency personnel, as well as to dispatch personnel, and must be updated frequently to ensure accuracy.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

- ✓ Saves time in locating specially trained personnel.
- ✓ Makes cooperating agencies aware of each others' capabilities and limitations.

Disadvantages

- ✗ Difficult to keep updated.
- ✗ Initial coordination among the responding agencies may be difficult.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

Options for Reducing Response Time

EQUIPMENT AND MATERIALS RESOURCE LIST

GENERAL DESCRIPTION

A comprehensive list of available equipment or materials can be compiled for each area or region. This list should identify the locations and possible operators of large tow trucks, special incident handling equipment, and equipment suitable for handling hazardous materials incidents, as well as other standard and specialty equipment types. To be comprehensive, the list should include all the appropriate equipment each of the responding agencies possesses and should also include listings of local chemical companies for incidents involving hazardous materials and local trucking companies for incidents involving debris or spills. Radio channels and/or cellular telephone numbers must be available, as well as off-hour phone numbers for operators of the specialty equipment. Once it has been completed, this list should be distributed to all appropriate responding agency personnel, as well as dispatch personnel, and must be updated frequently to ensure accuracy.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

- ✓ Saves time in locating larger or specialty response vehicles or materials.
- ✓ Makes cooperating agencies aware of each others' capabilities and limitations.

Disadvantages

- ✗ Difficult to keep updated.
- ✗ Initial coordination among the responding agencies may be difficult.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

Options for Reducing Response Time

GENERAL DESCRIPTION

Advanced vehicle control (AVC) systems help prevent incidents rather than improve their management. Advanced vehicle control systems can prevent incidents both in both the longitudinal and lateral directions. Longitudinal direction incidents include head-on and rear-end collisions. Lateral direction incidents include side-swipe or other incidents caused when a vehicle has left its lane. In addition, advanced vehicle control systems allow motorists to be automatically rerouted to avoid congestion.

The advanced vehicle control systems technology is still being developed and is not widely deployed. The implementation of this technology will likely be in stages, the final stage of which will be the fully automated vehicle on a fully instrumented highway.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where incident impacts are major.

Advantages

- ✓ Avoids the incident rather than mitigates the consequences of the incident.
- ✓ Allows for the automatic diversion of motorists around incident sites.
- ✓ May reduce the stress of driving for motorists.
- ✓ Prevents incidents resulting from human error.

Disadvantages

- ✗ Greatest benefits result only when system is fully automated.
- ✗ Fully automated system may experience lengthy implementation times.
- ✗ System is costly.

Costs	Capital	Variable - See Below
	Maintenance	High
	Operating	High
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with an advanced vehicle control system are high. However, some of the cost burden may be assumed by the private sector through public/private partnerships.

Special Equipment Required

The type of equipment required depends upon the level of automation offered through the advanced vehicle control system. Each of the vehicles must be appropriately equipped to allow either for the motorist to be warned of a potential incident or for the vehicle to automatically take control to avoid the incident. In addition, the roadway must be instrumented to allow real-time information to be sent to the vehicle.

Special Training Required

The required training depends on the level of automation offered through the advanced vehicle control system. Public education must take place for the new technology to be accepted and properly used. In addition, the controlling agency must train personnel to operate and maintain the new equipment as part of the system.

Liability

A chance for liability exists if an incident occurs after the implementation of the advanced vehicle control system. However, this chance for liability can be greatly reduced if the limitations of the system are carefully defined.

Operation

Public or Private

An advanced vehicle control system should be a cooperative effort with both public and private agency involvement. The instrumented roadway should be operated by a public agency because of its direct impact on the public agency's facilities and the risk of liability placed upon that agency. The development and implementation of the instrumented vehicle should be the responsibility of the private sector, either automative manufacturers or after-market suppliers.

Operating Agency

An advanced vehicle control system should be cooperatively operated by a transportation agency (Operations division) and private agencies, automative manufacturers, or after-market suppliers. Coordination must occur with other response agencies.

Funding Responsibility

The funding responsibility lies with both operating agencies, namely the transportation and private agencies.

GENERAL DESCRIPTION

The establishment of peak period motorcycle patrols may result in numerous incident management improvements for a potentially minimal cost. To obtain the most benefit, the motorcycle patrols should operate in congested areas during the peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures.

With the implementation of this program, incident response times should improve because motorcycles are more maneuverable in congested areas than larger response vehicles, allowing trained personnel to reach and assess the incident site more quickly. The appropriate equipment can thus reach the site in less time, reducing the overall impact of the incident.

Also, with well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection time should be reduced.

A third benefit that should result from the establishment of peak period motorcycle patrols is that because motorcycles are small and maneuverable, they can more easily access the incident site than larger response vehicles. This quick access allows traffic control procedures to begin early in the incident management process, decreasing the incident's impact on the motoring public.

This option may be implemented in place of a dedicated freeway/service patrol program or increased regular police patrol units, depending on the incident management needs and available funding.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where larger incident response vehicles are limited in their approach of the incident site.

Advantages

- ✓ In addition to reducing detection times, motorcycle patrols also improve response times and site management efforts.
- ✓ Increase police mobility during peak hours, allowing more rigid enforcement of traffic laws (i.e., speed limits).
- ✓ Can reach and assess the incident quickly and can call for other emergency vehicles to respond if necessary.

Disadvantages

- ✘ Motorcycles lack incident clearing capabilities.
- ✘ Motorcycles do not offer protection for the officer in case of secondary accidents or inclement weather.

Costs	Capital	Variable - See Below
	Maintenance	Variable - See Below
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Police Agencies
Funding Responsibility		Police Agencies

DETAILED DESCRIPTION

Costs

Capital

Capital costs may range from low to medium, depending on whether new response patrol vehicles are purchased or existing or reconditioned vehicles are used. If existing or reconditioned vehicles are used, capital costs will remain low. However, capital costs may be higher if new response vehicles are required, and it may be wise to consider other options that can provide better incident clearance and respondent protection for an equal expenditure. Such alternatives may include a small scale dedicated freeway/service patrol program or an investment in special equipment such as push bumpers for existing patrol vehicles.

Maintenance

Maintenance costs may also range from low to medium, depending on the condition of the response vehicles. If capital expenses are relatively high because of the purchase of new motorcycle patrol vehicles, maintenance costs should remain relatively low. The inverse is also true: if reconditioned vehicles are chosen over new vehicles, maintenance costs may run higher.

Special Equipment Required

New response patrol vehicles, equipped with the required electrical and communication systems, may be purchased if an inadequate number of vehicles exist. However, it might be wise to explore other alternatives.

Special Training Required

The required training depends on the background and experience of the responding personnel. However, a well trained motorcycle patrol respondent should be knowledgeable in the following areas:

- Emergency medical training including CPR and first aid
- Radio communication with an emphasis on reporting
- Traffic control
- Public relations
- Surveillance of suspicious activities
- A general knowledge of departmental procedures and policies of each of the responding agencies (transportation, police, fire and rescue).

Obviously, some of these areas will overlap with the existing police agency training requirements, so a unique training program may be needed for motorcycle patrol personnel.

Options for Reducing Response Time

GENERAL DESCRIPTION

The establishment of a dedicated freeway/service patrol program may resul in numerous improvements to the incident management effort for a potentially minimal cost. To achieve the greatest benefit, the freeway/service patrols should operate in congested areas during the peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures.

As a consequence of a dedicated freeway/service patrol, incident response times should also improve because the patrol vehicles are usually physically closer to the incident site than vehicles that depart from a location far from the corridor under surveillance.

With well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection time should decrease.

A third benefit that may result from the establishment of a dedicated freeway/service patrol is that many minor incidents or disablements can be cleared with the responding patrol vehicle, eliminating the delay caused when a tow truck is needed. The legal implications of this service, as well as the variety of cost levels at which this program can be implemented, are discussed in the Detailed Description.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where efficiency in incident detection is critical.

Advantages

✓ In addition to improving detection times, dedicated freeway/service patrols improve response and clearance times.

✓ Trained personnel can quickly assess incident severity.

✓ Patrol vehicles can often quickly remove minor incidents.

Disadvantages

✗ May conflict with other operating agency budgetary priorities.

✗ Additional personnel may be required.

✗ Quickly becomes ineffective if implemented improperly.

Costs	Capital	Variable - See Below
	Maintenance	Low
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with a dedicated freeway/service patrol vary greatly, depending on the size of the initial program, the aim of the program, and the source of the equipment or supplies. In any case, it is wise to initiate a small scale patrol program that requires minimal capital investment, then expand as the program proves successful. Or, if the program has not proved successful, it may be altered or abandoned for a new program that better meets the incident management needs.

Along with the size of the program, the aim of the program can greatly affect initial capital requirements. For instance, to mitigate the impacts of major incidents that involve numerous vehicles and/or trucks, larger, heavy-duty response vehicles such as wreckers or tow rigs are required. These vehicles have high initial capital funding requirements. However, if the aim of the program is to mitigate minor accidents or vehicle disablements, smaller response vehicles such as pickup trucks or vans can be chosen , greatly reducing the initial capital required.

A third factor that affects the required capital funding is the source of the equipment or supplies. Various methods exist for the initial purchase of the appropriate equipment. One option is for the public operating agency to acquire the new vehicles, but this option requires a large amount of initial funding. A second option is to utilize backup or refurbished vehicles as incident patrol vehicles. This choice greatly reduces the capital funding required. A third option is to obtain privately sponsored vehicles. Many private agencies are willing to assume the cost of purchasing, operating, and maintaining a small number of freeway/service patrol vehicles in return for beneficial public relations and additional advertising. Even though a specified public agency (i.e., a transportation or police agency) must frequently monitor or inspect the patrol program, it does not directly incur any capital costs, making this the lowest cost option.

Special Equipment Required

The type of equipment required depends upon the specific incident management needs, as well as the amount of funding available for the development of the program. Relatively low cost options include using light/medium duty pickup trucks, vans, or patrol cars to mitigate the impacts of minor vehicle accidents or disablements. These vehicles may be purchased new by the public operating agency, refurbished, or sponsored by the private sector in return for advertising and public relations benefits. Each of the vehicles must be appropriately equipped with gasoline, water, tools for minor repair, jumper cables, flares, first aid kits, warning lights, and possibly push bumpers. Auto parts are not recommended, since the goal is to offer the service to the public with negligible associated costs.

For major incidents, larger or specially designed vehicles may be chosen. Tow trucks/rigs, cranes, or wreckers may be used to patrol localized areas that suffer from high incident rates or limited access. In this instance, though response may be relatively infrequent, the decrease in the usually lengthy delays may warrant implementation.

In each of these cases, it is better to begin on a small scale with the purchase of only a few vehicles, prove the program's success, and then increase the response fleet to improve efficiency.

Special Training Required

The required training depends on the background and experience of the responding personnel. However, a well trained freeway/service patrol respondent should be knowledgeable in the following areas:

- Emergency medical training including CPR and first aid
- Radio communication with an emphasis on reporting
- Traffic control
- Public relations
- Surveillance of suspicious activities
- A general knowledge of departmental procedures and policies of each of the responding agencies (transportation, police, and fire and rescue).

Obviously, some of these areas will overlap with the existing public agency training requirements, so a unique training program may be needed for freeway/service patrol personnel.

Liability

A minimal chance for liability exists from damage that the disabled or blocking vehicle may possibly incur. However, this chance for liability can be greatly reduced if an emphasis is placed on training the respondent personnel.

Operation

Public or Private

A dedicated freeway/ service patrol program can be operated by either a public or private agency.

Operating Agency

A dedicated freeway/service patrol program can be operated by a transportation agency (operations or maintenance divisions), police agency, or private agency. If a private agency wishes to undertake the operation, some coordination must occur with either the transportation or

police agency to ensure that the vehicles are operated safely and are properly equipped and that patrol respondents are properly trained.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the transportation, police, or private agency involved. However, if operation is undertaken by the transportation agency, freeway/service patrols are eligible for Federal Aid Primary, Urban, and Interstate 4R Funds. These funds are available for the establishment of the service but not the day-to-day operational costs.

GENERAL DESCRIPTION

An agency should support personnel training programs that not only focus on its own required policies and procedures, but also on the policies and procedures of other responding agencies. Since a safe and efficient inciden response process is dependent on all responding personnel, these personnel must be aware of each agency's needs and requirements. Such cooperative training programs can serve to greatly improve interagency relationships.

Conditions Under Which Appropriate

Appropriate under all conditions, but requires an initial willingness to participate from all responding agencies.

Advantages

- ✓ Improves incident response, site management and incident clearance efforts.
- ✓ Improves interagency relationships.

Disadvantages

- ✗ Requires an initial willingness from all responding agencies to be successful.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Training should focus not only on the policies and procedures of the personnel's own agency, but also on the policies and procedures of each of the responding agencies. Once all of the responding personnel have become aware of other agencies' requirements, the overall response process will operate much more efficiently.

Operation

Operating Agency

For personnel training programs to be successful, a cooperative effort on the part of all responding agencies is required. A single agency, most likely the transportation agency involved, should coordinate the involvement of the various agencies.

Funding Responsibility

Ideally, the funding responsibility should be a cooperative effort because all agencies will benefit from this program. However, costs are so minimal that they can easily be absorbed by the operating or coordinating agency.

TOW TRUCK/REMOVAL CRANE CONTRACTS

GENERAL DESCRIPTION

Contracts may be established with private agencies to allow immediate use of necessary equipment without prior collection of a permit. The contract will serve to improve interagency cooperation, as well as save time and money during the response process because it will eliminate questions about who to call. Obtaining equipment does not have to be limited to standard means - other options are possible, such as nearby construction site equipment.

Conditions Under Which Appropriate

This option will be most beneficial in areas where tow truck/removal crane response times are normally lengthy because of the apathy of private agency personnel.

Advantages

✓ Eliminates questions about who to call when specific equipment is required.

Disadvantages

✗ Private agencies not chosen for the contract agreements may object to the loss of business.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Liability

Liability should be considered because other capable private agencies may object to being excluded from the contract agreements.

Operation

Operating Agency

Operation responsibilities should lie with either a transportation agency or police agency, which should coordinate with the eligible private agencies.

Funding Responsibility

The required funding for this option should be minimal and could be easily absorbed by the transportation or police agency responsible for operation.

IMPROVED INTERAGENCY RADIO COMMUNICATION

GENERAL DESCRIPTION

Improvements can be made to radio communication among the responding agencies. These improvements may require the purchase of compatible, two-way radio systems. They may also include the installation of cellular phone systems. However, to be successful, each respondent vehicle must be able to communicate with any other respondent vehicle, and all must be able to understand and use a common radio language or lingo. Once this capability had been acquired, enormous time savings would result because repetitious commands and indirect communications would be eliminated.

Conditions Under Which Appropriate

This option is appropriate when good relations exist among the responding agencies so that a common, cooperative effort can be achieved. If this situation does not exist, the common radios will never be utilized.

Advantages

- ✓ Decreases repetitious communications efforts.
- ✓ Improves site management efforts.
- ✓ Respondent personnel can be better informed through direct communications.

Disadvantages

- ✗ Can be difficult to convince all responding agencies to implement and invest in a new communications system.
- ✗ Good relationships rarely exist among all responding agencies.

Costs

Capital	Variable - See Below
Maintenance	Low
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement this program would vary, depending on the level of interagency communication present and the extent to which the program was implemented. For instance, common radios might initially be placed only in supervisory vehicles and might be installed later in all responding vehicles.

Special Equipment Required

The only required equipment to implement this program would be the common radio systems.

Special Training Required

The training required to make interagency radio communication successful would cover only the operation of the new radio system. However, to use this communications system to its full potential, some training would have to encourage interagency coordination and cooperation in the field.

Funding Responsibility

Ideally, the responsibility for securing funding for the common communication system should lie with each of the individual responding agencies. However, if the agencies were not willing to take part in the program because of the added expense, the transportation agency in charge of operation might choose to absorb the costs.

ORDINANCES GOVERNING TRAVEL ON SHOULDERS

GENERAL DESCRIPTION

Newly constructed or redesigned roads could be subjected to a minimum shoulder width ordinance so that, in the case of a lane blocking incident, adequate space was available to reroute traffic along the shoulder. The space would also allow a truck to tow or push the incident vehicle along the shoulder or simply push it over to the shoulder and leave it for a short duration. Any of these options would reduce the queues that form behind a lane blocking incident. Areas such as bridges, tunnels, and overpasses would be exempt from the ordinance.

Conditions Under Which Appropriate

Appropriate in less populated areas where everyday traffic volumes do not require the use of all available space.

Advantages

✓ Allows secondary choice of access or clearance for response vehicles.

Disadvantages

✗ Difficult to accomplish in the densely populated or travelled areas where it would be most useful.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	Variable - See Below

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Legislative Requirements

An ordinance would be required to set a minimum shoulder width limitation for newly constructed or redesigned roads. AASHTO or other organizations should be looked to for standards governing shoulder design and the process required for the approval of design exceptions.

Options for Reducing Response Time

GENERAL DESCRIPTION

Movable barriers and U-turns at key locations can reduce response times for emergency vehicles. This option requires an initial identification of freeway links that do not have adequate access. All responding agencies must then be informed of the existence and usage of these access routes.

Conditions Under Which Appropriate

Appropriate in areas with limited access such as bridges, overpasses, or tunnels.

Advantages

- ✓ Emergency vehicles can approach the incident from both directions.
- ✓ Both response and clearance efforts benefit with the implementation of emergency vehicle access areas.

Disadvantages

- ✗ Unauthorized motorists are tempted to use the U-turns.
- ✗ The purchase and installation of barriers are expensive.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required	If movable barriers are selected, a mechanical means for quickly and safely relocating the barriers is necessary. Whatever option is chosen, signing is required to identify the locations of the emergency vehicle access areas.
Special Training Required	If movable barriers are selected, training is required in the operation of any new equipment that may be purchased to relocate the barriers. In this case, knowledge of the safest method of placement, as well as the placement itself, is important.
Liability	If movable barriers are used to alter traffic flow, liability may ensue if proper notification or signing of the traffic channelization is not provided and secondary accidents occur.

GENERAL DESCRIPTION

Advanced vehicle control (AVC) systems help prevent incidents rather than improve their management. Advanced vehicle control systems can prevent incidents both in both the longitudinal and lateral directions. Longitudinal direction incidents include head-on and rear-end collisions. Lateral direction incidents include side-swipe or other incidents caused when a vehicle has left its lane. In addition, advanced vehicle control systems allow motorists to be automatically rerouted to avoid congestion.

The advanced vehicle control systems technology is still being developed and is not widely deployed. The implementation of this technology will likely be in stages, the final stage of which will be the fully automated vehicle on a fully instrumented highway.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where incident impacts are major.

Advantages

- ✓ Avoids the incident rather than mitigates the consequences of the incident.
- ✓ Allows for the automatic diversion of motorists around incident sites.
- ✓ May reduce the stress of driving for motorists.
- ✓ Prevents incidents resulting from human error.

Disadvantages

- ✗ Greatest benefits result only when system is fully automated.
- ✗ Fully automated system may experience lengthy implementation times.
- ✗ System is costly.

Costs

Capital	Variable - See Below
Maintenance	High
Operating	High
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	Variable - See Below
Legislative Requirements	None

Operation

Public or Private	Variable - See Below
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with an advanced vehicle control system are high. However, some of the cost burden may be assumed by the private sector through public/private partnerships.

Special Equipment Required

The type of equipment required depends upon the level of automation offered through the advanced vehicle control system. Each of the vehicles must be appropriately equipped to allow either for the motorist to be warned of a potential incident or for the vehicle to automatically take control to avoid the incident. In addition, the roadway must be instrumented to allow real-time information to be sent to the vehicle.

Special Training Required

The required training depends on the level of automation offered through the advanced vehicle control system. Public education must take place for the new technology to be accepted and properly used. In addition, the controlling agency must train personnel to operate and maintain the new equipment as part of the system.

Liability

A chance for liability exists if an incident occurs after the implementation of the advanced vehicle control system. However, this chance for liability can be greatly reduced if the limitations of the system are carefully defined.

Operation

Public or Private

An advanced vehicle control system should be a cooperative effort with both public and private agency involvement. The instrumented roadway should be operated by a public agency because of its direct impact on the public agency's facilities and the risk of liability placed upon that agency. The development and implementation of the instrumented vehicle should be the responsibility of the private sector, either automative manufacturers or after-market suppliers.

Operating Agency

An advanced vehicle control system should be cooperatively operated by a transportation agency (Operations division) and private agencies, automative manufacturers, or after-market suppliers. Coordination must occur with other response agencies.

Funding Responsibility

The funding responsibility lies with both operating agencies, namely the transportation and private agencies.

GENERAL DESCRIPTION

In the case of a lane blocking incident, motorists can be directed to use preplanned alternative routes to help mitigate the impacts of the incident. Their use requires prior analysis of the freeway corridor. All responding agencies must then be made aware of these routes. Such routes require adequate temporary or permanent signing at key locations.

Conditions Under Which Appropriate

Appropriate in all circumstances as long as care is taken to avoid alternative routes that inhibit the flow of normal traffic because of low overpasses or severe turns.

Advantages

- ✓ Route diversion can occur quickly.
- ✓ May be part of a civil defense or disaster response program.
- ✓ Provides coordinated alternative route planning for participating agencies.

Disadvantages

- ✘ Requires sizable investment of staff time.
- ✘ Some communities do not wish to have traffic diverted onto their streets, regardless of the circumstances.

Costs

Capital	Variable - See Below
Maintenance	Low
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Capital

Capital costs may vary, depending on the size of the urban area involved and the extent of the alternative route study. Also, the extent to which signing is provided, both before and along the alternative routes, can affect capital costs. In some cases, unexpected capital costs may be incurred because of the minor revisions in the roadways required to make them suitable.

Special Equipment Required

Signing equipment, either temporary or permanent, is required at junctions and along alternative routes to reduce confusion and encourage smooth traffic flow.

GENERAL DESCRIPTION

Equipment and materials could be stored at key locations near areas that suffer from high incident rates. These facilities would greatly reduce the response time to the incident if they were easily accessible and used by all responding agencies. Cooperative agreements might be developed to describe the equipment that would be stored, who would be responsible for keeping the facility stocked, and who would be responsible for the initial costs associated with the facility.

Conditions Under Which Appropriate

Appropriate in areas that suffer from high incident rates and where response times are normally lengthy. Sufficient space must also exist for the construction of the facility.

Advantages

- ✓ Provides quick access to emergency equipment.
- ✓ May be implemented with surplus space for later expansion.

Disadvantages

- ✘ Sufficient storage space does not often exist near congested or high incident areas.
- ✘ Requires continual stocking of materials or supplies.
- ✘ May encourage vandalism or theft, depending on facility type.

Costs

Capital	Variable - See Below
Maintenance	Low
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Capital

Capital costs would vary, depending on the size of the facility and the types of equipment/materials stored. If large equipment such as trucks or wreckers were stored, a larger, covered facility with adequate security would be required. If smaller equipment or materials such as flares, barriers, cones, or sand were stored, a much smaller facility would be required and security measures could be more relaxed.

Special Equipment Required

The equipment required to implement an equipment storage site would depend on the purpose of the facility. Larger equipment might include wreckers, sand trucks, and other response vehicles. Small equipment might include portable barriers, cones, flares, and other equipment/supplies required for traffic control or clean up.

ADMINISTRATIVE TRAFFIC MANAGEMENT TEAMS

GENERAL DESCRIPTION

Administrative traffic management teams comprise officials from all incident response agencies, including transportation, police, and fire and rescue agencies. Their purpose is to quickly provide necessary funding and resources through the establishment of cooperative agreements and improved interagency relationships.

Administrative Traffic Management Teams can also act as a key catalyst in initiating an Incident Management System, as well as suppoting an existing program. With adequate interagency communication, a successful Incident Management Program should result which meets the needs of all agencies involved in addition to meeting the traffic management needs of the area.

Conditions Under Which Appropriate

This option is appropriate under all conditions but requires a willing participation from all agencies to be successful.

Advantages

✓ Provides a forum for interagency cooperation.

✓ May develop personal relations among agency leaders, improving their communication.

✓ Agencies can learn about the specific abilities and limitations of the other responding agencies.

Disadvantages

✗ Senior staff may spend too much time going to each monthly meeting.

✗ Quickly becomes ineffective if participants are unable to make commitments.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

Options for Reducing Response Time

GENERAL DESCRIPTION

A complete public education campaign would be undertaken to inform the driving public about when it they should remove vehicles from the road prior to the arrival of a police officer. In many cases, small incidents can be completely removed without the need for a response if the involved motorists would simply move their vehicles to the shoulder and exchange information. Many motorists are reluctant to do this because they are under the impression that a uniformed police officer must observe the scene before vehicles can legally be moved.

Conditions Under Which Appropriate

This option is appropriate under all conditions where existing laws do not restrict the removal of vehicles from the scene of small accidents prior to the arrival of a uniformed law enforcement officer.

Advantages

- ✓ Provides very fast removal of incident cause.
- ✓ Has no cost to the operations section of law enforcement or highway agencies.
- ✓ Frees law enforcement officers to perform other, more important duties.
- ✓ Frees incident management personnel to respond to other incidents.
- ✓ Can be part of a larger public information program.

Disadvantages

- ✘ It is difficult to change motorists behavior.
- ✘ Such a public information campaigns would be out of the scope of "normal" activities undertaken by most agencies involved in incident management.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Operations

Operating Agency

Either a highway agency or a police agency would be likely operating organizations for such a public information campaign. The campaign could also be a joint effort of many agencies.

Funding Responsibility

Ideally, the funding responsibility would be undertaken by the agency or agencies that will implement and operate the public education program.

GENERAL DESCRIPTION

Automatic vehicle location (AVL) systems allow dispatchers to instantly determine the location of any vehicle. Several technologies can be used for automatic vehicle location, including on-board navigation systems, terrestrial-based location systems, or global location systems (global positioning systems). Automatic vehicle location systems are presently most widely used by commercial and public fleet operators.

Conditions Under Which Appropriate

Appropriate under all circumstances.

Advantages

✓ Nearest available response vehicle can be instantly identified, thus reducing response time.

✓ Makes more efficient use of personnel and resources.

Disadvantages

✘ Automatically identified location may not be accurate enough to provide the optimum benefit.

✘ Technology is still emerging and may still result in false locations.

Costs	Capital	Variable - See Below
	Maintenance	Medium
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with an automatic vehicle location system are high. However, some of the cost burden may be assumed by the private sector through public/private partnerships.

Special Equipment Required

The type of equipment required depends upon the type of technology used for automatically locating vehicles.

Special Training Required

The required training depends on the type of technology used for automatically locating vehicles. The controlling agency must train personnel to operate and maintain the new equipment as part of the system.

Operation

Public or Private

An automated vehicle location system could be operated by any public or private agency.

Operating Agency

An automated vehicle location system could be operated by any public agency that relies on dispatch and quick response (i.e., police, fire, transportation) or by a private agency. If it is operated privately, coordination with other response personnel is necessary to ensure incident management benefits.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the public or private agencies.

GENERAL DESCRIPTION

Geographic information systems (GIS) allow geographically referenced data to be captured, analyzed, modeled, and displayed using a computer and appropriate software. Geographic information systems can support incident management activities in two ways. First, geographic information systems allow detailed mapping of an area, including its infrastructure, resources, and utilities. Second, geographic information systems, when combined with automatic vehicle location, allow dispatchers to exactly locate and dispatch the nearest vehicle.

Conditions Under Which Appropriate

Appropriate under all circumstances.

Advantages

✓ Infrastructure, resources, and utilities can be immediately located, improving the efficiency and safety at the scene in the event of a major incident.

✓ Nearest available response vehicle can be instantly identified, thus reducing response time.

✓ Makes more efficient use of personnel and resources.

Disadvantages

✗ May be costly and time consuming to develop a GIS database.

Costs	Capital	High
	Maintenance	Medium
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Equipment Required

The type of equipment required includes a computer, GIS and desktop mapping software with data input, management, manipulation, analysis, and output capabilities.

Special Training Required

Training in computer use and software operation is required.

Operation

Public or Private

A geographic information system could be operated by any public or private agency.

Operating Agency

A geographic information system could be operated by any public agency that relies on infrastructure, resource, or utility location information or relies on accurate dispatch and quick response (i.e., police, fire, transportation), or by a private agency. If a GIS is operated privately, coordination with other response personnel is necessary to ensure incident management benefits.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the public or private agencies.

CENTRAL INFORMATION PROCESSING AND CONTROL SITE

GENERAL DESCRIPTION

A Central Information Processing and Control Site is a control center which collects and analyzes traffic performance, incident, and incident response information from multiple agencies and jurisdictions. It serves as an information resource for agencies responding to incidents by monitoring the status of incidents and related traffic performance.

The intent of the center is to provide a single location which is responsible for the monitoring the need for response actions, and then track the progress of those actions, and their impact on traffic performance. This function takes place over a large urban area and usually encompasses several jurisdictions and operating authorities.

When such a center is developed by private industry, the primary intent is to provide traffic performance information directly to motorists or to news agencies which then provide that information to motorists. When operated by a public agency, the center is usually meant to improve the operational performance of a series of facilities, by providing a more coordinated system of traffic monitoring and response.

An integrated central data processing center provides agencies with an effective method for increasing the control and coordination of their incident response efforts. However, resources are required to provide this level of improved control and coordination, and these resources must be obtained either by selling the information collected, or by increasing the total budget allowed for incident response.

Conditions Under Which Appropriate

A central control center will provide a better level of response for less overall cost in larger urban areas where multiple agencies or jurisdictions collect traffic performance information and/or respond to incidents. Central information processing centers are usually more expensive than the the uncoordinated alternatives, but provide a better overall level of service.

Advantages

- ✓ Provides a single source of information on conditions on facilities, the need for incident response, and the status of response activities, as well as for news media inquiries. This single source produces more reliable and comprehensive information.
- ✓ Provides a better level of incident response through better coordination of response actions and monitoring.
- ✓ Can reduce unnecessary response actions, by eliminating duplication of response actions by different agencies.

Disadvantages

- ✗ Requires agencies to develop systems that automatically share information.
- ✗ Designing and developing such a center carries a high initial cost.
- ✗ Operating a central information processing center requires continuous funding from those agencies or companies which participate in the center, as well as the continued cooperation of those agencies which provide input data to the central system.
- ✗ Funds for development and operation of a multi-jurisdictional center are usually "out-of-pocket" expenditures for participating agencies. As a result, these funds are often hard to secure on an continuing basis.

Costs	Capital	High
	Maintenance	None
	Operating	Variable - See Below
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement a central information processing and control site are high due to the need for large computer and communications resources to collect, store, manipulate and transmit traffic performance and incident information.

Operating

Operating costs vary with the size of the control center, the number of hours per day it operates, and the number of staff required to operate the center. A multi-jurisdictional center usually must obtain funds from multiple sources, which can be politically difficult, while private centers require a large market for the information developed in order to create the revenue necessary to run the system.

Special Equipment Required

At a minimum, the center will need computer resources to accept and process traffic performance and incident information. Communications facilities are also needed to transmit incident and traffic performance data t the end users of that data, whether it be operating agencies, news organizations or motorists. The design of these communications links will vary from simple telephone lines to radio and cellular communications capabilities, depending on the role to be played by the central location.

Special Training Required

Training in operational procedures is required to educate the center staff on how to identify, track incidents and on how to coordinate the appropriate responses to those incidents. This training must be tailored to the specific operating environment developed for each control center and its participating agencies.

Legislative Requirements

Legislative action may be needed to empower the control center agencies to share data. If the control center directs incident responses, it may also need authorizing legislation allowing control center personnel to request the action of agency personnel outside of their direct line of supervision.

Operation

Public or Private

The control center can be operated either as a public or private entity. If the control center operates solely as a clearing house for information on incidents and traffic performance, it can be privately run, although a public agency can also undertake this mission. If the center's personnel actually direct the actions of public agency field personnel, the center must probably be publicly operated.

Operating Agency

A central system requires a cooperative effort between transportation, police, fire and rescue, and other responding agencies.

Funding Responsibility

Ideally, the funding for this program is provided by all participating agencies or private groups. The size of each agency's (or company's) participation should depend on their level of benefit from the system and their ability to pay. A shared funding arrangement requires written agreements between agencies and the creation of these agreements may delay implementation of a program if such an agreement is not easily reached, or if some agencies are not convinced of the merits of the system. A second option is for the agency which will benefit the most from the center to assume responsibility for funding and establish contracts with the other agencies that delineate guidelines for obtaining data and for sharing equipment and personnel.

Options for Reducing Response Time

CLOSELY SPACED MILEPOST MARKERS

GENERAL DESCRIPTION

Placing more frequent milepost markers on urban facilities, for example at 1/10 mile spacings, allows for more accurate location of accidents by incident response personnel and citizens reporting incidents. The improved location information improves the speed with which additional response vehicles can reach the scene and clear the incident. Simple, accurate, numerical location information also provides the best method for locating incidents for recording keeping and analysis purposes.

Conditions Under Which Appropriate

Closely spaced milepost markers can provide significant improvements to incident response in areas where incident rates are high, where improvements in response time are needed, and in those situations where communications between field personnel from different agencies are limited, making it difficult for one agency to provide specific location information to another agency's personnel.

Advantages

✓ Closely spaced milepost markers provide a reliable and simple system for locating incidents or other events and objects.

✓ A consistently applied numerical milepost system allows for simplified automated record keeping and analysis of incident response measures by geographic location.

Disadvantages

✗ Not all facilities have obvious locations for closely spaced milepost signs.

Costs

Capital	Low
Maintenance	Low
Operating	None
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

Options for Reducing Response Time

Options for Improving Site Management

Once the selected personnel and equipment have begun to arrive at the incident scene, the effectiveness of the response is a function of both how well suited the response technique is to that incident and how well the personnel at the scene manage the incident site. A well managed response that uses an "inferior" technique may be more effective at clearing an incident than a "superior" technique that is not well managed.

When a single agency responds to an incident, management at the site entails ensuring that the personnel working at the scene understand their duties and are appropriately trained and led. However, when multiple agencies respond to an incident, managerial difficulty takes a quantum jump. Not only must each agency understand its own responsibilities and train its staff, but some means of coordination and control must exist among the responding agencies. This process becomes more complicated as the size of the incident grows and the number of agencies involved increases.

The success of these coordination efforts directly impacts the success of the incident response process, especially for larger incidents. Whether coordination is successful often relates directly to the attitude of upper management and its desire to compromise and find solutions to problems that cross jurisdictional boundaries. Techniques that are useful in improving the management of personnel and equipment at an incident site are shown in Table 2.9. Table 2.10 shows alternative ways for agencies to be involved in each management technique.

Table 2.9 Options for Improving Site Management

Type of Program	Potential Benefits	Potential Costs	Comments
Incident Response Teams	👍👍⇨👍👍👍👍	💰⇨💰💰💰	Highly trained, coordinated response teams can greatly reduce site management delays and can reduce interagency conflicts.
Personnel Training Programs	👍👍👍	💰💰	Highly trained personnel can speed the management process as well as reduce the number of interagency conflicts that may arise.
Peak Period Motorcycle Patrols	👍👍👍👍	💰💰⇨💰💰💰	Motorcycle patrols have more maneuverability in highly congested areas and carry out tasks vital to the incident management process (i.e., traffic control).
Improved Interagency Radio Communication	👍👍👍	💰⇨💰💰	Direct communication between the various responding agencies can reduce repetitious commands and improve interagency relationships.
Command Posts	👍👍	💰	Allows information and instruction to disseminate from a single, central location, improving efficiency and reliability of information.
Identification Arm Bands	👍	💰	Allows quick differentiation between respondents and public or media personnel who may also be present.
Properly Defined Traffic Control Techniques	👍👍👍	💰	Provides greater safety for motoring public, as well as improving the safety of the respondents.
Properly Defined Parking for Response Vehicles	👍👍	💰	Ensures that excess lanes are not blocked by response vehicles and smooth operation of incident management processes are not impeded.
Flashing Lights Policy	👍	💰	Need to consider safety of respondents, liability and impacts on normal traffic flow.
Administrative Traffic Management Team	👍	💰	Provides a forum to discuss and provide funding for area incident management programs aimed at improving site management efforts.
Central Information Processing and Control Site	👍👍👍	💰💰💰	Central collection and analysis of incident information allows for more coordinated response to incidents.
Alternative Route Planning	👍👍	💰	Serves to improve both response and clearance efforts.
Incident Response Manual	👍👍👍	💰	Predetermined chain of command and responses can facilitate decision-making, communications, and site management.
Incident Response Database	👍👍	💰💰	Provides consistent and comprehensive incident information for improved resource allocation and cost recovery.
Automatic Cargo Identification	👍👍👍	💰💰💰	Provides a safeguard when a potentially hazardous cargo is unidentifiable. Still requires confirmation from other HAZMAT references.

Key for Table 2.9

= Minor benefits

= Moderate benefits

= Substantial benefits

= Very substantial benefits

= Indicates a range of benefit/cost levels

= Minor costs

= Moderate costs

= Substantial costs

= Very substantial costs

Table 2.10 Agency Involvement in Improving Site Management

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Incident Response Teams	A	△	△	△			△		
Personnel Training Programs	A	△	△	△	△	△	△	△	
Peak Period Motorcycle Patrols	A		▲						
Improved Interagency Radio Communication	A	△	△	△			△	△	
Command Posts	A	△	△	△			△		
Identification Armbands	A	△	△	△			△		
Properly Defined Traffic Control Techniques	A	△	△	△					
Properly Defined Parking for Response Vehicles	A	△	△	△			△		
Flashing Lights Policy	A	△	△	△			△		
Administrative Traffic Management Teams	A	△	△	△	△				
Central Information Processing and Control Site	A	▲							
	B	△	△			△	△	△	
	C						▲		
Alternative Route Planning	A	△	△	△	△		△		
Incident Response Manual	A	△	△	△			△		
Incident Response Database	A	▲							
	B		▲						
	C			▲					
Automatic Cargo Identification	A	△					△		
	B		△				△		
	C			△			△		

▲ Indicates sole involvement

△ Indicates shared involvement

<u>Example of Sole Involvement</u>
Peak period motorcycle patrols should be implemented and operated solely by police agencies with no interagency cooperation.

<u>Example of Shared Involvement</u>
Administrative Traffic Management Teams require a cooperative effort among transportation, police, fire and rescue, and public works agencies to ensure a complete examination of possible traffic management strategies and a variety of funding alternatives.

GENERAL DESCRIPTION

Incident Response Teams are interdisciplinary teams trained in handling large or severe incidents. The teams may be staffed by volunteers from each of the responding agencies (i.e., transportation, police, and fire and rescue), but someone must be available to coordinate all of the responding personnel if this alternative is to operate efficiently.

Conditions Under Which Appropriate

Appropriate in areas where interagency cooperation is lacking and on-site efforts are often uncoordinated.

Advantages

- ✓ Teams are prepared to handle unusual incidents.
- ✓ Individuals know each other and their roles.
- ✓ Improves both site management and clearance efforts.

Disadvantages

- ✗ Additional costs are created for the coordinating agency.
- ✗ Coordination can be extremely difficult.

Costs

Capital	Variable - See Below
Maintenance	Medium
Operating	Variable - See Below
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	Variable - See Below
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement an incident response team program vary, depending on the size of the program implemented and the cooperative agreements established among agencies defining equipment and personnel use. It is wise to begin the program on a small scale, determine its success, and then choose to expand or abandon the program.

Operating

Operating costs also vary, depending on the size of the program and the equipment requirements.

Special Equipment Required

The equipment required varies greatly, depending on the types of incidents tackled by the response team. If a wide range of agencies take part in the incident response process, a wide range of equipment should be easily accessible.

Special Training Required

Little training in operational procedures is required because regular agency training sessions cover these areas. However, interagency training is required for on-site coordination.

Liability

Liability should be a concern if unnecessary damage may be incurred by either the persons or vehicles at the incident site. However, the possibility of damage can be greatly reduced with adequate training programs.

Operation

Operating Agency

Requires a cooperative effort between transportation, police, fire and rescue, and other responding agencies.

Funding Responsibility

Ideally, the funding for this program is provided by all responding agencies, depending on their degree of participation. This arrangement requires specific guidelines and may delay implementation of the program if an agreement among the appropriate agencies is lacking. A second option is for the transportation agency to assume responsibility for funding and to establish contracts with the other agencies that delineate guidelines for equipment and personnel use.

GENERAL DESCRIPTION

An agency should support personnel training programs that not only focus on its own required policies and procedures, but also on the policies and procedures of other responding agencies. Since a safe and efficient inciden response process is dependent on all responding personnel, these personnel must be aware of each agency's needs and requirements. Such cooperative training programs can serve to greatly improve interagency relationships.

Conditions Under Which Appropriate

Appropriate under all conditions, but requires an initial willingness to participate from all responding agencies.

Advantages

✓ Improves incident response, site management and incident clearance efforts.

✓ Improves interagency relationships.

Disadvantages

✗ Requires an initial willingness from all responding agencies to be successful.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Training should focus not only on the policies and procedures of the personnel's own agency, but also on the policies and procedures of each of the responding agencies. Once all of the responding personnel have become aware of other agencies' requirements, the overall response process will operate much more efficiently.

Operation

Operating Agency

For personnel training programs to be successful, a cooperative effort on the part of all responding agencies is required. A single agency, most likely the transportation agency involved, should coordinate the involvement of the various agencies.

Funding Responsibility

Ideally, the funding responsibility should be a cooperative effort because all agencies will benefit from this program. However, costs are so minimal that they can easily be absorbed by the operating or coordinating agency.

PEAK PERIOD MOTORCYCLE PATROLS

GENERAL DESCRIPTION

The establishment of peak period motorcycle patrols will result in numerous improvements in the incident management effort for what a potentially minimal cost. To obtain the most benefit, the motorcycle patrols should operate in congested areas during the peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures.

Site management efforts should show noticeable improvements. Because of their small size and maneuverability, motorcycles can more easily access the incident site than larger response vehicles. This quick access should allow traffic control procedures to begin earlier in the incident management process, decreasing an incident's impact on the motoring public.

Also, with well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection time should decrease.

A third benefit that from the establishment of peak period motorcycle patrols is that because trained personnel can reach and assess the incident site in less time, the appropriate equipment can reach the site in less time, reducing the overall impact of the incident.

This option may be implemented in place of a dedicated freeway/service patrol program or increased regular police patrol units, depending on the incident management needs and available funding.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where larger incident response vehicles have limited access to the incident site.

Advantages

- ✓ In addition to reducing detection times, motorcycle patrols also improve response times and site management efforts.
- ✓ Increase police mobility during peak hours, allowing more rigid enforcement of traffic laws (i.e., speed limits).
- ✓ Can reach and assess the incident in less time and can call for other emergency vehicles to respond if necessary.

Disadvantages

- ✘ Motorcycles lack incident clearing capabilities.
- ✘ Motorcycles do not offer protection for the officer in case of secondary accidents or inclement weather.

Costs	Capital	Variable - See Below
	Maintenance	Variable - See Below
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Police Agencies
Funding Responsibility		Police Agencies

DETAILED DESCRIPTION

Costs

Capital

Capital costs may range from low to medium, depending on whether new response patrol vehicles are purchased or existing or reconditioned vehicles are used. If existing or reconditioned vehicles are used, capital costs will remain low. However, capital costs become much higher if new response vehicles are required, and in this case other options may provide more benefit in the areas of incident clearance and respondent protection for an equal expenditure. Such alternatives may include a small scale dedicated freeway/service patrol program or an investment in special equipment such as push bumpers for existing patrol vehicles.

Maintenance

Maintenance costs may also range from low to medium, depending on the condition of the response vehicles. If capital expenses are relatively high because of the purchase of new motorcycle patrol vehicles, maintenance costs should remain relatively low. The inverse is also true: if reconditioned vehicles are chosen over new vehicles, maintenance costs may run higher.

Special Equipment Required

New response patrol vehicles, equipped with the required electrical and communication systems, may be purchased if an inadequate number of vehicles currently exist. But again, if this is the case, other alternatives may be more cost effective.

Special Training Required

The required training varies, depending on the background and experience of the responding personnel. However, a well trained motorcycle patrol respondent should be knowledgeable in the following areas:

- Emergency medical training, including CPR and first aid
- Radio communication, with an emphasis on reporting

- Traffic control
- Public relations
- Surveillance of suspicious activities
- A general knowledge of the departmental procedures and policies of each of the responding agencies (transportation, police, fire and rescue).

Obviously, some of these areas will overlap with the already existing police agency training requirements, so a unique training program may be need for motorcycle patrol personnel.

IMPROVED INTERAGENCY RADIO COMMUNICATION

GENERAL DESCRIPTION

Efforts can be made to improve radio communications among the various responding agencies. These improvements may require the purchase of compatible radio systems that are two-way operational. They may also be accomplished with the installation of cellular phone systems. However, to be successful, each respondent vehicle must be able to communicate with any other respondent vehicle. This ability includes the existence of a common radio language or lingo that all respondents understand and utilize. Once this capability is acquired, a large time savings will result because repetitious commands and indirect communications will be eliminated.

Conditions Under Which Appropriate

This option is appropriate when good relations exist among the various responding agencies so that a cooperative effort can be achieved. If such relations do not exist, the common radios will never be utilized.

Advantages

- ✓ Decreases repetitious communications efforts.
- ✓ Improves site management efforts.
- ✓ Respondent personnel are better informed through direct communications.

Disadvantages

- ✗ It is often difficult to convince all responding agencies to invest in and implement a new communications system.
- ✗ Good relationships rarely exist among all responding agencies.

Costs

Capital	Variable - See Below
Maintenance	Low
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement this program vary, depending on the level of interagency communication already present and the extent to which this program will be implemented. For instance, common radios may initially be placed only in supervisory vehicles with plans to later install radios in all responding vehicles.

Special Training Required

The training required to make interagency radio communication successful is minimal. It consists only of the operation of the new radio system. However, to use this communications system to its full potential, some training should encourage interagency coordination and cooperation in the field.

Funding Responsibility

Ideally, the responsibility for securing funding for the common communication system should lie with each of the responding agencies. However, if the agencies are not willing to take part in the program because of the added expense, the transportation agency in charge of operation may choose to absorb the costs.

GENERAL DESCRIPTION

Command posts, either formal or informal, may be established initially at every major incident in which two or more respondents are present. These respondents may be from different agencies or the same agency. In each case, information or instruction should emanate from a centrally located post to ensure the most systematic and efficient approach to incident management. The command post may be established by the first person on the scene and may be as simple as a flag tied to the antenna of the respondent vehicle. Every responding agency arriving thereafter should report to the command post to learn which tasks have already been accomplished and to receive instructions for the next steps. This process ensures that everyone strives toward a common goal. Media agencies should receive their information directly from the personnel at the command post to ensure that they are given timely and accurate information without impeding the efficiency of the response process.

Conditions Under Which Appropriate

This option is appropriate when sufficient interagency relationships exist to result in complete cooperation.

Advantages

- ✓ Diminishes questions about who should do what and what has already been done.
- ✓ Saves time by reducing repetitious commands.

Disadvantages

- ✗ May be difficult to gain the cooperation of all responding personnel.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Additional training should focus on interagency coordination. Since command post personnel will rotate, depending on who arrives at the scene first, whoever disseminates information or instructions should fully understand the roles and responsibilities of other agency personnel.

Operation

Operating Agency

For this option to operate most efficiently, it must be a continually cooperative effort involving all responding agencies.

Funding Responsibility

Ideally, the funding for this option should come cooperatively from all responding agencies because each agency will benefit from the implementation of command posts. However, the funding requirements are so minimal that the transportation agency may easily absorb the costs.

GENERAL DESCRIPTION

Identification armbands can be used to quickly differentiate respondents from members of the public or media who may also be at the incident site. To further simplify the identification process, standard colors, patterns, or other denoting insignia should be established for each of the responding agencies. All personnel should be able to recognize the various agencies by their armbands. While armbands serve the identification purposes that a full uniform does, they do not offer the same protection of visibility from moving traffic.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ Saves time in locating and identifying various agency personnel.

Disadvantages

✗ Does not offer as much visibility protection as a full uniform.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	None
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Equipment Required

The only equipment required to implement this program are the identification armbands. Variations may include color, reflectorization, water repellency, and velcro or snap closures.

Operation

Public or Private

For this option to operate successfully, a cooperation is necessary among all public and private agencies that respond to incidents.

Operating Agency

To gain the most efficiency in site management procedures, a cooperation is necessary among all agencies involved at the incident scene. However, for this option to be utilized, each of the responding agencies must make an effort. In convincing responding staff members of the importance of the armbands, instruction by their own supervisors, rather than an outside entity, may be most effective.

Funding Responsibility

Ideally, the funding requirements should be met cooperatively by each of the responding agencies because all agencies will benefit equally from the implementation of this program. However, since funding requirements are so minimal, a second option is to have the transportation agency involved absorb the costs.

PROPERLY DEFINED TRAFFIC CONTROL TECHNIQUES

GENERAL DESCRIPTION

A standard set of traffic control guidelines may be defined for various lane blocking configurations. Proper traffic control techniques ensure greater safety for the motoring public, as well as the respondents.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ Improves the safety of both the respondents and the motoring public.

Disadvantages

✘ The cooperation of all the responding agencies may be difficult to gain without legislative action.

✘ May be difficult to enforce.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Once the proper traffic control techniques have been determined, each of the responding agency personnel must understand and be able to implement the safest and most efficient form of traffic control for any situation.

Legislative Requirements

Because it is often difficult for one agency to abandon its own procedures, even though a standard set of guidelines has been created, legislative steps may be required to gain complete cooperation from each responding agency.

Operation

Operating Agency

Even though the transportation agency will be responsible for defining the proper traffic control guidelines, this option requires a cooperative effort on the part of each of the responding agencies to ensure that these guidelines are followed in the field. In defining the traffic control techniques, the MUTCD can be looked to for guidance. However, it should be remembered that the needed traffic control procedures are for emergency situations when time and manpower are very limited.

PROPERLY DEFINED PARKING FOR RESPONSE VEHICLES

GENERAL DESCRIPTION

A set of guidelines may be established to describe the proper parking of response vehicles at various incident situations. The location of the response vehicles will vary according to the type of incident. For example, if the incident involves a fire, the fire and rescue vehicles need to be directly in front of the inflamed vehicle. Once the fire has been extinguished, the blocking vehicle will have to be pushed or towed off of the roadway. Therefore, the appropriate vehicle needs to be directly in front of or behind the blocking vehicle to move the vehicle. Never should response vehicles block more lanes of travel than necessary or impede the smooth operation of the incident management process. The goal in defining proper parking procedures is to minimize required maneuvering and, in turn, allow the site management process to operate more safely and efficiently.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ Improves safety of respondents and motoring public by reducing unnecessary vehicle maneuvering.

Disadvantages

✗ May be difficult to gain the cooperation from each of the responding agencies without legislative steps.

Costs

Capital---------- Low
Maintenance---------- Low
Operating---------- Low
Special Equipment Required---------- None
Special Training Required---------- Variable - See Below
Liability---------- None
Legislative Requirements---------- Variable - See Below

Operation

Public or Private ---------- Public
Operating Agency---------- Variable - See Below

Funding Responsibility

---------- Transportation Agency

DETAILED DESCRIPTION

Costs

Special Training Required

Once the proper response vehicle parking has been defined, all of the responding agency personnel must understand and be able to maneuver their response vehicles to the correct locations.

Legislative Requirements

Because it is often difficult for one agency to abandon its current procedures, even though a standard set of guidelines has been created, legislative steps may be required to gain complete cooperation from each responding agency.

Operation

Operating Agency

Even though the transportation agency will be responsible for establishing the guidelines for proper response vehicle parking, this option requires a cooperative effort by the responding agencies to ensure that these guidelines are followed in the field.

GENERAL DESCRIPTION

An official set of guidelines may be established to specify the appropriate times to use flashing lights and the best type to use (e.g., amber or directional). Respondents should be informed of the possible motorist distraction that can accompany the overuse of flashing lights. Flashing lights should be utilized only when vehicles are in the travel lanes or at night, in high speed traffic areas. Flashing lights are not required during daylight hours if the incident vehicle is sufficiently off the roadway. Items that must be considered when such a policy is developed include the safety of the respondents, liability, and the impacts on normal traffic flow. Once they have been developed, the policy guidelines should be incorporated into all responding agencies' training programs.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ Reduces gaper's block and improves traffic flow, thus mitigating the impact of the incident.

✓ Decreases the number of secondary accidents.

Disadvantages

✗ Respondents may feel more vulnerable to the passing traffic.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	Variable - See Below

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Special Training Required

Once the proper guidelines for flashing light use have been defined, all of the responding agency personnel must understand and be able to follow these guidelines in any incident situation.

Legislative Requirements

Because it is often difficult for one agency to abandon its current procedures, even though a standard set of guidelines has been created, legislative steps may be required to gain complete cooperation from each responding agency.

Operation

Operating Agency

Even though the transportation agency will be responsible for establishing the guidelines for flashing light use, this option requires cooperation from each of the responding agencies to ensure that these guidelines are followed in the field.

ADMINISTRATIVE TRAFFIC MANAGEMENT TEAMS

GENERAL DESCRIPTION

Administrative traffic management teams comprise officials from all incident response agencies, including transportation, police, and fire and rescue agencies. Their purpose is to quickly provide necessary funding and resources through the establishment of cooperative agreements and improved interagency relationships.

Conditions Under Which Appropriate

This option is appropriate under all conditions but requires willing participation from all agencies to be successful.

Advantages

- ✓ Provides a forum for interagency cooperation.
- ✓ May develop personal relations among agency leaders, improving their communication.
- ✓ Agencies can learn about the specific abilities and limitations of the other responding agencies.

Disadvantages

- ✘ Senior staff may spend too much time going to each monthly meeting.
- ✘ Quickly becomes ineffective if participants are unable to make commitments.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

CENTRAL INFORMATION PROCESSING AND CONTROL SITE

GENERAL DESCRIPTION

A Central Information Processing and Control Site is a control center which collects and analyzes traffic performance, incident, and incident response information from multiple agencies and jurisdictions. It serves as an information resource for agencies responding to incidents by monitoring the status of incidents and related traffic performance.

The intent of the center is to provide a single location which is responsible for the monitoring the need for response actions, and then track the progress of those actions, and their impact on traffic performance. This function takes place over a large urban area and usually encompasses several jurisdictions and operating authorities.

When such a center is developed by private industry, the primary intent is to provide traffic performance information directly to motorists or to news agencies which then provide that information to motorists. When operated by a public agency, the center is usually meant to improve the operational performance of a series of facilities, by providing a more coordinated system of traffic monitoring and response.

An integrated central data processing center provides agencies with an effective method for increasing the control and coordination of their incident response efforts. However, resources are required to provide this level of improved control and coordination, and these resources must be obtained either by selling the information collected, or by increasing the total budget allowed for incident response.

Conditions Under Which Appropriate

A central control center will provide a better level of response for less overall cost in larger urban areas where multiple agencies or jurisdictions collect traffic performance information and/or respond to incidents. Central information processing centers are usually more expensive than the the uncoordinated alternatives, but provide a better overall level of service.

Advantages

✓ Provides a single source of information on conditions on facilities, the need for incident response, and the status of response activities, as well as for news media inquiries. This single source produces more reliable and comprehensive information.

✓ Provides a better level of incident response through better coordination of response actions and monitoring.

✓ Can reduce unnecessary response actions, by eliminating duplication of response actions by different agencies.

Disadvantages

- ✘ Requires agencies to develop systems that automatically share information.
- ✘ Designing and developing such a center carries a high initial cost.
- ✘ Operating a central information processing center requires continuous funding from those agencies or companies which participate in the center, as well as the continued cooperation of those agencies which provide input data to the central system.
- ✘ Funds for development and operation of a multi-jurisdictional center are usually "out-of-pocket" expenditures for participating agencies. As a result, these funds are often hard to secure on an continuing basis.

Costs	Capital	High
	Maintenance	None
	Operating	Variable - See Below
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement a central information processing and control site are high due to the need for large computer and communications resources to collect, store, manipulate and transmit traffic performance and incident information.

Operating

Operating costs vary with the size of the control center, the number of hours per day it operates, and the number of staff required to operate the center. A multi-jurisdictional center usually must obtain funds from multiple sources, which can be politically difficult, while private centers require a large market for the information developed in order to create the revenue necessary to run the system.

Special Equipment Required

At a minimum, the center will need computer resources to accept and process traffic performance and incident information. Communications facilities are also needed to transmit incident and traffic performance data t the end users of that data, whether it be operating agencies, news organizations or motorists. The design of these communications links will vary from simple telephone lines to radio and cellular communications capabilities, depending on the role to be played by the central location.

Special Training Required

Training in operational procedures is required to educate the center staff on how to identify, track incidents and on how to coordinate the appropriate responses to those incidents. This training must be tailored to the specific operating environment developed for each control center and its participating agencies.

Legislative Requirements

Legislative action may be needed to empower the control center agencies to share data. If the control center directs incident responses, it may also need authorizing legislation allowing control center personnel to request the action of agency personnel outside of their direct line of supervision.

Operation

Public or Private

The control center can be operated either as a public or private entity. If the control center operates solely as a clearing house for information on incidents and traffic performance, it can be privately run, although a public agency can also undertake this mission. If the center's personnel actually direct the actions of public agency field personnel, the center must probably be publicly operated.

Operating Agency

A central system requires a cooperative effort between transportation, police, fire and rescue, and other responding agencies.

Funding Responsibility

Ideally, the funding for this program is provided by all participating agencies or private groups. The size of each agency's (or company's) participation should depend on their level of benefit from the system and their ability to pay. A shared funding arrangement requires written agreements between agencies and the creation of these agreements may delay implementation of a program if such an agreement is not easily reached, or if some agencies are not convinced of the merits of the system. A second option is for the agency which will benefit the most from the center to assume responsibility for funding and establish contracts with the other agencies that delineate guidelines for obtaining data and for sharing equipment and personnel.

GENERAL DESCRIPTION

In the case of a lane blocking incident, motorists can be directed to use preplanned alternative routes to help mitigate the impacts of the incident. Their use requires prior analysis of the freeway corridor. All responding agencies must then be made aware of these routes. Such routes require adequate temporary or permanent signing at key locations.

Conditions Under Which Appropriate

Appropriate in all circumstances as long as care is taken to avoid alternative routes that inhibit the flow of normal traffic because of low overpasses or severe turns.

Advantages

✓ Route diversion can occur quickly.

✓ May be part of a civil defense or disaster response program.

✓ Provides coordinated alternative route planning for participating agencies.

Disadvantages

✗ Requires sizable investment of staff time.

✗ Some communities do not wish to have traffic diverted onto their streets, regardless of the circumstances.

Costs	Capital	Variable - See Below
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	None
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Capital

Capital costs may vary, depending on the size of the urban area involved and the extent of the alternative route study. Also, the extent to which signing is provided, both before and along the alternative routes, can affect capital costs. In some cases, unexpected capital costs may be incurred because of the minor revisions in the roadways required to make them suitable.

Special Equipment Required

Signing equipment, either temporary or permanent, is required at junctions and along alternative routes to reduce confusion and encourage smooth traffic flow.

GENERAL DESCRIPTION

An incident response manual could be developed to improve efficiency at the incident site. This set of guidelines would have to be a cooperative effort by all responding agencies, since their input would be required to compile accurate procedural steps. Once the guide had been completed, these guidelines could be distributed to all responding personnel and incorporated into regular training sessions.

Conditions Under Which Appropriate

Appropriate in instances where clearance efforts are uncoordinated and inefficient.

Advantages

✓ Helps to ensure that the safest and most efficient clearance procedures are followed.

Disadvantages

✗ May be difficult to gain the cooperation of all responding agencies.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Once the incident response manual had been developed, all personnel who respond to incidents would have to be able to quickly and efficiently follow the defined procedures. This might require special training sessions in addition to regular agency training. An emphasis should be placed on interagency cooperation.

Operation

Operating Agency

Although the transportation agency would be responsible for developing the incident response manual (to include interaction with the other responding agencies to ensure accurate procedures), this option would require a cooperative effort on the part of all responding agency personnel to ensure that the guidelines defined in the manual were followed in field procedures.

Funding Responsibility

The transportation agency involved would be responsible for securing funding for the development of the incident response manual. However, once the manual had been developed, associated training costs should be cooperatively provided by all responding agencies.

GENERAL DESCRIPTION

An incident response database eliminates the need for field notes and data entry duties. Such a database can prompt the respondent to answer a series of question relating to the incident at hand. This information when entered can be stored and later manipulated to monitor changes in incident response. The availability of a database helps to ensure that consistent information is obtained for every incident.

Conditions Under Which Appropriate

Appropriate under all circumstances.

Advantages

- ✓ Allows consistent information to be obtained from every incident.
- ✓ Eliminates the need for office-based data entry.
- ✓ Allows incident statistics to be more readily obtained.
- ✓ Allows more cost recovery from the responsible party.

Disadvantages

- ✗ Requires that all respondents have access to laptop computers.
- ✗ Some respondents may be reluctant to use the computers.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Equipment Required

Portable or laptop computers are required and should be available in every response vehicle.

Special Training Required The required training depends on the background and experience of the responding personnel. Varying levels of computer-use training will be required, as well as training for moving though and storing information in the database.

Operation

Operating Agency An incident response database can be operated by a transportation agency (Operations or Maintenance divisions), police agency, or other response agency that is required to maintain a record of events.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the transportation, police, or other agency involved.

AUTOMATIC CARGO IDENTIFICATION

GENERAL DESCRIPTION

Automatic cargo identification (ACI) technologies rely on the identification of a specific cargo, independent of the vehicle, to determine, in the event of an incident, the presence of a hazardous material. Automatic cargo identification provides a safeguard if the vehicle's placard is not visible, the driver's manifest is not obtainable, or the first respondent to the scene is not trained to identify the substance. Automatic cargo identification requires the cargo container to be equipped with an electronic tag unique to that cargo. Portable electronic tag readers recognize a particular cargo's tag. Detailed cargo information, such as origin, destination, substance, and responsible party, can be maintained in a computer database and obtained, via communications link, by the respondents at the scene.

Conditions Under Which Appropriate

Appropriate in all circumstances, but will have the greatest benefit in densely populated or highly traveled areas where the consequence of a hazardous materials spill would be great.

Advantages

✓ Because potentially hazardous cargo can be identified more quickly, without the need for on-site experts, the safety of motorists and first respondents can be improved through more appropriate response actions (i.e., evacuation, road closure).

✓ The detailed information available from the tag can quickly identify responsible party information, thus speeding the clearance process for for both hazardous and non-hazardous materials.

Disadvantages

✗ Technology may experience slow implementation for all cargo to be tagged.

✗ Requires a database for detailed cargo and responsible party information.

✗ Requires that all responding personnel be aware of the ACI system capabilities and have access to the electronic readers and information.

✗ Other hazardous materials identification resources are still needed to confirm the automatically identified cargo.

Costs	Capital	High
	Maintenance	High
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	High
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Equipment Required

The special equipment required to implement an automatic cargo identification system includes electronic tags and portable electronic readers. In addition, a computer with a database program is required to maintain the detailed cargo and responsible party information. A communication link is required between the respondents at the scene and the computer database.

Special Training Required

Training in the operation of the new equipemnt may be required.

Operation

Public or Private

An automatic cargo identification system can be operated by either a public or private agency.

Operating Agency

An automatic cargo identification system can be operated by a transportation, police, fire, or private agency. The operating agency must have good communication capabilities with all of the other response agencies to ensure that the benefits of an automatic cargo identification system are fully realized.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the transportation, police, fire, or private agency.

Options for Reducing Clearance Time

Incident clearance is the process by which the vehicle(s) and/or debris causing the disruption to normal traffic conditions are safely and efficiently removed from any lanes of travel or from the immediate shoulder, where it may still serve as a hazard or distraction to the motoring public.

The types of programs chosen for implementation within this management category vary, depending on the incident clearance needs. To mitigate the impacts of minor incidents or disablements, an emphasis should be placed on providing space for temporary vehicle storage in the form of a holding area or off-road accident investigation site. The implementation of these options needs to be preceded or accompanied by public education efforts that inform the motoring public of the existence of these facilities and their ability to remove their vehicles from the incident scene without waiting for a police agency representative to arrive.

If the goal of the implementing agency is to reduce the impacts resulting from major incidents, the types of programs chosen for implementation should reflect this. For relatively immediate improvements in incident clearance efforts, programs should be implemented that serve to improve response vehicle access and maneuverability at the incident site. This can be accomplished with the implementation of the proper traffic control and channelization techniques. It is also important to ensure that the response vehicles are adequately equipped and that any larger, specialty equipment is easily obtainable. A more progressive, yet permanent, method for improving incident clearance is emphasis on improved personnel training. Ideally, a standardized set of guidelines should be developed for incident clearance procedures and incorporated into regular staff training sessions.

A number of techniques that serve to improve incident clearance efforts are listed in Table 2.11, along with their potential for providing benefits and their potential costs. Table 2.12 shows alternative ways for agencies to be involved in each management technique.

Table 2.11 Options for Reducing Clearance Time

Type of Program	Potential Benefits	Potential Costs	Comments
Policy Requiring Fast Vehicle Removal	👍👍👍👍	💰	Serves to quickly restore the capacity of the roadway,but may require passage of an ordinance to be used.
Accident Investigation Sites	👍👍	💰💰 ⇨ 💰💰💰	Serves to improve the safety of the motoring public, as well as improving the safety of the respondents, by removing the incident from the roadway.
Dedicated Freeway/Service Patrol	👍👍 ⇨ 👍👍👍👍	💰💰 ⇨ 💰💰💰💰	Specially equipped freeway/service patrol vehicles can clear most minor incidents without the assistance of other response vehicles.
Push Bumpers	👍👍	💰	Allows minor incidents to be cleared quickly.
Automated Debris Recovery System	👍👍	💰💰💰	Improves respondent safety, but response times may be too lengthy to reduce incident impacts.
Inflatable Air Bag Systems	👍👍	💰💰	Improves clearance times for incidents usually involving overturned trucks; however, use is severely limited by the truck trailer type involved.
Responsive Traffic Control Systems	👍👍	💰💰💰💰	Can improve clearance efforts by limiting congestion in the immediate area.
Advanced Vehicle Control	👍👍👍👍	💰💰💰💰	Can prevent incidents, as well as improve response and clearance.
Variable Lane Closure	👍👍	💰	Can speed clearance efforts by allowing the interruption of flowing traffic; may require a change in existing policy.
Ordinances Governing Shoulder Travel	👍	💰	Can provide additional travel lane for removing disabled vehicles but may be severely limited by space constraints.
Emergency Vehicle Access	👍👍	💰💰	Requires identification of those freeway links which suffer from poor access.
Alternative Route Planning	👍👍	💰	If implemented simultaneously with motorist information programs, can serve to reduce congestion and improve mobility at the incident site by rerouting uninvolved vehicles.
Identification of Fire Hydrant Locations	👍👍	💰	Can greatly speed clearance efforts by allowing the quick location of utilities in incidents involving fire.
Incident Response Teams	👍👍 ⇨ 👍👍👍👍	💰 ⇨ 💰💰💰	Coordinated response teams should be trained in a variety of equipment use to provide greatest clearance capabilities.
Personnel Training Programs	👍👍👍	💰💰	An emphasis of personnel training through knowledge and repetition of tasks can reduce required clearance times.
Incident Response Manual	👍👍👍	💰	Once developed, should be included in regular training procedures to further clearance efforts.
Hazardous Materials Manual	👍👍👍	💰	Once developed, should be included in regular training procedures to further benefit clearance efforts.

Table 2.11 Continued

Type of Program	Potential Benefits	Potential Costs	Comments
Administrative Traffic Management Teams	👍	💰	Provides a forum to discuss and provide funding for area incident management programs aimed at improving clearance times.
Public Education Program	👍👍👍	💰	Can educate drivers regarding disabled vehicle removal policies and can result in the immediate clearance of disabled vehicles off the roadway.
Total Station Surveying Equipment	👍👍👍👍	💰	Can reduce the time required for accident investigation by nearly half.

👍 = Minor benefits

👍👍 = Moderate benefits

👍👍👍 = Substantial benefits

👍👍👍👍 = Very substantial benefits

⇨ = Indicates a range of benefit/cost levels

💰 = Minor costs

💰💰 = Moderate costs

💰💰💰 = Substantial costs

💰💰💰💰 = Very substantial costs

Table 2.12 Agency Involvement in Reducing Clearance Time

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Fast Vehicle Removal	A	△	△				△		
Accident Investigation Sites	A	△	△				△		
Dedicated Freeway/Service Patrols	A	▲							
	B		▲						
	C						▲		
Push Bumpers	A		▲						
Automated Debris Recovery System	A	▲							
Inflatable Air Bag System	A	▲							
Responsive Traffic Control Devices	A	▲							
Advanced Vehicle Control	A	△					△		
Variable Lane Closure	A	△	△						
Ordinances Governing Travel on the Shoulder	A	▲							
Emergency Vehicle Access	A	△	△	△					
Alternative Route Planning	A	△	△	△	△		△		
Identification of Fire Hydrant Locations	A			▲					
Incident Response Teams	A	△	△	△			△		
Personnel Training Programs	A	△	△	△	△	△	△	△	
Incident Response Manual	A	△	△	△			△		
Hazardous Materials Manual	A	△	△	△			△		△
Administrative Traffic Management Teams	A	△	△	△	△				
Public Education Program	A	▲							
	B		▲						
	C	△	△	△	△	△	△	△	
Total Station Surveying Equipment	A		▲						

▲ Indicates sole involvement △ Indicates shared involvement

POLICY REQUIRING FAST VEHICLE REMOVAL

GENERAL DESCRIPTION

A policy can be created to require the removal of vehicles along the shoulder within a given short amount of time, usually one to two hours. The vehicle owner, police, or transportation agencies can notify private towing companies, which then quickly remove the vehicle to a specified location or a nearby holding area.

Conditions Under Which Appropriate

Appropriate where shoulders exist and adequate space for a holding area is not far away.

Advantages

✓ Increases roadway capacity.

✓ Motivates car owners to have their vehicles moved quickly.

Disadvantages

✗ May require passage of an ordinance or legislative steps.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	Variable - See Below
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Liability

If the transportation or police agency involved initiate the tow, liability concerns are relevant because of the unnecessary damage that may occur to the disabled vehicle during the towing or pushing.

Legislative Requirements

This option requires the passage of an ordinance to gain the cooperation of the responding agencies and the general public.

Operation

Operating Agency

Police agencies should be responsible for enforcing this ordinance, but must have the cooperation of the transportation and private agencies involved.

Funding Responsibility

Funding requirements are minimal and may easily be absorbed by the transportation or police agency involved.

GENERAL DESCRIPTION

Accident investigation sites consist of a turnout from the freeway mainline that provides motorists and police a place to fill out accident reports and possibly place necessary telephone calls. Area surfacing may consist of dirt/gravel, asphalt concrete, or concrete, depending on location and site conditions. Signing is required to notify the motoring public of the existence and use of this facility.

Conditions Under Which Appropriate

Appropriate in areas where enough land exists to give motorists an adequate turnout without their having to travel great distances.

Advantages

- ✓ Reduces delay from gapers' block.
- ✓ Reduces secondary accidents.
- ✓ May provide forms for reporting.
- ✓ May include telephone for reporting incidents.

Disadvantages

- ✘ Finding a good location may be difficult.
- ✘ Site preparation and signing may be costly.
- ✘ Publicity may be costly.
- ✘ Driver education is required.

Costs

Capital	Medium
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	Variable - See Below
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Variable - See Below

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Liability

Liability is a concern if unnecessary damage may occur to the disabled vehicle when the vehicle is pushed or towed off the roadway to the accident investigation site.

Operation

Operating Agency

Even though the implementation and maintenance responsibilities lie solely with the transportation agency involved, the day to day operation of the accident investigation site should be a cooperative effort among the transportation, police, and private agencies involved.

GENERAL DESCRIPTION

The establishment of a dedicated freeway/service patrol program may resul in numerous improvements to the incident management effort for a potentially minimal cost. To achieve the greatest benefit, the freeway/service patrols should operate in congested areas during the peak hours or in areas that suffer from high incident rates. Patrol personnel should be trained in general incident response procedures, including emergency medical training, departmental procedures and policies, and traffic control procedures.

A noticeable benefit that may result from the establishment of a dedicated freeway/service patrol is that many minor incidents or disablements can be cleared with the responding patrol vehicle, eliminating the delay caused when a tow truck is needed. The legal implications of this service, as well as the variety of cost levels at which this program can be implemented, are discussed in the Detailed Description.

With well trained personnel and a geographic surveillance area that is compatible with the number of vehicles in the patrol, incident detection time should decrease.

A third benefit is that incident response times should improve. The patrol vehicles are usually physically closer to the incident site than vehicles that depart from a location far from the corridor under surveillance.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where efficiency in incident detection is critical.

Advantages

✓ In addition to improving detection times, dedicated freeway/service patrols improve response and clearance times.

✓ Trained personnel can quickly assess incident severity.

✓ Patrol vehicles can often quickly remove minor incidents.

Disadvantages

✘ May conflict with other operating agency budgetary priorities.

✘ Additional personnel may be required.

✘ Quickly becomes ineffective if implemented improperly.

Costs	Capital	Variable - See Below
	Maintenance	Low
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with a dedicated freeway/service patrol vary greatly, depending on the size of the initial program, the aim of the program, and the source of the equipment or supplies. In any case, it is wise to initiate a small scale patrol program that requires minimal capital investment, then expand as the program proves successful. Or, if the program has not proved successful, it may be altered or abandoned for a new program that better meets the incident management needs.

Along with the size of the program, the aim of the program can greatly affect initial capital requirements. For instance, to mitigate the impacts of major incidents that involve numerous vehicles and/or trucks, larger, heavy-duty response vehicles such as wreckers or tow rigs are required. These vehicles have high initial capital funding requirements. However, if the aim of the program is to mitigate minor accidents or vehicle disablements, smaller response vehicles such as pickup trucks or vans can be chosen, greatly reducing the initial capital required.

A third factor that affects the required capital funding is the source of the equipment or supplies. Various methods exist for the initial purchase of the appropriate equipment. One option is for the public operating agency to acquire the new vehicles, but this option requires a large amount of initial funding. A second option is to utilize backup or refurbished vehicles as incident patrol vehicles. This choice greatly reduces the capital funding required. A third option is to obtain privately sponsored vehicles. Many private agencies are willing to assume the cost of purchasing, operating, and maintaining a small number of freeway/service patrol vehicles in return for beneficial public relations and additional advertising. Even though a specified public agency (i.e., a transportation or police agency) must frequently monitor or inspect the patrol program, it does not directly incur any capital costs, making this the lowest cost option.

Special Equipment Required

The type of equipment required depends upon the specific incident management needs, as well as the amount of funding available for the development of the program. Relatively low cost options include using light/medium duty pickup trucks, vans, or patrol cars to mitigate the impacts of minor vehicle accidents or disablements. These vehicles may be purchased new by the public operating agency, refurbished, or sponsored by the private sector in return for advertising and public relations benefits. Each of the vehicles must be appropriately equipped with gasoline, water, tools for minor repair, jumper cables, flares, first aid kits, warning lights, and possibly push bumpers. Auto parts are not recommended, since the goal is to offer the service to the public with negligible associated costs.

For major incidents, larger or specially designed vehicles may be chosen. Tow trucks/rigs, cranes, or wreckers may be used to patrol localized areas that suffer from high incident rates or limited access. In this instance, though response may be relatively infrequent, the decrease in the usually lengthy delays may warrant implementation.

In each of these cases, it is better to begin on a small scale with the purchase of only a few vehicles, prove the program's success, and then increase the response fleet to improve efficiency.

Special Training Required

The required training depends on the background and experience of the responding personnel. However, a well trained freeway/service patrol respondent should be knowledgeable in the following areas:

- Emergency medical training including CPR and first aid
- Radio communication with an emphasis on reporting
- Traffic control
- Public relations
- Surveillance of suspicious activities
- A general knowledge of departmental procedures and policies of each of the responding agencies (transportation, police, and fire and rescue).

Obviously, some of these areas will overlap with the existing public agency training requirements, so a unique training program may be needed for freeway/service patrol personnel.

Liability

A minimal chance for liability exists from damage that the disabled or blocking vehicle may possibly incur. However, this chance for liability can be greatly reduced if an emphasis is placed on training the respondent personnel.

Operation

Public or Private

A dedicated freeway/ service patrol program can be operated by either a public or private agency.

Operating Agency

A dedicated freeway/service patrol program can be operated by a transportation agency (Operations or Maintenance divisions), police agency, or private agency. If a private agency wishes to undertake the operation, some coordination must occur with either the transportation or

police agency to ensure that the vehicles are operated safely and are properly equipped and that patrol respondents are properly trained.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the transportation, police, or private agency involved. However, if operation is undertaken by the transportation agency, freeway/service patrols are eligible for Federal Aid Primary, Urban, and Interstate 4R Funds. These funds are available for the establishment of the service but not the day-to-day operational costs.

GENERAL DESCRIPTION

Patrol cars or small response vehicles can be equipped with a push bumper, which allows patrol cars/response vehicles to move disabled vehicles off the travelled way without the use of a tow truck. Installation of such a device must be accompanied by a set of clearly defined guidelines describing when it is appropriate to remove a damaged or disabled vehicle.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ All patrol vehicles are able to clear minor incidents.

Disadvantages

✗ Use is limited to cars and light trucks to prevent possible transmission damage to the respondent vehicle.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Equipment Required

The only equipment required are the push bumpers themselves. Depending on the incident management needs, these bumpers may be specially designed for extremely heavy vehicles or with special bumper configurations.

Special Training Required

Sufficient instruction must cover the use of the push bumpers to ensure adequate safety for the respondents and the motoring public, as well as reduce the possibility for liability. Guidelines can be established to give appropriate instances in which to use push bumpers and the proper operation techniques. For instance, push bumpers are appropriate when the wheels on the damaged or disabled vehicle still move freely and the driver is still deemed capable of driving, despite the possible loss in power steering and brakes. Then, after any injuries have been treated and acciden data have been collected, the push bumpers can be utilized.

Push bumpers are not appropriate if the damaged or disabled vehicle is too large, if the wheels are immobile, if the driver seems unfit to safely maneuver the car, if the bumper connection poses a problem, or no shoulder or emergency pullout is nearby.

If the vehicle appears capable of being pushed, the respondent must clearly explain to the driver what will happen. Common practice is to push the disabled or damaged vehicle to the right shoulder unless crossing traffic to the right is too difficult and adequate room exists on the left shoulder.

Even though these issues should be thoroughly discussed in a set of procedural guidelines, these issues also need to be incorporated into regulai agency training sessions.

Liability

Liability should be a concern, since the disabled vehicle may incur unnecessary damage in the process of being pushed off the travel way. However, the possibility of liability is greatly reduced with the proper training in the use of vehicles equipped with push bumpers.

Operation

Operating Agency

Push bumpers can be utilized by any responding agency. However, they will be most beneficial if used by a police or transportation agency because these agencies generally have smaller response vehicles capable of maneuvering in congested areas.

Funding Responsibility

Funding responsibility lies solely with the operating agency involved, namely the transportation or police agencies involved.

AUTOMATED DEBRIS RECOVERY SYSTEM

GENERAL DESCRIPTION

An automated debris recovery system is a self-propelled vehicle that can pick up and store debris from the roadway and later dispose of it at a suitable location. An automated debris recovery system can pick up small to large debris including tire treads, hubcaps, road kill, blankets, and other items while traveling at between 5 to 30 miles per hour. Slower speeds allow the automated debris recovery system to pick up small er debris. For larger debris, higher speeds can be attained.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where efficiency in debris clearance is critical.

Advantages

✓ Reduces the respondents' exposure to danger at the incident scene.

✓ Reduces the potential for manual labor-induced injuries.

✓ Debris is cleared much more quickly with the automated debris recovery system than through manual methods.

✓ Automated debris recovery system can be used for routine maintenance and clean up when not in use for incidents.

Disadvantages

✗ Response times may be lengthy, depending on location, because an automated debris recovery system fleet will be small and will have poor area coverage.

✗ An automated debris recovery system vehicle, being fairly large, may have difficulty accessing an incident scene if the traffic is backed up.

Costs

Capital	High
Maintenance	Medium
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agencies

Funding Responsibility

Transportation Agencies

DETAILED DESCRIPTION

Costs

Special Equipment Required	An automated debris recovery system vehicle is required.
Special Training Required	Vehicle-use training for the automated debris recovery system is required.

INFLATABLE AIR BAG SYSTEMS

GENERAL DESCRIPTION

Air bag systems, which can effectively right overturned vehicles, consist of several heavy rubber inflatable cylinders of various heights, lengthy air hoses, and an air pumping system. These systems work ideally in constrained areas, such as tunnels, bridges, or overpasses, where larger towing or response vehicles may have difficulty maneuvering. When deflated, the air bags can be positioned almost anywhere to begin the righting process. As the process continues, the cooperation of a wrecking vehicle may be required. However, limitations do exist on its use with some truck trailer types. Some trailers, depending on their size and shape, can puncture the air bags. However, air bag systems are ideal for fragile loads/tankers that may be damaged or punctured by other righting means.

Conditions Under Which Appropriate

Appropriate when an incident involves an overturned vehicle that is either fragile or in a constrained area and that will not damage the air bag system.

Advantages

- ✓ Especially useful when the incident involves fragile tankers.
- ✓ Operable in constrained areas (i.e., bridges, tunnels, overpasses).

Disadvantages

- ✗ Limited in use by vehicle type.
- ✗ May still require a wrecker to fully right the vehicle.

Costs

Capital	Medium
Maintenance	Low
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	Variable - See Below
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The only equipment that is required for the implementation of an air bag system is the system itself. This consists of a series of heavy rubber inflatable cylinders of differing heights, lengthy rubber air hoses, and an air pumping system. One option is to have the air pumping system built directly into one of the response vehicles and to include storage for the air bags and hoses for ease of transport and maneuvering.

Special Training Required

Training is required not only in the operation of the air bag system, but also in recognizing when it is appropriate to use. Serious injury to the respondents or motoring public may result if the system is used inappropriately.

Liability

Some possibility for liability exists if unnecessary damage is caused to the truck, trailer, or load or if injury is caused to the driver, respondent, or motoring public through the improper use of the air bag system. This possibility for liability should diminish with proper training in the operation and appropriateness of the air bag system.

RESPONSIVE TRAFFIC CONTROL SYSTEMS

GENERAL DESCRIPTION

Responsive traffic control systems, such as ramp metering devices, can greatly aid in the clearance process. By preventing an excess number of vehicles from approaching the incident scene, the systems create more space for the response vehicles to easily maneuver and quickly clear the incident. However, the delayed motoring public must be kept informed, either through signing (i.e., VMS) or the media, about the cause of delay.

Conditions Under Which Appropriate

Appropriate in areas where queueing on the freeway access ramps will not cause secondary accidents or congestion problems on the arterials.

Advantages

✓ Keeps the incident site free from an excess of vehicles, providing more space for the response vehicles to maneuver.

✓ Improves the safety of respondent by limiting traffic at the incident site.

Disadvantages

✗ Requires an information system to inform the motoring public of the cause of the delay.

✗ Difficult to implement fast enough after the incident has occurred to be effective.

Costs

Capital	High
Maintenance	Medium
Operating	High
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

	Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The equipment of choice is most likely a ramp metering system, which, through red/green signals controlled from a central monitoring station, can limit freeway access. This system should be accompanied by some type of signing or other communication to inform the delayed motorists of the reasons behind and expected duration of the delay.

Special Training Required

Training is required in the operation and maintenance of any new equipment obtained.

GENERAL DESCRIPTION

Advanced vehicle control (AVC) systems help prevent incidents rather than improve their management. Advanced vehicle control systems can prevent incidents both in both the longitudinal and lateral directions. Longitudinal direction incidents include head-on and rear-end collisions. Lateral direction incidents include side-swipe or other incidents caused when a vehicle has left its lane. In addition, advanced vehicle control systems allow motorists to be automatically rerouted to avoid congestion.

The advanced vehicle control systems technology is still being developed and is not widely deployed. The implementation of this technology will likely be in stages, the final stage of which will be the fully automated vehicle on a fully instrumented highway.

Conditions Under Which Appropriate

Appropriate in areas of intense congestion or limited access (i.e., bridges, tunnels, overpasses) where incident impacts are major.

Advantages

- ✓ Avoids the incident rather than mitigates the consequences of the incident.
- ✓ Allows for the automatic diversion of motorists around incident sites.
- ✓ May reduce the stress of driving for motorists.
- ✓ Prevents incidents resulting from human error.

Disadvantages

- ✘ Greatest benefits result only when system is fully automated.
- ✘ Fully automated system may experience lengthy implementation times.
- ✘ System is costly.

Costs

Capital	Variable - See Below
Maintenance	High
Operating	High
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	Variable - See Below
Legislative Requirements	None

Operation

Public or Private	Variable - See Below
Operating Agency	Variable - See Below

Funding Responsibility

Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs involved with an advanced vehicle control system are high. However, some of the cost burden may be assumed by the private sector through public/private partnerships.

Special Equipment Required

The type of equipment required depends upon the level of automation offered through the advanced vehicle control system. Each of the vehicles must be appropriately equipped to allow either for the motorist to be warned of a potential incident or for the vehicle to automatically take control to avoid the incident. In addition, the roadway must be instrumented to allow real-time information to be sent to the vehicle.

Special Training Required

The required training depends on the level of automation offered through the advanced vehicle control system. Public education must take place for the new technology to be accepted and properly used. In addition, the controlling agency must train personnel to operate and maintain the new equipment as part of the system.

Liability

A chance for liability exists if an incident occurs after the implementation of the advanced vehicle control system. However, this chance for liability can be greatly reduced if the limitations of the system are carefully defined.

Operation

Public or Private

An advanced vehicle control system should be a cooperative effort with both public and private agency involvement. The instrumented roadway should be operated by a public agency because of its direct impact on the public agency's facilities and the risk of liability placed upon that agency. The development and implementation of the instrumented vehicle should be the responsibility of the private sector, either automative manufacturers or after-market suppliers.

Operating Agency

An advanced vehicle control system should be cooperatively operated by a transportation agency (Operations division) and private agencies, automative manufacturers, or after-market suppliers. Coordination must occur with other response agencies.

Funding Responsibility

The funding responsibility lies with both operating agencies, namely the transportation and private agencies.

POLICY ALLOWING VARIABLE LANE CLOSURES

GENERAL DESCRIPTION

To minimize traffic flow delays that result from a lane blocking incident, a policy allowing variable lane closures could be developed to facilitate the necessary vehicle removal. Such a policy would allow the motoring public to travel in the unblocked lanes with the understanding that, as soon as the vehicle could be moved, the traffic flow would be interrupted. This policy would prevent lengthy closures of entire roadways. Adequate signing or notification of the temporary closure would have to occur to prevent severe secondary accidents.

Conditions Under Which Appropriate

Appropriate in areas where the safety of the motoring public or respondents would not be jeopardized by limited visibility caused by horizontal curves, vertical curves, or obstructions.

Advantages

✓ Traffic is not delayed through the entire response process.

Disadvantages

✗ Unexpected stopping of traffic may cause severe secondary accidents.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Training Required Special training might be required in the area of traffic control safety. Even though traffic control procedures are incorporated into most transportation agency training sessions, a new emphasis would have to be placed on providing adequate visibility and stopping room for the motoring public, especially around horizontal and vertical curves.

Liability

A chance for liability would exists if proper safety measures were not taken when the normal flow of traffic was interrupted. Unexpected stopping might lead to severe secondary accidents. Therefore, adequate notification of the required stop would have to occur.

Legislative Requirements

Since the practice of allowing traffic breaks may not be incorporated into present agency policy, legislative steps might be required to utilize this option in the field.

ORDINANCES GOVERNING TRAVEL ON THE SHOULDER

GENERAL DESCRIPTION

Newly constructed or redesigned roads could be subjected to a minimum shoulder width ordinance so that, in the case of a lane blocking incident, adequate space would be available to reroute traffic along the shoulder. This policy would also allow the incident vehicle to be towed or pushed along the shoulder or simply pushed over to the shoulder and left for a short duration. Any of these options would reduce the queues that form behind a lane blocking incident. Areas such as bridges, tunnels, and overpasses would, of course, be exempt from the ordinance.

Conditions Under Which Appropriate

Appropriate in less populated areas where everyday traffic volumes do not require the use of all available space.

Advantages

✓ Allows secondary choice of access or clearance for response vehicles.

Disadvantages

✗ Difficult to accomplish in the densely populated or travelled areas where it would be most useful.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	None
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Legislative Requirements

An ordinance would be required to set a minimum shoulder width limitation for newly constructed or redesigned roads. AASHTO or other organizations should be looked to for standards governing shoulder design and the process required for the approval of design exceptions.

Options for Reducing Clearance Time

GENERAL DESCRIPTION

Movable barriers and U-turns at key locations can reduce response times for emergency vehicles. This option requires an initial effort to identify freeway links that do not have adequate access. All responding agencies must then be informed of the existence and usage of these access routes.

Conditions Under Which Appropriate

Appropriate in areas with limited access such as bridges, overpasses, or tunnels.

Advantages

✓ Emergency vehicles can approach the incident from both directions.

✓ Both response and clearance efforts benefit with the implementation of emergency vehicle access areas.

Disadvantages

✘ Unauthorized motorists are tempted to use the U-turns.

✘ The purchase and installation of barriers are expensive.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

If movable barriers are selected, a mechanical means for quickly and safely relocating the barriers is needed. Whatever option is chosen, signing is required to identify the locations of the emergency vehicle access areas.

Special Training Required

If movable barriers are chosen, training is required in the operation of any new equipment that may be purchased to relocate the barriers. Then, knowledge of the safest method of placing, as well as the placement itself, is important.

Liability

If movable barriers are used to alter the traffic flow, liability may ensue if proper notification or signing of the traffic channelization is not provided and secondary accidents occur.

GENERAL DESCRIPTION

In the case of a lane blocking incident, motorists can be directed to use preplanned alternative routes to help mitigate the impacts of the incident. Their use requires prior analysis of the freeway corridor. All responding agencies must then be made aware of these routes. Such routes require adequate temporary or permanent signing at key locations.

Conditions Under Which Appropriate

Appropriate in all circumstances as long as care is taken to avoid alternative routes that inhibit the flow of normal traffic because of low overpasses or severe turns.

Advantages

- ✓ Route diversion can occur quickly.
- ✓ May be part of a civil defense or disaster response program.
- ✓ Provides coordinated alternative route planning for participating agencies.

Disadvantages

- ✗ Requires sizable investment of staff time.
- ✗ Some communities do not wish to have traffic diverted onto their streets, regardless of the circumstances.

Costs

Capital	Variable - See Below
Maintenance	Low
Operating	Low
Special Equipment Required	Variable - See Below
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Capital

Capital costs may vary, depending on the size of the urban area involved and the extent of the alternative route study. Also, the extent to which signing is provided, both before and along the alternative routes, can affect capital costs. In some cases, unexpected capital costs may be incurred because of the minor revisions in the roadways required to make them suitable.

Special Equipment Required

Signing equipment, either temporary or permanent, is required at junctions and along alternative routes to reduce confusion and encourage smooth traffic flow.

IDENTIFICATION OF FIRE HYDRANT LOCATIONS

GENERAL DESCRIPTION

A comprehensive list can be developed to give the exact location (e.g., 35 feet east of the northbound lane fog line) of all fire hydrants that are easily accessible from the main freeways, highways, or expressways. Once this list has been completed, adequate signing must be installed so that fire hydrant locations can be immediately recognized in the field. This comprehensive list should be kept in all fire and rescue responding vehicles, and all personnel should be aware of its existence.

Conditions Under Which Appropriate

Appropriate under all conditions.

Advantages

✓ Allows quick location of utilities.

Disadvantages

✗ None.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	None
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Fire and Rescue Agency
Funding Responsibility		Fire and Rescue Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The only equipment that is required to implement this option is extensive signing to would allow quick location of the utilities in the field.

Options for Reducing Clearance Time

GENERAL DESCRIPTION

Incident Response Teams are interdisciplinary teams trained in handling large or severe incidents. The teams may be staffed by volunteers from each of the responding agencies (i.e., transportation, police, and fire and rescue), but someone must be available to coordinate all of the responding personnel if this alternative is to operate efficiently.

Conditions Under Which Appropriate

Appropriate in areas where interagency cooperation is lacking and on-site efforts are often uncoordinated.

Advantages

- ✓ Teams are prepared to handle unusual incidents.
- ✓ Individuals know each other and their roles.
- ✓ Improves both site management and clearance efforts.

Disadvantages

- ✗ Additional costs are created for the coordinating agency.
- ✗ Coordination can be extremely difficult.

Costs	Capital	Variable - See Below
	Maintenance	Medium
	Operating	Variable - See Below
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement an incident response team program vary, depending on the size of the program implemented and the cooperative agreements established among agencies defining equipment and personnel use. It is wise to begin the program on a small scale, determine its success, and then choose to expand or abandon the program.

Operating

Operating costs also vary, depending on the size of the program and the equipment requirements.

Special Equipment Required

The equipment required varies greatly, depending on the types of incidents tackled by the response team. If a wide range of agencies take part in the incident response process, a wide range of equipment should be easily accessible.

Special Training Required

Little training in operational procedures is required because regular agency training sessions cover these areas. However, interagency training is required for on-site coordination.

Liability

Liability should be a concern if unnecessary damage may be incurred by either the persons or vehicles at the incident site. However, the possibility of damage can be greatly reduced with adequate training programs.

Operation

Operating Agency

Requires a cooperative effort between transportation, police, fire and rescue, and other responding agencies.

Funding Responsibility

Ideally, the funding for this program is provided by all responding agencies, depending on their degree of participation. This arrangement requires specific guidelines and may delay implementation of the program if an agreement among the appropriate agencies is lacking. A second option is for the transportation agency to assume responsibility for funding and to establish contracts with the other agencies that delineate guidelines for equipment and personnel use.

PERSONNEL TRAINING PROGRAMS

GENERAL DESCRIPTION

An agency should support personnel training programs that not only focus on its own required policies and procedures, but also on the policies and procedures of other responding agencies. Since a safe and efficient inciden response process is dependent on all responding personnel, these personnel must be aware of each agency's needs and requirements. Such cooperative training programs can serve to greatly improve interagency relationships.

Conditions Under Which Appropriate

Appropriate under all conditions, but requires an initial willingness to participate from all responding agencies.

Advantages

- ✓ Improves incident response, site management and incident clearance efforts.
- ✓ Improves interagency relationships.

Disadvantages

- ✗ Requires an initial willingness from all responding agencies to be successful.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Training should focus not only on the policies and procedures of the personnel's own agency, but also on the policies and procedures of each of the responding agencies. Once all of the responding personnel have become aware of other agencies' requirements, the overall response process will operate much more efficiently.

Operation

Operating Agency

For personnel training programs to be successful, a cooperative effort on the part of all responding agencies is required. A single agency, most likely the transportation agency involved, should coordinate the involvement of the various agencies.

Funding Responsibility

Ideally, the funding responsibility should be a cooperative effort because all agencies will benefit from this program. However, costs are so minimal that they can easily be absorbed by the operating or coordinating agency.

GENERAL DESCRIPTION

An incident response manual could be developed to improve efficiency at the incident site. This set of guidelines would have to be a cooperative effort by all responding agencies, since their input would be required to compile accurate procedural steps. Once the guide had been completed, these guidelines could be distributed to all responding personnel and incorporated into regular training sessions.

Conditions Under Which Appropriate

Appropriate in instances where clearance efforts are uncoordinated and inefficient.

Advantages

✓ Helps to ensure that the safest and most efficient clearance procedures are followed.

Disadvantages

✗ May be difficult to gain the cooperation of all responding agencies.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Once the incident response manual had been developed, all personnel who respond to incidents would have to be able to quickly and efficiently follow the defined procedures. This might require special training sessions in addition to regular agency training. An emphasis should be placed on interagency cooperation.

Operation

Operating Agency

Although the transportation agency would be responsible for developing the incident response manual (to include interaction with the other responding agencies to ensure accurate procedures), this option would require a cooperative effort on the part of all responding agency personnel to ensure that the guidelines defined in the manual were followed in field procedures.

Funding Responsibility

The transportation agency involved would be responsible for securing funding for the development of the incident response manual. However, once the manual had been developed, associated training costs should be cooperatively provided by all responding agencies.

GENERAL DESCRIPTION

A hazardous materials manual could be developed to describe the procedures appropriate for incidents that involve hazardous substances. This set of guidelines should be a cooperative effort by all responding agencies, since their input would be required to compile accurate procedural steps. Once the guide had been completed, these guidelines could be distributed to all responding personnel and could be incorporated into regular training sessions.

Conditions Under Which Appropriate

Appropriate in instances where clearance efforts are uncoordinated and inefficient.

Advantages

✓ Helps to ensure that the safest and most efficient clearance procedures are followed.

Disadvantages

✗ May be difficult to gain the cooperation of all responding agencies.

Costs	Capital	Medium
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Special Training Required

Once the hazardous material manual had been developed, all personnel wh(respond to incidents would have to be able to quickly and efficiently follow the defined procedures. This might require special training sessions in addition to regular agency training. An emphasis should also be placed on interagency cooperation.

Operation

Operating Agency

Although the transportation agency would be responsible for developing the hazardous materials manual (to include interaction with the other responding agencies to ensure accurate procedures), this option would require a cooperative effort by all responding agency personnel to ensure that the guidelines defined in the manual were followed in field procedures

Funding Responsibility

The transportation agency involved would be responsible for securing funding for the development of the hazardous materials manual. However, once the manual had been developed, associated training costs should be cooperatively provided by all responding agencies.

ADMINISTRATIVE TRAFFIC MANAGEMENT TEAMS

GENERAL DESCRIPTION

Administrative traffic management teams comprise officials from all incident response agencies, including transportation, police, and fire and rescue agencies. Their purpose is to quickly provide necessary funding and resources through the establishment of cooperative agreements and improved interagency relationships.

Administrative Traffic Management Teams can also act as a key catalyst in initiating an Incident Management System, as well as supporting an existing program. With adquate interagency communication, a successfull Incident Mangement Program should result which meets the needs of all agencies involved in addition to meeting the traffic management.

Conditions Under Which Appropriate

This option is appropriate under all conditions but requires willing participation from all agencies to be successful.

Advantages

✓ Provides a forum for interagency cooperation.

✓ May develop personal relations among agency leaders, improving their communication.

✓ Agencies can learn about the specific abilities and limitations of the other responding agencies.

Disadvantages

✘ Senior staff may spend too much time going to each monthly meeting.

✘ Quickly becomes ineffective if participants are unable to make commitments.

Costs

Capital	Low
Maintenance	Low
Operating	Low
Special Equipment Required	None
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

PUBLIC EDUCATION PROGRAM

GENERAL DESCRIPTION

A complete public education campaign would be undertaken to inform the driving public about when it they should remove vehicles from the road prior to the arrival of a police officer. In many cases, small incidents can be completely removed without the need for a response if the involved motorists would simply move their vehicles to the shoulder and exchange information. Many motorists are reluctant to do this because they are under the impression that a uniformed police officer must observe the scene before vehicles can legally be moved.

Conditions Under Which Appropriate

This option is appropriate under all conditions where existing laws do not restrict the removal of vehicles from the scene of small accidents prior to the arrival of a uniformed law enforcement officer.

Advantages

- ✓ Provides very fast removal of incident cause.
- ✓ Has no cost to the operations section of law enforcement or highway agencies.
- ✓ Frees law enforcement officers to perform other, more important duties.
- ✓ Frees incident management personnel to respond to other incidents.
- ✓ Can be part of a larger public information program.

Disadvantages

- ✗ It is difficult to change motorists behavior.
- ✗ Such campaigns would be outside the scope of activities undertaken by most agencies involved in incident management.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	Variable - See Below
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Operations

Operating Agency

Either a highway agency or a police agency would be likely operating organizations for such a public information campaign. The campaign could also be a joint effort of many agencies.

Funding Responsibility

Ideally, the funding responsibility would be undertaken by the agency or agencies that will implement and operate the public education program.

TOTAL STATIONS SURVEYING EQUIPMENT

GENERAL DESCRIPTION

New technologies such as infra-red total station surveying equipment can greatly reduce the amount of time required by Police agencies for accident investigation. Implementation of this option would consequently reduce the need for road and lane closures. Once data is collected, the data can then be downloaded into a CADD system and accident re-creation can be modeled.

Conditions Under Which Appropriate

This option is appropriate under all conditions.

Advantages

✓ Greatly reduces the time required by police agencies to collect acciden investigation data.

✓ Allows more accident-related information to be collected with greater accuracy.

Disadvantages

✗ Requires supporting computer systems for maximum benefit (i.e., accident re-creation).

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Police Agency
Funding Responsibility		Police Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

Requires the obtainment of the total station surveying equipment and may require the obtainment of additional supporting systmes such as computers and/or plotters for accident re-creation.

Special Training Required Introductory training in the use, care, and purpose for the new equipment may be required.

Options for Improving Motorist Information

The general intent of motorist information systems is to reduce both the traffic congestion caused by an incident and the hazards associated with the incident location. Adequately informing motorists of the incident location and the scope of the incident can help reduce traffic volumes that pass the site, spread the traffic mitigation measures over a greater geographic area, and reduce vehicle speeds approaching the site (or at least heighten drivers' awareness of upcoming conditions). All of these items benefit both the agencies, who try to reduce congestion levels and improve the safety of work crews, and the motorists, who need to use the congested facilities.

A list of the incident management techniques that serve to improve the amount and quality of information provided to motorists can be found in Table 2.13 along with their potential costs and benefits. Table 2.14 shows alternative ways for agencies to be involved in each management technique.

Table 2.13 Options for Improving Motorist Information

Type of Program	Potential Benefits	Potential Costs	Comments
Improved Media Ties	👍👍	💰	Information disseminated by the media must be effective and accurate and must therefore come from a single and central dissemination point.
Highway Advisory Radio	👍⇨👍👍	💰⇨💰💰	Variations include mobile and truck mounted, but in each case must be kept current and accurate to be utilized by the motoring public.
Variable Message Signs	👍👍	💰⇨💰💰	Variations include flap, matrix, drum, permanent and portable, but in each case must be kept current and accurate to be utilized by the motoring public.
Radio Data Systems (RDS)	👍👍👍	💰💰💰💰	Provides information to motorists when they want it, but is still in the early implementation stage.
Externally Linked Route Guidance (ELRG) Systems	👍👍👍👍	💰💰💰💰	Provides the most comprehensive information concerning traffic situations, but is still in development stage.
Central Information Processing and Control Site	👍👍👍	💰💰💰	A central location which can collect data from multiple sources will be able to provide a more accurate picture of existing traffic conditions.
Advanced Traveler Information Systems	👍👍	💰⇨💰💰💰	Relies on motorists to change their driving behavior, which may not happen.

👍 = Minor benefits

👍👍 = Moderate benefits

👍👍👍 = Substantial benefits

👍👍👍👍 = Very substantial benefits

⇨ = Indicates a range of benefit/cost levels

💰 = Minor costs

💰💰 = Moderate costs

💰💰💰 = Substantial costs

💰💰💰💰 = Very substantial costs

Table 2.14 Agency Involvement in Improving Motorist Information

Type of Program	Options	Transport Agencies	Police Agencies	Fire & Rescue	Public Works	Transit Authorities	Private Agencies	Media	Other
Improved Media Ties	A	△	△	△				△	
Highway Advisory Radio	A	▲							
Variable Message Signs	A	▲							
Radio Data Systems	A	▲							
Externally Linked Route Guidance	A	▲							
Central Information	A	▲							
Processing and	B	△	△			△	△	△	
Control Site	C						▲		
Advanced Traveler	A	▲							
Information Systems	B	△						△	

▲ Indicates sole involvement

△ Indicates shared involvement

<u>Example of Sole Involvement</u>
Highway Advisory Radio should be implemented and operated solely by a transportation agency and requires no interagency cooperation for the success of the program.

<u>Example of Shared Involvement</u>
Improved media ties require a cooperative effort on the part of transportation, police, fire and rescue agencies and the media to be successful.

IMPROVED MEDIA TIES

GENERAL DESCRIPTION

The purpose of this alternative is to shift the task of incident-related information dissemination from public agencies to private media agencies through improved interagency relationships. This cooperative effort greatly reduces the need for publicly financed information systems. However, to be effective and accurate, the information obtained by the media must come from a single and central dissemination point such as a public agency contact, an aircraft patrol, or a ground patrol.

Conditions Under Which Appropriate

Any conditions are appropriate. May be chosen when funding for Highway Advisory Radio is not available.

Advantages

- ✓ Frequent traffic reports may help motorists delay trips or use alternative routes, easing congestion.
- ✓ Improves public image of all involved agencies.

Disadvantages

- ✗ Personnel must be available for media inquiries.
- ✗ Many commercial radio and television stations only provide traffic information during peak times.

Costs	Capital	Low
	Maintenance	Low
	Operating	Low
	Special Equipment Required	None
	Special Training Required	None
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Operation

Operating Agency

For this alternative to succeed, a cooperation must take place among any transportation, police, and fire and rescue agencies involved with incident response, as well as with local media agencies.

Funding Responsibility

The need for funding is minimal and could easily be absorbed by the transportation agency involved.

GENERAL DESCRIPTION

Highway Advisory Radio (HAR) is a dedicated radio frequency that provides information about traffic and alternative routes during congested periods. Several variations exist, including the HAR Portable System (HARPS), which is contained in its own trailer for ease of movement but is best suited for monthly projects, and the HAR Truck System (HARTS), which is mounted on a truck and can be moved easily.

Conditions Under Which Appropriate

This alternative is most effective when implemented either coincidentally or following adequate alternative route planning. Key HAR locations must be identified to give motorists ample time to choose alternative routes.

Advantages

✓ Makes instant traffic reports available.

✓ Helps motorists decide on alternative routes when they need the information, not when the radio station is broadcasting it.

Disadvantages

✗ Recorded messages become repetitious.

✗ Motorists stop using it if it does not provide timely, accurate information.

✗ Needs to be updated frequently.

✗ High Maintenance.

Costs

Capital	Low
Maintenance	High
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	Variable - See Below
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required	Along with the appropriate Highway Advisory Radio equipment required, a special broad area HAR licence must be acquired from the FCC.
Special Training Required	Requires introductory training in system set up and operation.

GENERAL DESCRIPTION

Mounted on trucks or permanent fixtures, variable message signs can communicate special warnings and directional information such as lane closures, traffic diversions, and slow traffic ahead. Several varieties of variable message signs exist, including flap, matrix, velcro, and others. Regardless of the type of message sign used, an accompanying booklet should list both the standard and unusual messages that may be displayed. This documentation will save time and lend consistency to the program.

Conditions Under Which Appropriate

Appropriate in high incident locations, construction sites, and preceding junctions for alternative routes or detours.

Advantages

✓ Same sign may be used for different messages.

✓ The possibility of secondary accidents is reduced.

Disadvantages

✘ Motorists must become accustomed to different messages on the same sign.

✘ Bulbs or other components need to be regularly serviced.

✘ Message wording can be difficult.

✘ Message must be updated regularly.

Costs

Capital	Variable - See Below
Maintenance	Variable - See Below
Operating	Medium
Special Equipment Required	Variable - See Below
Special Training Required	None
Liability	None
Legislative Requirements	None

Operation

Public or Private	Public
Operating Agency	Transportation Agency

Funding Responsibility

Transportation Agency

DETAILED DESCRIPTION

Costs

Capital

Capital costs vary, depending on the type of variable message sign chosen. For instance, capital costs are lower if smaller, portable signs are selected over permanently mounted signs.

Maintenance

Maintenance costs also vary with the type of sign chosen. For example, maintenance costs are lower if velcro-type message signs are selected over the standard bulb type of message sign.

Special Equipment Required

Equipment consists only of the sign itself, unless added equipment is needed for mounting purposes.

GENERAL DESCRIPTION

Radio data systems can be developed to inform motorists of severe congestion or necessary rerouting when the information is pertinent. The radio data system (RDS) would enable digitally encoded data to be inaudibly superimposed on the stereo multiplex signal of a conventional FM broadcast. This data could then be decoded by a specially adapted car radio. When traffic information was pertinent, RDS would automatically switch the car radio to the strongest of several signals given out by the transmitters. When the traffic message is through, the radio would return to its previous FM broadcast.

Conditions Under Which Appropriate

This alternative would be most effective if implemented coincidentally with or following adequate alternative route planning. Key RDS transmitter locations would have to be determined to allow smooth traffic rerouting to occur.

Advantages

- ✓ Would provide impacted motorists with the necessary information when they needed it.
- ✓ Motorists could be better informed about the unexpected delay, easing their tension and frustration.
- ✓ Motorists could possibly reroute, lessening the impact of the incident.

Disadvantages

- ✘ Still in the development stages.
- ✘ For this option to operate most successfully, sufficient alternative route plans would have to exist and public awareness of these routes would have to be emphasized.
- ✘ Drivers would have to listen to FM broadcasts to be aware of the traffic reports.

Costs	Capital	High
	Maintenance	Medium
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The special equipment required for the implementation of the Radio Data System would include the radio transmitting system, which would be capable of transmitting digitally coded, real-time traffic information. Also, motorists wishing to utilize this system would have to adapt their vehicle radios to receive and decode the traffic information.

Special Training Required

Introductory training would be required to cover system set up, maintenance, and operation.

EXTERNALLY-LINKED ROUTE GUIDANCE (ELRG)

GENERAL DESCRIPTION

Externally-linked route guidance systems (ELRG) would require vehicles to be equipped with in-vehicle guidance systems. A communications link, such as a Radio Data System (described previously) or a cellular communications system, from an external source could then provide real-time traffic information. This source might be the transportation or police agency. However, to ensure that the information obtained by the motoring public was accurate, traffic news would have to emanate from a single and central location.

Conditions Under Which Appropriate

For this option to operate successfully, previous or coincidental alternative route planning would have to take place.

Advantages

- ✓ Motorists could possibly reroute, decreasing the impact of the incident.

Disadvantages

- ✘ The system is still in the early development stages.
- ✘ For this option to operate most successfully, sufficient alternative route plans would have to exist.

Costs	Capital	High
	Maintenance	Medium
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Public
	Operating Agency	Transportation Agency
Funding Responsibility		Transportation Agency

DETAILED DESCRIPTION

Costs

Special Equipment Required

The externally-linked route guidance system would rely on in-vehicle guidance systems and would simply combine this with a communications link, allowing real-time information to reach the motorist. The communications link might be as sophisticated as the Radio Data System described previously or a common cellular system.

Special Training Required

Introductory training would be required to cover system set up, maintenance, and operation.

CENTRAL INFORMATION PROCESSING AND CONTROL SITE

GENERAL DESCRIPTION

A Central Information Processing and Control Site is a control center which collects and analyzes traffic performance, incident, and incident response information from multiple agencies and jurisdictions. It serves as an information resource for agencies responding to incidents by monitoring the status of incidents and related traffic performance.

The intent of the center is to provide a single location which is responsible for the monitoring the need for response actions, and then track the progress of those actions, and their impact on traffic performance. This function takes place over a large urban area and usually encompasses several jurisdictions and operating authorities.

When such a center is developed by private industry, the primary intent is to provide traffic performance information directly to motorists or to news agencies which then provide that information to motorists. When operated by a public agency, the center is usually meant to improve the operational performance of a series of facilities, by providing a more coordinated system of traffic monitoring and response.

An integrated central data processing center provides agencies with an effective method for increasing the control and coordination of their incident response efforts. However, resources are required to provide this level of improved control and coordination, and these resources must be obtained either by selling the information collected, or by increasing the total budget allowed for incident response.

Conditions Under Which Appropriate

A central control center will provide a better level of response for less overall cost in larger urban areas where multiple agencies or jurisdictions collect traffic performance information and/or respond to incidents. Central information processing centers are usually more expensive than the the uncoordinated alternatives, but provide a better overall level of service.

Advantages

- ✓ Provides a single source of information on conditions on facilities, the need for incident response, and the status of response activities, as well as for news media inquiries. This single source produces more reliable and comprehensive information.
- ✓ Provides a better level of incident response through better coordination of response actions and monitoring.
- ✓ Can reduce unnecessary response actions, by eliminating duplication of response actions by different agencies.

Disadvantages

- ✘ Requires agencies to develop systems that automatically share information.
- ✘ Designing and developing such a center carries a high initial cost.
- ✘ Operating a central information processing center requires continuous funding from those agencies or companies which participate in the center, as well as the continued cooperation of those agencies which provide input data to the central system.
- ✘ Funds for development and operation of a multi-jurisdictional center are usually "out-of-pocket" expenditures for participating agencies. As a result, these funds are often hard to secure on an continuing basis.

Costs	Capital	High
	Maintenance	None
	Operating	Variable - See Below
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	Variable - See Below
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs required to implement a central information processing and control site are high due to the need for large computer and communications resources to collect, store, manipulate and transmit traffic performance and incident information.

Operating

Operating costs vary with the size of the control center, the number of hours per day it operates, and the number of staff required to operate the center. A multi-jurisdictional center usually must obtain funds from multiple sources, which can be politically difficult, while private centers require a large market for the information developed in order to create the revenue necessary to run the system.

Special Equipment Required

At a minimum, the center will need computer resources to accept and process traffic performance and incident information. Communications facilities are also needed to transmit incident and traffic performance data t the end users of that data, whether it be operating agencies, news organizations or motorists. The design of these communications links will vary from simple telephone lines to radio and cellular communications capabilities, depending on the role to be played by the central location.

Special Training Required

Training in operational procedures is required to educate the center staff on how to identify, track incidents and on how to coordinate the appropriate responses to those incidents. This training must be tailored to the specific operating environment developed for each control center and its participating agencies.

Legislative Requirements

Legislative action may be needed to empower the control center agencies to share data. If the control center directs incident responses, it may also need authorizing legislation allowing control center personnel to request the action of agency personnel outside of their direct line of supervision.

Operation

Public or Private

The control center can be operated either as a public or private entity. If the control center operates solely as a clearing house for information on incidents and traffic performance, it can be privately run, although a public agency can also undertake this mission. If the center's personnel actually direct the actions of public agency field personnel, the center must probably be publicly operated.

Operating Agency

A central system requires a cooperative effort between transportation, police, fire and rescue, and other responding agencies.

Funding Responsibility

Ideally, the funding for this program is provided by all participating agencies or private groups. The size of each agency's (or company's) participation should depend on their level of benefit from the system and their ability to pay. A shared funding arrangement requires written agreements between agencies and the creation of these agreements may delay implementation of a program if such an agreement is not easily reached, or if some agencies are not convinced of the merits of the system. A second option is for the agency which will benefit the most from the center to assume responsibility for funding and establish contracts with the other agencies that delineate guidelines for obtaining data and for sharing equipment and personnel.

GENERAL DESCRIPTION

The aim of advanced traveler information systems (ATIS), also known as advanced driver information systems (ADIS), is to provide motorists with the most comprehensive and accurate information about roadway conditions. Through ATIS, real-time, dynamic traffic information is provided to motorists at differing levels and times through either one-way or two-way communication capabilities. This information can be provided in the vehicle or at a location outside the vehicle, allowing the motorist to reroute to avoid congestion or to postpone or eliminate the trip altogether.

Conditions Under Which Appropriate

Appropriate under all circumstances.

Advantages

✓ Ensures that the information provided to motorists is the most accurate and comprehensive.

✓ Allows motorists to reroute or postpone their trips, decreasing the impact of the incident.

Disadvantages

✗ Many elements of the system are still in the development stages.

✗ To achieve the greatest benefit, sufficient alternative route plans would have to exist.

✗ Relies on motorist to change driving behavior, which may not always happen.

Costs	Capital	Variable - See Below
	Maintenance	Medium
	Operating	Medium
	Special Equipment Required	Variable - See Below
	Special Training Required	Variable - See Below
	Liability	None
	Legislative Requirements	None
Operation	Public or Private	Variable - See Below
	Operating Agency	Variable - See Below
Funding Responsibility		Variable - See Below

DETAILED DESCRIPTION

Costs

Capital

The capital costs associated with an advanced traveler information system are highly variable, depending on the technologies used to obtain the real-time traffic information and the technologies used to communicate this information to the public. Lower capital costs can be achieved if private media organizations are used to communicate the information to the public. Other communication strategies such as variable message signs or in-vehicle devices may result in higher capital costs.

Special Equipment Required

Equipment required for an advanced traveler information system includes technologies such as electronic loops, video imaging, cellular telephone monitoring, or automatic vehicle identification systems to provide real-time traffic information, a communications link with the operating agency, and a communication link to the motorists or travelers.

Special Training Required

Training in the operation and maintenance of the new equipment may be required.

Operation

Public or Private

An advanced traveler information system can be operated by either a public or private agency.

Operating Agency

An advanced traveler information system can be operated by a transportation agency or private agency, such as the media. If a private agency wishes to undertake the operation, some coordination must occur with the transportation agency to ensure that the information provided is real-time and accurate and that suggested alternative routes are acceptable.

Funding Responsibility

The funding responsibility lies with the operating agency, namely the transportation or private agency involved.

Section

3

Systems

Development

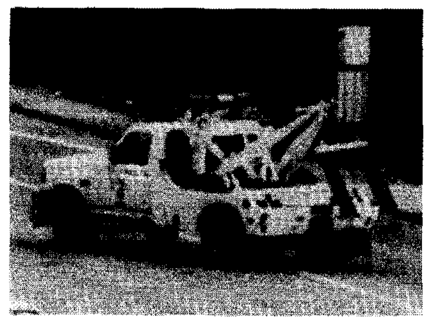
Process and

References

Incident Management Systems: A Step-by-Step Approach

This chapter presents some simple guides to help develop new incident management systems and to "flesh out" specific incident management measures that are being considered for implementation within an existing system.

Because these two processes involve different types of questions and actions, this chapter is divided into two parts. The first half discusses the steps that an agency should be consider when it is initially designing an incident management process and the questions it must answer to successfully perform those steps. The second half provides questions designed to ensure that an agency fully understands the implications of specific incident management measures. The answers to these questions should help determine how response techniques will function within a given management system, and they are appropriate for agencies that want to refine or improve an existing incident management system.



Both parts of this chapter assume that the user is familiar with the general subjects covered in the previous sections of this guide.

DESIGNING A NEW INCIDENT MANAGEMENT SYSTEM

As indicated above, this chapter presents brief guidelines on how to design and implement an incident management system. Because developing such a system requires considerable interagency cooperation and coordination, performing the tasks described below may take anywhere from several months to several years, depending upon the urgency of the incident problem, and agencies' ability and desire to allocate resources to alleviate that problem.

Because of the potentially long time frame, a series of tables lists the actions to be taken and questions that an agency should answer order to develop and implement a successful incident management process.

The material presented below follows the same organization as the second and third chapters of Section I. The reader is referred to those chapters for additional information.

Jurisdiction

Questions presented in this area are intended to ensure that all of the appropriate agencies have been included in the incident management system and that their roles and interactions have been adequately considered. The questions below will help ensure that the information necessary to adequately identify and resolve the jurisdictional problems that accompany a multi-agency incident management system can be answered.

What jurisdictions should/will be involved in the incident management process?

Agency Perspectives and Responsibilities

Once the agencies that should/will be involved in the project have been identified, it is necessary to consider how each of these agencies views incident management, what their roles are, and how they interact with each other.

What actions does each agency currently perform?

What are each of those agency's responsibilities?

Do those responsibilities conflict with respect to incident response or clearance? (Is it possible that they might result in some type of conflict? If so what is that conflict?)

Should the duties or capabilities of one or more agencies be expanded? Why?

How would that expansion be viewed by the other participating agencies?

Site Management

After an understanding of the participating agencies has been gained, it is important to understand how those agencies' personnel should interact at an incident site.

When more than one agency responds to an incident site, which agency should control that site? Does this change with the type of incident?

Does one agency need to change its perspective to work within the incident response system?

Interagency Field Communications

When multiple agencies respond to an incident site, it is necessary for the responding personnel to be able to communicate quickly and reliably for the response to be well directed. When an incident management system is set up, it is important to determine how this interagency field communication will take place.

How will staff from different agencies perform the following communications tasks:

- contacting and requesting that a specific agency respond to an incident,
- contacting field personnel from a different agency from a field location, and
- performing on-site (out of their respective vehicles) communication?

Administrative Coordination Among Agencies

In addition to the needs for real-time communication among personnel in the field, agencies need to communicate at the administrative and managerial levels to keep the incident management process functioning smoothly.

How will the coordination among agencies be monitored, maintained, and revised as needed? (Set up a structure to do this, for example, have monthly meetings between mid-level management involved with the incident management process.)

Usually, at least one person must be dedicated to incident management and must spend a significant portion of his/her time performing administrative coordination among agencies. Who is that person? What are his/her authority and specific responsibilities?

Legal Ramifications

Legislative statutes often restrict or constrain the development of incident management techniques. Before the broad structure of an incident management process has been designed, and before specific incident management strategies have been selected, the limitations imposed by existing laws and regulations must be understood.

What are the legal limits to the incident response roles a specific agency's personnel can perform?

What are the legal restrictions to the methods that can be used to clear an accident or other traffic blockage?

What is the financial liability of agencies, agency personnel and the public with respect to incidents and specific incident management options?

Which agency's personnel are allowed to handle hazardous material?

Do regulations exist for governing who may close a road and for how long that road may remain closed?

What are the laws governing the financial responsibility of persons involved in accidents? (Does a state have the right to charge a motorist for the time and equipment required to respond to an incident?)

What are the laws governing the actions public agencies may take as part of their incident management actions? Do these laws change the financial responsibility of persons involved in the incident?

Forming Consensus

The agencies participating in an incident management process must agree on the steps to be taken by all agencies. Cooperation beyond this first level of agreement can significantly benefit the operation of the system by reducing the total cost of the system and by smoothing and speeding the response process.

What actions can/should the respective agencies take independently and under what conditions should they take them? (For example, under what conditions must a facility be closed, and under what conditions may a facility be kept open or partially open?)

Is it possible to develop some type of inter-jurisdictional agreement, training or new legislation to eliminate legal or other restrictions to desirable incident management actions? (For example, can highway personnel be trained to handle hazardous waste or assist emergency crews?)

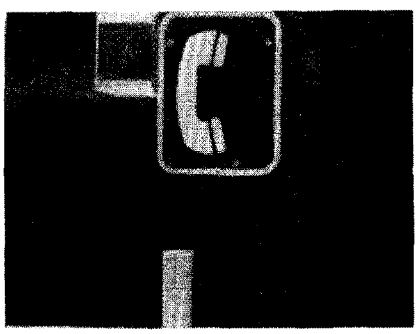
Can specific "deals" be made between agencies to promote the incident management process? (For example, "We'll buy you an extra 10 radio sets for incident response communications, if you will let the interagency incident response teams use your on-site communications radio frequency when responding to incidents.")

What are the geographic areas of operation and the manner in which response is handled within those boundaries during specific times of day or at specific types of incidents?

Political Sensitivity

Political and public impact is also important for incident management systems. When a system is created, the need for political support and the need to address public perceptions of traffic congestion must be considered. These issues apply to both the selection of management measures and the need to justify the operation of the system.

> What political stimuli should the incident management process address?
>
> How does the proposed management action address those stimuli?
>
> What are the political consequences or potential ramifications of the proposed management action?
>
> In what manner can credit be obtained by the participating agencies if the management process is successful?
>
> How will the success and/or failure of response measures be determined?



Geographic Constraints

Resources requirements and administrative burdens are directly impacted by the size of the geographic area covered by an incident management system. It is important to carefully consider just what the bounds of the incident management system will be, and how those boundaries will impact the operation and administration of the response process.

> What are the geographic boundaries of the incident management system? (Provide a map where possible.)
>
> Are there internal divisions within the proposed geographic area (e.g., a "north" response zone and a "south" response zone)?

If so, how does the location of an incident affect the operational procedures used to respond to that location?

Do different agencies respond in different geographic areas? If so, describe where these boundaries are and which agencies respond within each boundary.

Are different sets of response guidelines needed for different geographic areas within the basic incident management system (urban versus rural areas)?

Are different sets of administrative oversight committees (both internal to an agency and among multiple agencies) needed for different geographic stratifications of the incident management area?

What will the incident management process be outside of the "covered" incident management system?

Can personnel from one geographic area assist with an incident in another geographic area? If so, which personnel can cross boundaries and under what conditions can they be called in (on both a regular and emergency basis)?

When should the police or highway authority in a neighboring geographic area be notified of an incident, and who should make that notification?

What additional actions can be taken if the congestion caused by an accident crosses a political boundary?

$ Available Resources

Determining the resources that are already available for use in incident management can dramatically decrease the cost of implementing an incident management system by limiting the need to purchase additional equipment or hire new staff. It also helps determine the easiest, most cost effective management strategies (i.e., the strategies for which equipment and staff already exist). An inventory of available resources also helps identify shortcomings that need to be addressed as part of developing a comprehensive management process.

Equipment, Staffing and Funding

The first part of this effort is to identify the resources available for incident response, both within the lead agency and within other cooperating agencies.

What resources exist within the incident management system's geographic boundaries that can be used as part of the incident management system?

Can those resources be used on short notice to respond to incidents?

Do finances limit the size of the area the incident management system can cover?

If so, what are the options for reducing the size of the area covered or reducing the cost of the incident management process so that it can cover a larger area? What are the mechanisms for prioritizing different geographic areas within the basic management system?

Resource Sharing Agreements

Where resources exist within one agency but are needed by another agency, interagency agreements can be developed to share those resources. These resource sharing arrangements can result in financial advantages to both cooperating agencies.

Are sufficient resources readily available to one participating agency but not others?

Can the agency with available funding subsidize the incident management activities of other agencies?

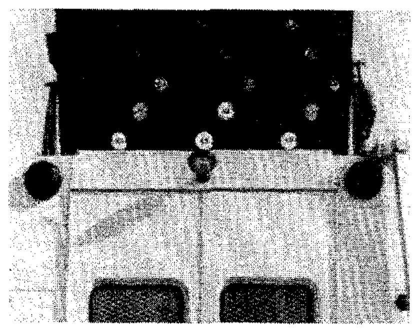
If not, can one agency supply resources to another agency or take over specific duties as part of an incident management agreement?

If one agency can "borrow" equipment or staff, does a mechanism exist to provide access to those resources (i.e., can the incident response team from the highway department call the city and borrow its crane)?

Can procedures be developed or identified to bring the appropriate resources to bear on incidents within the desired time period (i.e., if the highway department has money for incident management, is there a mechanism it can use to reimburse the city for the use of the city's crane)?

When resource sharing makes sense, can an agreement between agencies be designed to clarify the resources to be shared? The agreement should include the following:

- the conditions under which specific equipment or personnel should be called to an incident site,
- how that equipment or personnel should be requested,
- who will operate the shared equipment,
- whether payments will be made for the use of that equipment, how those payments will be made, and what the size of those payments will be, and
- any statements required to shift the legal liability for using the shared equipment to the appropriate operating agency.



Operational Procedures

Once the specific incident management measures have been selected for implementation (or even for detailed analysis), it is important to determine how the operation of those techniques will impact the participating agencies. The operational procedures selected should reflect previous decisions regarding how agencies and jurisdictions will interact and what and how equipment will be used.

How can all agencies involved in the incident process ensure that they are using the same set of incident management procedures?

How is equipment called to an incident site?

Under what conditions should specific equipment be called to an incident site?

What records will be kept concerning the incident management process (cost, benefits, the number of incidents responded to, the time involved in those responses, the reductions to travel time delay)?

Field Communications

Perhaps the most critical of the operational issues is how incident management staff will communicate with both staff of the same organization and staff of different organizations.

What communication channels are needed to make the management process work for

- call out,
- arrival on the scene, and
- communications on site?

Does the above communications scheme account for the needed interagency communication? If not, how will these communications take place?

If additional communications equipment is needed, how will these purchases be funded?

Legal Ramifications And Operational Decisions

When the incident management procedures are developed, it is important that the selected management techniques do not conflict with existing laws or regulations. This is especially true for union rules and other labor usage regulations.

Are there legal considerations for the operation of selected management techniques (e.g., who is allowed to handle hazardous material, and is the selected response technique safe for the employees that will be implementing it)?

Is more legal clarification needed to allow proper operation of the system? For example, what constitutes hazardous material? How is hazardous material disposed of after it has been collected at an incident site? Are particular steps required by law when someone first reaches an incident that contains (or might contain) hazardous material?

What legal requirements must be met in the response to specific types of incidents, and do those required legal steps change how the candidate management process should take place? (For example, most states have different procedural requirements for fatal accidents than for non-fatal accidents, but many also have different requirements for serious injury accidents versus "non-serious injury" accidents.)

For incidents involving hazardous material, the following issues need to be resolved:

- Who is allowed to handle hazardous material?
- What constitutes hazardous material?
- How is hazardous material disposed of after it has been collected at an incident site?
- Are particular steps required when someone first reaches an incident that contains (or might contain) hazardous material?

Do regulations exist for governing who may close a road and for how long that road may remain closed?

What are the laws governing the financial responsibility of persons involved in accidents?

What are the laws governing the actions public agencies may take as part of their incident management actions? Do these laws change the financial responsibility of persons involved in the incident?

When should the scene and/or approach to the scene be photographed?

Training

Another item that must be resolved to develop an incident management system is the need to train the personnel who will make the system work. Training is the key to making the operational procedures function smoothly. At the administrative level, it is important to determine what information must be given, who that information should be given to, and how often those training sessions should take place.

What training is needed to implement the selected management measures? (At a minimum training should include general operational procedures such as how to set up traffic control, communications procedures to be followed, where to get additional help and/or resources when at an incident site, what each staff person's role is at an incident site, what the perspectives and job functions are for staff from participating agencies, and what the command structure is at an incident site under various conditions.)

Which agencies/jurisdictions should be included in the training performed as part of implementing the incident management system?

When will that training be offered, and will field personnel be allowed to work on incident management before they have had special incident management training?

Is training required for personnel outside of your agency? If so, how will that training be accomplished?

Who will teach the training sessions and what materials will be used to do the teaching?

How does the available training discuss the perspectives other agencies will have and the tasks they will perform during the incident management process?

Administration

Because incident management staff and equipment requirements often cross division boundaries within an organization, the need for communication, cooperation and consensus within an agency is almost as great as that between agencies. Many of the same topics discussed above should be re-examined to address differences in mission, perspective, and priority among divisions within an agency. In addition, topics such as those below must be reviewed.

General Administrative Coordination

How will the individuals involved in incident management measures fit into the existing organizational structure of the agency? The more self contained these resources are, the less difficult will be the administrative burden of the incident management process. The more diffused these resources are, the more difficult the administrative tasks will be.

Are the personnel and equipment that will participate in the incident management system directed by the same portion of the organization that will direct the system? (That is, if the Operations division is in charge of incident management, are the responding field staff from the Operations division or the Maintenance division?)

Is responding to incidents a "normal" part of that portion of the agency's routine duties, or is the response technique "borrowing" workers and equipment from other job functions?

If the resources are being "borrowed," how will that borrowing impact the performance of that staff's regular duties?

Is there a cost transfer from one division to the other in return for the use of those persons and equipment? How will that transfer work?

How are the rewards/penalties for the proper/improper use of those personnel/equipment designed so that the appropriate use of those resources is encouraged? (What are the rewards/penalties?)

What mechanism has been set up to resolve conflicts over the use (or the priority of use) of personnel and equipment?

Is there a need to expand the duties or capabilities of the agency division that will perform the selected incident management alternatives?

How would that expansion be viewed by the other divisions within the agency?

Internal Agency Perspectives

The degree of conflict within an agency that will result from the use of personnel and equipment from different divisions for incident management will depend on the perspective those divisions have of incident management. Where incident management contributes directly to the perceived goals of that part of the agency, support for incident management will be strong. When incident management does not contribute directly to the those perceived goals, support will be less strong. Opposition will occur when resources are taken from a division of an agency for incident management and little benefit returns to that division:

What are the responsibilities of the different divisions that are impacted by the need for resources for incident management?

Do those responsibilities conflict with respect to incident response actions or clearance? (Is it possible that they may result in some type of conflict? If so what is that conflict?)

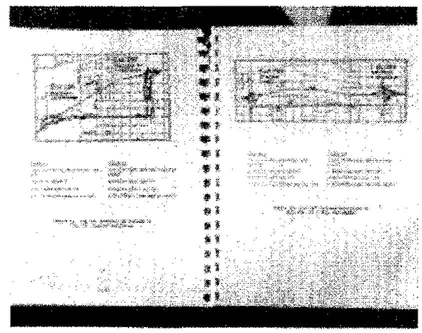
Do the duties or capabilities of the agency divisions performing incident management need to be expended?

How would that expansion be viewed by the other divisions within the agency?

In what manner can credit for a "job well done" be given to divisions that cooperate with incident management (e.g., that provide equipment or staff), especially when incident management is not their major impetus? (In other words, what types of "carrots" can be used to encourage cooperation with incident management?)

DEVELOPING SPECIFIC INCIDENT MANAGEMENT MEASURES

The next section is a step-by-step process for developing alternative incident management measures for consideration in an existing incident management system. This process provides a consistent manner with which to "flesh out" the basic incident techniques described in Section II. Answering the questions below will allow the implementing agency to systematically consider all of the major issues that impact a specific incident management technique.



This information can be used either to help differentiate among alternative management measures or to simply provide a better understanding of the complexities of operating a specific management measure. As in the previous half of this chapter, the material presented below follows the same organization as the second and third chapters in Section I. These earlier chapters should be referenced as necessary.

Because each incident management system is different and each possible technique is unique as it is applied to each urban area, it is impossible to design a single series of questions that are both sufficiently detailed and relevant for all uses. Therefore, the question sets below err on the side of completeness. Portions of the following question series that do not apply to the technique being examined should be disregarded.

To develop a complete alternative for evaluation, follow the steps outlined below:

- Identify the problem to be solved.
- Select one or more alternatives from the techniques listed in Section II that improve the condition or relieve the problem area.
- Answer the applicable questions listed below for each alternative selected from Section II to determine the pros and cons for each alternative.
- Evaluate the alternatives that have been selected for study.

These last two steps can be performed in reverse order if the evaluation process does not need to consider the detailed workings of the incident management technique's implementation (i.e., if the evaluation is between two very disparate alternatives, rather than two related alternatives).

Jurisdiction

To determine the jurisdictional impacts of the proposed alternative, consider the following questions.

What agency(s) will perform the incident management alternative action under consideration?

Will two or more agencies need to interact to undertake this alternative?

If more than one agency is involved, how will this interaction work (which tasks will be performed by which agency, and which agency will manage the site? Will site management be the same under all conditions?)

Have all of the participating agencies been contacted to gather their input in the development of this measure? If so, what are their comments, needs, and/or concerns?

Can some portion of this management action be taken independently by one agency, and if so, under what conditions?

Is it necessary to develop some type of inter-jurisdictional agreement, training, or new legislation to eliminate legal or other restrictions to this incident management alternative?

Do jurisdictional disputes exist between agencies in the response areas that might restrict potential management measures (e.g., "We won't respond to incidents over that border because they won't contribute to our costs.")?

Agency Perspectives and Responsibilities

Different agencies and jurisdictions may view an alternative from decidedly different outlooks. Consequently, what may be the perfect alternative to one agency may be a disaster to another. Before an alternative has been selected, it is important that the agency considers how each agency and jurisdiction within the geographic boundaries of the management system will view the application of each particular incident management approach.

Is it possible that this technique will conflict with the goals, objectives or operations of some other agency (e.g., a "fast clearance technique" may warrant objections because it creates an unsafe working environment for some other responding agency's workers)?

If so, can these issues be resolved through minor changes in operating procedures?

Do these issues mean that the objecting agency has strong feelings against implementation of this technique? Should these objections cause this alternative to be withdrawn from consideration or significantly revised to reduce this negative impact?

Similarly, do impacted agencies strongly favor this alternative and thus should it be given additional consideration because of these other impacts?

Interagency Field Communications

If more than one agency is involved in performing an incident management technique, then the ways that communication will take place between staff from those agencies should be established.

How will staff from the different participating agencies perform the following communications tasks:

- contact and request that staff and/or equipment from the other agency respond to an incident,
- contact field personnel from a different agency from a field location, and
- perform on site (in or out of their respective vehicles) communication?

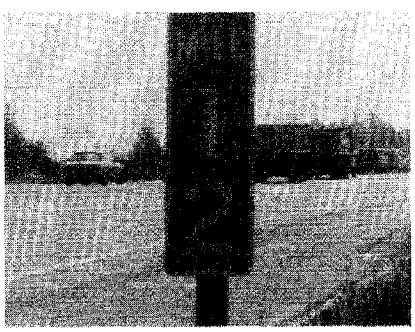
Administrative Coordination Among Agencies

In addition to the needs for real-time communication among personnel in the field, participating agencies need to communicate at the administrative and managerial levels to keep any incident management process functioning smoothly. In many cases, this same managerial communication is necessary among agencies, even when staff from one of those agencies is not directly involved with the incident management process. (That management technique may create problems for another agency that need to be resolved.) Therefore the following must be understood.

Does the proposed management measure require interagency coordination at the administrative level (e.g., for shared funding, shared equipment, or interaction among agency personnel)?

If so, list the persons who should perform that coordination and explain how that coordination will take place (e.g., a bi-monthly meeting among the administrative managers for each agency, or through multi-agency corridor management teams).

If not, how will coordination among agencies be monitored, maintained and revised as needed?



Legal Ramifications

Legislative statutes often restrict or constrain the incident management techniques that can be applied by an agency. Laws and regulations may also place an agency in an untenable financial position if it implements a particular management action. Thus, before a specific incident management option has been implemented, the legal consequences and/or limitations of that action must be understood.

Does legislation exist that specifically allows the agencies identified above to perform, or prevents them from performing, the selected tasks? (For example, is the highway agency legally allowed to handle spilled hazardous material?)

If barriers to implementation exist, can legislation be enacted to remove those limitations?

Can another agency perform the desired management actions without those legal limitations if it were given assistance (See Resource Sharing in Section I, "Major Issues in Selecting Incident Management Alternatives")?

If the legal relationship between an agency and a response technique is not clear, obtain the state Attorney General's opinion on the matter.

Does the proposed response technique change the financial liability of agencies, agency personnel, or the public? If so, list those changes. (Again, if these changes are uncertain, obtain the Attorney General's opinion on the matter.)

Forming Consensus

Agencies impacted by an incident management measure must be involved in the process that results in the implementation of that technique. A consensus among the agencies involved with (or impacted by) incident management will help ensure that the technique selected is supported once it has been implemented.

How do other agencies that are impacted by your agency's incident management process react to this proposal? Is it something they will support or oppose?

If there are objections to the proposed incident management technique, list those objections and potential ways to alleviate them.

Political Sensitivity

When the impact of a proposed incident management technique is considered, the ways in which those actions will be viewed by the public and by elected officials should also be examined. Support from these sectors is essential for continued support (both financial and political) of an incident management system. To help determine how a proposed management technique will be viewed politically, the following questions should be answered.

Are there political stimuli (e.g., traffic congestion at a specific location or a bridge that is deemed to be "unsafe") that need to be addressed by the incident management process?

How does the proposed management alternative action address those stimuli?

Are there other political consequences or potential ramifications of the proposed alternative?

In what manner can credit be obtained by the participating agencies if the response process is successful?

How will the success and/or failure of the incident management measure be determined?

Will there be a noticeable change in traffic performance as a result of the proposed incident management process, or will the management process be visible to the public ("your tax dollars at work")?

Geographic Constraints

Resource requirements and administrative burdens for a specific incident management technique are directly impacted by the size of the geographic area that will be covered. An agency must carefully consider the bounds within which the proposed management technique will be applied and how those boundaries will impact the operation and administration of the management process.

What are the geographic bounds to the proposed incident management technique?

Are there geographic divisions within the proposed coverage area (e.g., a "north" management zone and a "south" management zone)?

If so, how does the location of an incident affect the operational procedures used to respond to that location?

Is the management technique applied differently in some geographic areas? If so, describe how the technique applies to each of the covered areas.

Can personnel from one geographic area assist with incident management in another geographic area? If so, which personnel can cross boundaries and under what conditions can they be called in?

Under what conditions can the personnel or equipment from one jurisdiction be used in another jurisdiction (both on an emergency basis and on a regular basis)?

Are different sets of administrative oversight committees needed for different geographic stratifications of the incident management? If so, list the persons/organizations that should be included on each of these committees.

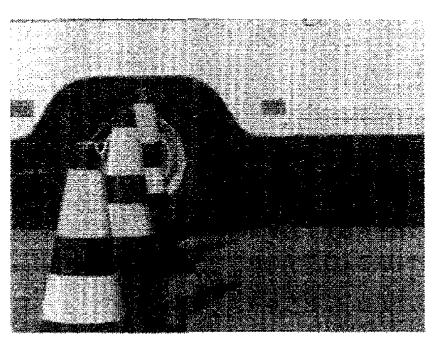
What jurisdictions should be included in the administrative information and training aspects of the incident management system?

What resources exist within the geographic areas that can be used as part of the incident management system?

What will the incident management process be outside of the "covered" incident management area?

$ Available Resources

Determining the resources that are already available for use in incident management can decrease the cost of implementing incident response by limiting the need to purchase additional equipment or hire new staff. It can also help resolve questions about which management strategies should be pursued first (e.g., those strategies for which equipment and staff already exist) and which will take more time and money to implement. Performing an inventory of available resources can also identify shortcomings that need to be addressed as part of the incident management development.



Equipment, Staffing and Funding

The first part of this effort is to identify the resources available for incident management, both within the lead agency and within other cooperating agencies.

What resources are required by the desired incident management technique?

Will these resources be needed or used on a 24-hour a day basis or only during particular time periods such as the peak commute hours?

Are these resources readily available to the agencies that will perform this technique?

Can those resources be used on short notice to respond to incidents?

If either of the above are not true, can one agency fund the participation of another agency?

What agency(s) are willing to fund or perform this incident management action or equipment purchase?

Are special communications equipment needed (e.g., for interagency radio links) to implement this effort? If so, how will this equipment be purchased?

Resource Sharing Agreements

Where resources exist within one agency but are needed by another agency, interagency agreements can be developed to share those resources. These resource sharing arrangements can result in financial advantages to both cooperating agencies.

Is it necessary for one agency to fund (or partially fund) the participation of another agency?

Do sufficient (cash) funds exist to pay for the use of another agency's resources?

Can specific "deals" be made between agencies to promote the incident management process and/or spread the cost of the system? If so what are they?

Does a mechanism exists to provide access to those resources (i.e., can the incident management team from the highway agency call the city and borrow its crane)? If so, describe that mechanism.

Are there legal ramifications from sharing equipment, staffing, or funding? If so, what are those ramifications, and how might they be mitigated?

Can procedures be developed or identified to apply the appropriate resources to incidents within the desired time period (i.e., if the highway agency has money for incident response, is there a mechanism to reimburse the city for the use of that crane)?

If resource sharing makes sense, agreements should be drawn up between agencies to clarify the resources to be shared (list the information to be included). The agreements should include the following:

- the conditions under which specific equipment or personnel should be called to an incident site (list any equipment that can be called and the conditions under which it should be requested),
- how that equipment is requested,
- who operates the equipment,
- whether the use of that equipment must be paid for, and
- if so, the procedures for making those payments.

Operational Procedures

It is important to determine how the operation of the selected techniques will impact the participating agencies. The operational procedures selected should reflect the decisions regarding how agencies and jurisdictions will interact, and what and how equipment will be used.

What are the procedures for operating the proposed incident management measure?

Under what conditions should specific equipment be called to an incident site?

How is equipment called to in incident site?

Who operates the equipment?

Who pays for the use of that equipment?

Are there special procedures for making those payments?

Should special record keeping be done to monitor the use of incident management equipment?

Field Communications

Perhaps the most critical of the operational issues is how incident management staff will communicate with staff of the same organization and staff of different organizations.

What communications channels are needed to make the candidate management measure work for

- call out,
- arrival on the scene, and
- communications on site?

Is more than one agency involved in the candidate response effort? If so, does the above communications scheme account for the needed interagency communication? If not, how will these communications take place?

If additional communications equipment is needed, how will these purchases be funded?

Legal Ramifications To Operational Decisions

When the incident management procedures are developed, it is important to make sure that the selected management techniques do not conflict with existing laws or regulations. This is especially true for union rules and other labor usage regulations.

Are there legal considerations for the operation of the selected management technique (e.g., who is allowed to handle hazardous material)?

Is additional legal clarification needed to allow proper operation of the system? For example, what constitutes hazardous material? How is hazardous material disposed of after it has been collected at an incident site? Are particular steps required by law when someone first reaches an incident that contains (or might contain) hazardous material?

Are there legal requirements that must be met in the response to specific types of incidents, and do those required legal steps change how the candidate management process should take place? (For example, most states have different procedural requirements for fatal accidents than for non-fatal accidents, but many also have different requirements for serious injury accidents versus "non-serious injury" accidents.)

Training

Another item that must be investigated before an incident management program is implemented is the need to train the personnel who will make the operational procedures developed function smoothly.

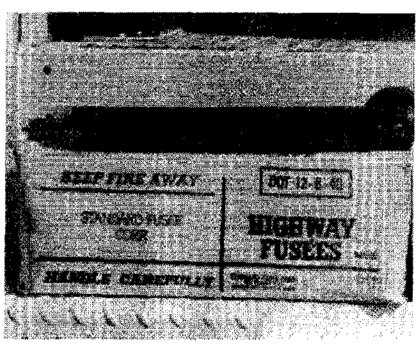
What training is needed to implement this incident management measure?

When will that training be offered, and who will teach the training session?

Is training required for personnel outside of the agency? If so, how will that training be accomplished?

How are the following issues covered by the training that will be employed as part of implementing the candidate incident management measure:

- what tasks will other agencies be performing,
- what perspectives on incident management do those agencies have,
- where can field personnel get additional assistance when responding to an incident (for example, additional equipment, additional traffic control, hazardous waste crews),
- what are the communications procedures that will be used,
- what decisions should field staff make for themselves and which should be made by other personnel,
- who should field staff take directions from when at an incident site, and
- how does the new procedure fit within the rest of the incident management system?



Administration

Because incident management staff and equipment needs often cross division boundaries within an organization, the need for communication, cooperation, and consensus within an agency is almost as great as that among agencies. Many of the same topics discussed above should be re-examined to address differences in mission, perspective, and priority among divisions within an agency. In addition, topics such as those below must be reviewed.

General Administrative Coordination

The way in which the individuals involved in the selected incident management measure will fit into the existing organizational structure of the agency should be reviewed. The more self contained the needed resources are the less difficult will be the administrative burden of the incident management measure. The more diffused these resources are, the more difficult the administrative tasks will be.

Are the response technique's equipment and personnel coming from the same portion of the organization?

Is responding to incidents a "normal" part of that department's routine duties, or is the response technique "borrowing" workers and equipment from other job functions?

If the resources are being "borrowed," how will that borrowing impact the performance of that staff's regular duties?

Is there a cost transfer for the use of those persons and equipment? How will that transfer work?

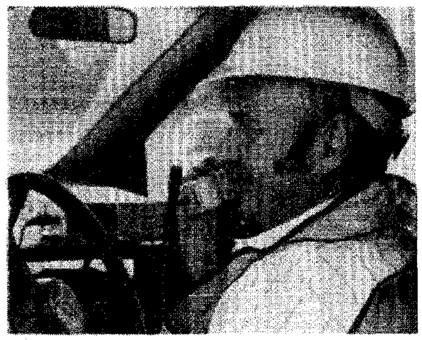
How are the rewards/penalties for the proper/improper use of those personnel/equipment designed so that the appropriate use of those resources is encouraged? (What are the rewards/penalties?)

What mechanism has been set up to resolve conflicts over the use (or the priority of use) of personnel?

Is there a need to expand the duties or capabilities of the agency divisions that will perform the selected incident management alternative?

How will that expansion be viewed by the other divisions within the agency?

Quantifying Incident Management Benefits



Although many factors are considered in incident management alternative evaluation (see Table 1.7), few have the publicity impact of being able to say that a specific incident management program has reduced the average duration of incidents by *x* minutes and this has saved commuters *y* hours of travel time. Unfortunately, arriving at statistically accurate values of *x* and *y* is an exceedingly difficult task. For example, in determining the reduction in incident duration resulting from a specific alternative, it is important to control for all naturally varying, non-alternative related factors (e.g., seasonal variations in traffic flow, weather conditions, the presence of special events, traffic growth, changes in operational procedures). Determination of the travel time savings resulting from reductions in incident duration requires extensive monitoring of queues and travel times or, alternatively, the use of a fairly sophisticated traffic simulation model. In both cases, arriving at precise values is not easy but is often considered worthwhile in accomplishing the following:

- demonstrating the effectiveness of an incident management alternative,
- isolating weaknesses in incident management programs, and
- measuring potential traffic impact benefits.

The following two sections outline some of the specifics of quantifying incident management benefits.

EVALUATING INCIDENT DURATION

Incident duration is typically defined as the time between incident (accident or vehicle disablement) occurrence and roadway clearance. In most metropolitan areas, such data are available from two sources: (1) accident reports and (2) state patrol or local patrol dispatch reports. The types of data typically available in these reports are presented in Tables 3.1 and 3.2 for accident report and dispatch logs, respectively. To evaluate incident duration and check for consistency in

Table 3.1 Information Typically Available from Accident Reports

Year	Year of accident
Month	Month of accident
Day	Day of Accident
Day of Week	Indicator for day of week Monday to Sunday
Hour	Hour accident report started
Minute	Minute accident report started
Sign Route	State route highway designation number
SR Milepost	State route mile post
Accident Sev	Accident severity index; property only, injury accident, or fatality
N. Injured	Number of persons injured in the accident
N. Fatal	Number of persons killed in the accident
Light	Indicator for illumination level at accident site: daylight, dawn, dusk, dark (with and without street lights, and other)
Collision Type	Code for various possible collision types including pedestrian/vehicle, vehicle/vehicle, parked vehicle and others kinds
Object Struck	Kind of object struck, if any (e.g., light standard)
M. Sev.Inj.	The most severe injury caused by the accident (no injury, fatal, disabling, non-disabling, possible, unknown)
N. Veh.	Number of vehicles involved in the accident
P.Dam.$	Property Damage measured in dollars
R. Char.	Roadway character - grades and curves
L. Char.	Location character - codes for various intersections, under and over passes and other facilities
R. Sur.	Road surface character: not stated, dry, wet, snow, ice, other
Weather	Weather at the accident site:clear/cloudy, rain, snow, fog, or other
Res. Prox.	Residence proximity of involved drivers: within 15 miles, elsewhere in state, or out of state
Sobriety	Sobriety of the drivers in the accident: 7 codes for had been drinking — ability impaired to had not been drinking
A. Sev.	Alcohol severity: drunkest driver involved in accident
Con.Circ	24 codes indicating different possible RCW violations or indicating no violation
D.V.Act	Driver Vehicle Action: codes indicating evasive or non evasive actions taken by the involved drivers
Veh. typ.	Vehicle type: vehicle type code
Age	Age for each of the involved drivers
Haz. Mat.	Kind of hazardous material involved, if any
Fuel	Fuel Spill (yes/no)
Fire	Fire Resulted (yes/no)

Table 3.2 Information Typically Available from Dispatch Logs

Year	Year of accident
Date	Month and day of the accident
DOW	Day of week: Monday to Sunday
TOD	Time of day: one of eight 3 hour time slots
Rcvd	Dispatcher received call for assistance
Enroute	Time Trooper was en route to accident scene
Atscene	Time Trooper arrived at the accident scene
Roadcl	Time road was cleared, if it had been blocked
Troopcl	Time Trooper cleared the scene of the accident
Tow	Number of tow trucks called to accident site
Amb	Number of ambulances called to the accident site
Other	Number of other emergency vehicles called to the accident site (e.g., Fire Department)
Exp	Indicates that accident occurred on the express lanes
Loc. C	Location Code: code for the cross streets on I-5 and SR 520 within our study area
Dir	Direction of travel
Lane	Lanes(s) involved
N.Veh	Number of vehicles involved
N.L.Block	Number of lanes blocked
Inj	Number of injuries
Ftl	Fatality accident (yes/no)
T/B	Truck or bus involved in the accident

data, it is desirable to match accident reports with corresponding dispatch logs to obtain a more complete description of each incident.

As mentioned earlier, to evaluate the effectiveness of an incident management alternative, it is important to control for naturally varying factors. A simple comparison of before and after duration data can easily produce erroneous or counter-intuitive results. Proper evaluation necessitates the use of multivariate statistical procedures that explicitly account for the effects of all factors that influence changes in incident duration, not just the incident alternative being studied. An example of such a multivariate statistical procedure is the hazard function approach recently used to study incident duration in Seattle (Jones, Janssen, and Mannering (1991)). This study found that incident duration was influenced by a variety of factors such as the following:

- Seasonal Effects — seasonal variations in traffic and weather.
- Daily Variations — variations by time of day (i.e., day versus night, rush hours versus. non-rush hours) and day of week (i.e., weekday versus weekend).
- Special Events — major sporting events such as college football games.
- Driver and Vehicle Characteristics — driver age, driver intoxication,whether or not trucks or buses were involved, and the number of vehicles.
- Accident Severity Measures — the number of lanes blocked, the number of injuries, and property damage.

A summary of the effect of these factors on incident duration is presented in Table 3.3.

On the basis of the multivariate statistical analysis of incident duration conducted by Jones, Janssen, and Mannering, the following conclusions were drawn regarding incident management in Seattle as it existed between 1987 and 1989:

- The fact that incidents occurring during special events and rush hours had smaller durations indicated very good incident management during these periods, and such incident management should be extended to other time periods, providing funding exists.
- Trooper response to accidents involving drunk drivers is exceptional (resulting in reduced incident duration) and such efforts should be extended to all accidents.

Table 3.3 Typical Factors Influencing Incident Duration

Factors Increasing Incident Duration	Factors Decreasing Incident Duration
• Winter months	• Rush hours*
• Night conditions	• Special events*
• Weekends	• Accidents involving drunk drivers*
• Accidents involving older drivers	
• Accidents involving trucks or buses	
• Accidents involving injuries	
• Accidents resulting in high property damage	
• Accidents blocking a high percentage of lanes	

*These factors were found to decrease incident duration because of the increased level of incident management available during rush hours and special events and the massive trooper response to accidents involving intoxicated drivers.

- During the 1987-89 time frame, Seattle-area incident management procedures demonstrated difficulty in clearing large accidents. This was evidenced by the disproportionate effect that accident severity had on increasing incident duration. It was recommended that Seattle improve its response to large incidents by providing additional personnel training and improving the access of necessary incident-clearing equipment to the scene.

The Jones, Janssen, Mannering multivariate statistical analysis was conducted over a single cross-sectional period. While single period data can reveal weaknesses in existing incident management practice, multi-period or continuously collected data are needed to quantify the before-and-after effects that a specific incident management alternative has on incident duration. The multivariate procedures demonstrated in the Jones, Janssen, Mannering article are ideally suited to such a before-and-after study and can be used to precisely quantify the effectiveness of the alternative, even in the presence of naturally varying factors such as traffic, weather, and so on. The procedure is to simply estimate before-and-after multivariate statistical models of incident duration and conduct a likelihood ratio test (which is chi-squared distributed) to test for the time-stability or model parameters (see Ben-Akiva and Lerman (1985)), as well as the magnitude and statistical significance of the reduction in incident duration resulting from the implementation of the incident management alternative. Schematically, this evaluation procedure is presented in Figure 3.1.

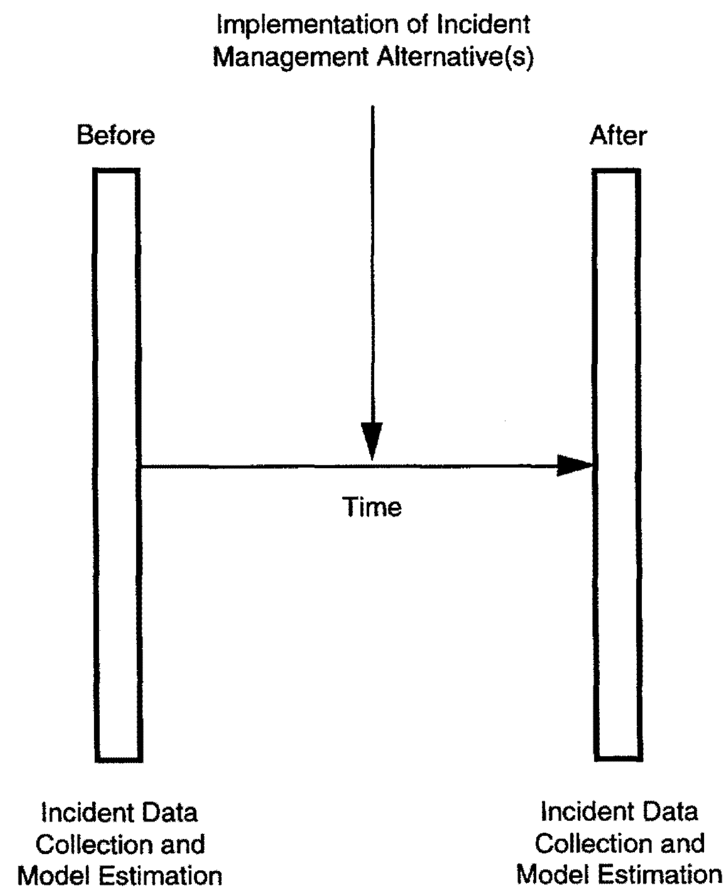


Figure 3.1 Schematic of Before-and-After Incident Duration Model Estimation

EVALUATING TRAFFIC IMPACTS

The traffic measure of the benefit of an incident management alternative is not necessarily the reduction in incident duration time but, instead, the impact that the reduction has on traffic delay, specifically, the number of vehicle or traveler hours saved as a result of implementing the incident management alternative. One would expect the number of hours saved to be dependent on the following factors:

1. the reduction in incident duration attributed to the incident management alternative;
2. the location of the incident on the traffic network (e.g., major freeway, minor collector, etc.);
3. the time of incident occurrence (e.g., during rush hour, off-peak periods, etc.); and
4. the nature and amount of incident related information provided to drivers (so that some route diversion can be undertaken).

Because collection of real-time traffic information relating to route diversion, queue formation and dissipation, and travel speeds (on all routes) is beyond current technical capabilities, the evaluation of traffic impacts, in terms of travel times, is best undertaken using a suitable traffic simulation model.

A wide-range of traffic simulation models could be used to simulate an incident of known duration. A comparison of these models, with respect to key features, is shown in Table 3.4.

From an implementation point-of-view, many of the traffic models presented in Table 3.4 must be modified to evaluate incident-induced traffic impact because they were originally intended for other purposes (e.g., peak hour flows, signal timing, etc.). One model designed specifically for incident evaluation is XXEXQ. The application of this model to the Seattle area is described in Garrison and Mannering (1990). The required inputs for XXEXQ are similar to those required for most standard traffic assignment models. They include the following:

1. a peak-hour trip origin—destination matrix,
2. capacity and speed limits of all highway links on the traffic network,
3. the percentage of drivers assumed to be receiving and responding to traffic information concerning incidents,
4. the physical location of the incident being studied and its effect on roadway capacity, and
5. the duration of the incidents.

Table 3.4 Comparison of Existing Traffic Models

	CORFLO	CORQ CORCON	FREQ	INTRAS	MACK	RFLO	SCOT	TMODEL2	XXE	XXEXQ	SIMX
Year Designed	Ongoing	late '60s	late '60s	late '70s	late '60s	new	late '60s	mid-'80s	early '80s	late '80s	late '80s
Macroscopic/ Microscopic	macro	macro	macro	micro	macro	macro	macro/ micro	macro	macro	macro	macro
Deterministic/ Stochastic	det/stoch	det	det	stoch	det	det	det	det	det	det	stoch
Simulate/Optimize	sim	sim	opt	sim	sim	sim	sim	sim	sim	sim	sim
Arterial/Freeway	art/frwy	frwy	art/frwy	frwy	frwy	art/frwy	art/frwy	art/frwy	art/frwy	art/frwy	art/frwy
Methodology	user eq	min. indiv. trav. costs	user's choice	car fol-lowing theory	fluid flow	fluid flow	fluid flow min. cost	incr/iter	user eq.	sequential user eq.	utility max.
Changes	route	route	route	route	route	route	route	route	route mode	route	route/dep. time
Inputs											
Turning	yes	yes	no	yes	no	no	yes	no	no	no	no
Signals	yes	no	no	yes	no	no	yes	no	no	no	no
Geometrics (requirement — simple, intermediate, complex)	complex	simple	simple	complex	interm.	interm.	complex	complex	simple	simple	simple
Operation (requirement — simple, intermediate, complex)	complex	interm.	interm.	complex	interm.	complex	complex	interm.	simple	simple	simple
Outputs											
Queues	no	yes	yes	no	yes	implied	yes	yes	implied	yes	yes
Emissions	no	no	yes	yes	yes	no	yes	no	no	no	no
Bus	yes	no	yes	yes	no	no	no	no	no	no	no

XXEXQ outputs include the following:

1. total vehicle travel time on the network,
2. traffic flows on all highway links,
3. traffic queues on all highway links, and
4. total vehicle miles of travel on the network.

XXEXQ employs a sequential user equilibrium algorithm to simulate incident-induced traffic impacts. Figures 3.2, 3.3, and 3.4 provide some examples of how XXEXQ's output can be presented to gain an understanding of a range of possible incident-related traffic impacts. Figure 3.2 shows the traffic impacts of various assumptions regarding the percentage of drivers receiving and responding to incident traffic information. Figures 3.3 and 3.4 show the impacts of a major freeway incident, of various durations, that causes a 50 percent reduction in roadway capacity. These two figures underscore the non-linear relationship between incident duration and travel time. The reader is referred to Garrison and Mannering (1990) for additional information on simulating the traffic impacts of incidents.

SUMMARY

As the preceding discussion has indicated, quantifying incident management benefits is not an easy task. The quantification of the effectiveness of specific incident management alternatives requires extensive data collection from accident reports, dispatch logs, and possibly other sources, as well as a multivariate statistical analysis of the collected data. This can be an expensive and time consuming task.

The assessment of traffic impacts resulting from incidents is best achieved by means of a traffic simulation model. While gathering the initial input data to run the traffic simulation model is a time consuming task (e.g., determining the origin-destination matrix, coding the highway network,), once this initial barrier has been overcome, the model can be applied fairly inexpensively. Still, occasional updates of the data, particularly the origin-destination matrix, are necessary to ensure reasonably accurate traffic impact estimates.

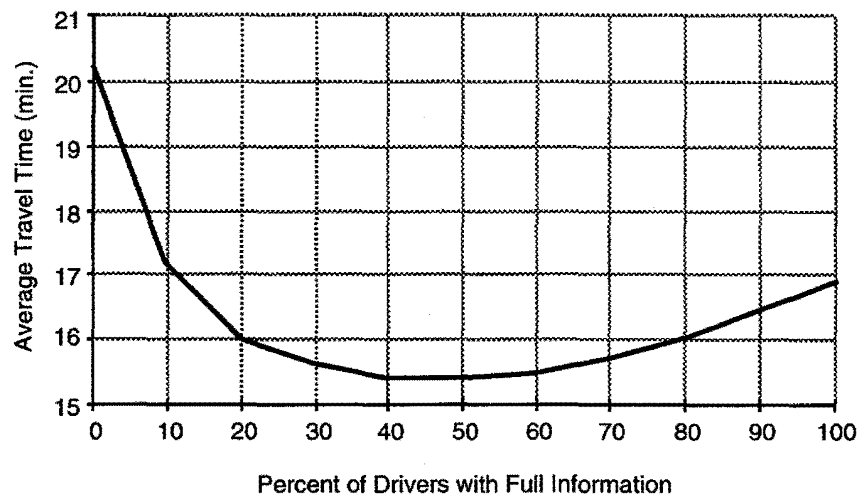


Figure 3.2 The Impact of Driver Information on Average Network Commute Time

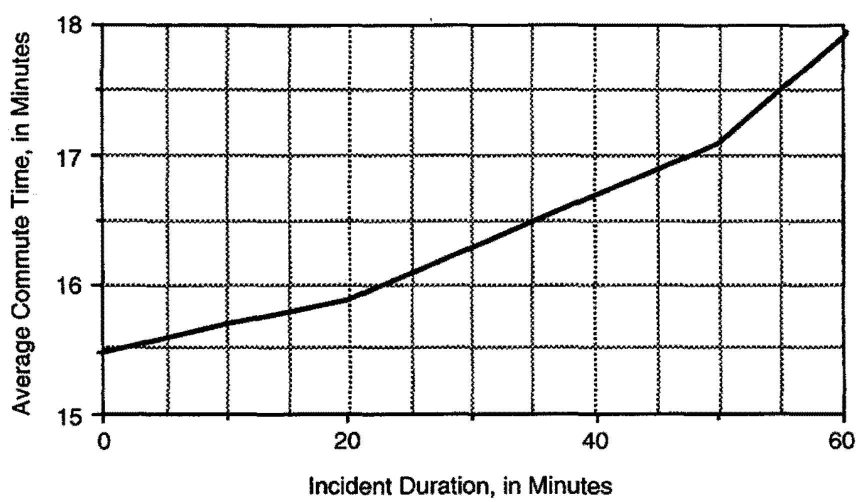


Figure 3.3 The Impact of Incident Duration on Average Network Commute Time

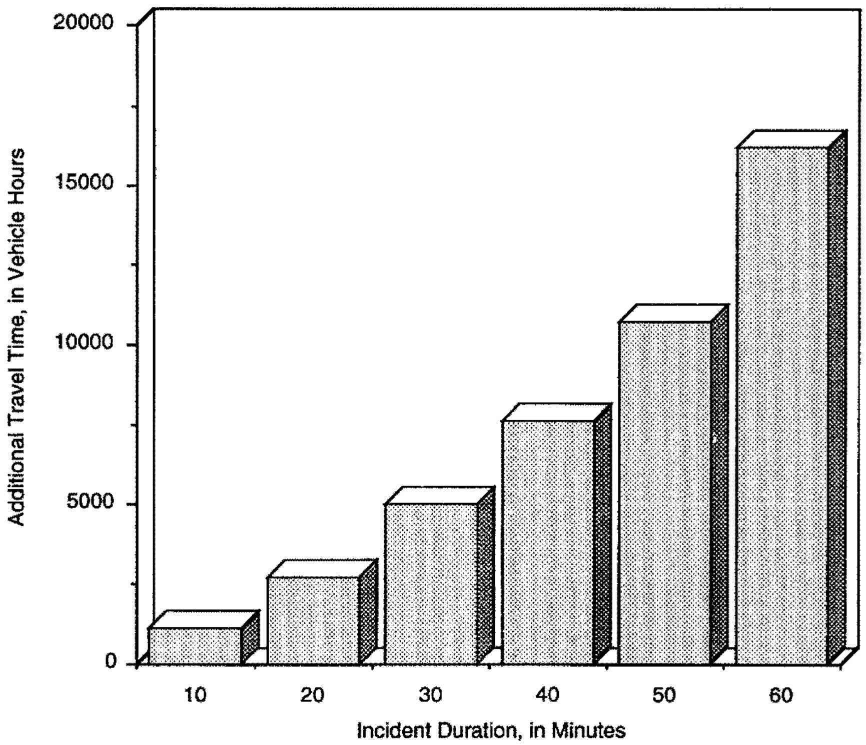


Figure 3.4 Impacts of Incident Duration on Total Network Travel Time

CHAPTER REFERENCES

1. Jones, Bryan, Lester Janssen, Fred Mannering, Analysis of the Frequency and Duration of Freeway Accidents in Seattle, Accident Analysis and Prevention, Vol. 23, No. 2, 1991.
2. Ben-Akiva, Moshe, and Steven Lerman, Discrete Choice Analysis, MIT Press, Cambridge, MA, 1985.
3. Garrison, Dan and Fred Mannering, Assessing the Traffic Impacts on Freeway Incidents and Driver Information, ITE Journal, Vol. 60, No. 8, August 1990.

Reference Guide

GENERAL

Adeel, Lari, David Christianson and Sue Porter, I-35W Incident Management and Impact of Incidents on Freeway Operations, Minnesota Department of Transportation, January 1982.

Baxter, D. H., T.C. Werner and R.M. Gardeski, The Integrated Motorist Information System: The Ideal and the Real, New York State Department of Transportation, March 1987.

Beaubien, Richard F. and Kunwar Rajendra, Metro Detroit's Incident Management Program-Applying ITS Technology, ITE Journal, April 1995.

Berg, D., B. Legg, and L. Showalter, The Washington State Department of Transportation's Seattle Area Incident Management Program, ITE Compendium of Technical Papers, 1992.

Botha, G.J. and M.J. Massingham, Incident Management, Civil Engineering, January 1993.

California Law Enforcement Mutual Aid Plan, Law Enforcement Division, Governor's Office of Emergency Services, State of California, 1985.

Colorado Department of Transportation, Recommendations of the Colorado Incident Management Coalition, Denver, Colorado, September 1992.

Court, Tanya, et al., Using Freeway Incident Management to Reduce Congestion, Public Works, 1994.

Cuddy, Michael J., Starting Incident Management on Long Island, New York State Department of Transportation.

Della, Rocca M., Development of a Statewide IVHS and Incident Management Master Plan for New Jersey, Proceedings of the IVHS America 1993 Annual Meeting, 1993.

Edelman, M., P.A. Einreinhofer, K.F. Turnbull, and M.R. Ringrose, Symposium on Integrated Traffic Management Systems, Irvine, California, June 24-26, 1992: Appendix A: ITMS White Papers;

Institutional Issuès in ITMS: TRANSCOM's Experience in NY and NJ, Transportation Research Circular, March 1993.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Fatal Accident Reporting System - 1986 and 1987, NHTSA, March 1988 and December 1988.

Federal-aid Participation in Traffic Management Improvements in Urban Areas: Memorandum, Office of Traffic Operations, Federal Highway Administration, April 20, 1989.

Fink, Kenneth L., Analysis of Incident Management Programs in North America, Graduate Student Papers on Advanced Surface Transportation Systems, 1993.

Freeway and Arterial Management Effort (FAME): Research Plan Executive Summary, Washington State University Transportation Center and Washington State Department of Transportation, December 1987.

Freeway Incident Management Plan: Draft, Division of Traffic, Maryland State Highway Administration, December 1985.

Freeway Incident Management: Instructional Memorandum No. 1.255, Office of Maintenance, Highway Division, Iowa Department of Transportation.

Gaj, Stephen J., Michigan's Department of Transportation District 6 Incident Management Program: Special Report, Federal Highway Administration, April 1985.

Gangisetty, R. and D.W. May, Traffic and Incident Management System for I-95 in the Philadelphia Area, ITE Journal, February 1992.

Graduate Student Papers on Advanced Traffic Management Systems, Texas A&M University, August 1991.

Grenzeback, L.R., R.S. Champion, and J.M. Schoen, Incident Management, Cambridge Systematics Inc., and American Trucking Association Inc., October 1990.

Grenzeback, Lance R. and Clyde E. Woodle, The True Costs of Highway Congestion, ITE Journal, March 1993.

Hadi, M.A. and C.E. Wallace, A State of the Art for Intelligent Vehicle-Highway Systems in Florida, Florida University, Transportation Research Center, and Florida Department of Transportation, August 1992.

Harrison, J.E., Hampton Roads Bridge Tunnel Traffic Control and Surveillance System: The First Ten Years, Virginia Department of Transportation, January 1987.

Hattan, D.E., J. Finch, L. Lipp, L.J. Corcoran, and L. Sumpter, Implementing an Areawide Incident Management and IVHS Program, ITE 1993 International Conference, 1993.

Haven, J., Traffic Management in California, Beheers Verkeer: Verslag Symposium 21 MAART 1990, April 1990.

Highway 401 Freeway Traffic Management System: Incident Management Plan, Ontario Ministry of Transportation, December 1991.

Hochmuth, J. and J. Diamond, Incident Management for the Tri-State Tollway (I-294) Widening Project, Operations Review, 1993.

Humphrey, T.F., Planning Study to Design a Demonstration Program to Illustrate the Benefits of Highway Technological Innovation, Massachusettts Institute of Technology, February 1991.

Incident Management in Virginia, Video, Virginia Transportation Research Council, and Virginia Department of Transportation, 1991.

Incident Management Programs in the United States, Office of Traffic Operations, Federal Highway Administration, April 14, 1989.

Incident Management Project - 1987 Highway 401 Metropolitan Toronto, Ontario Ministry of Transportation.

Incident Management Systems: Safety and Efficiency for All of Us, Video, Washington State Transportation Center (TRAC), Washington State Transportation Commission, U.S. Department of Transportation, 1991.

Incident Management: Executive Summary, Trucking Research Institute ATA Foundation Inc., October 1990.

Introduction to Freeway Management, Operational Guidelines for Freeway Management, Overview for New Team Members, Video, Florida Department of Transportation, 1991.

Jones, B. and F.L. Mannering, Generation and Assessment of Incident Management Strategies. Volume 2: Management, Surveillance, Control and Evaluation of Freeway Incidents: A Review of Existing Literature, TransNow, Transportation Northwest, University of Washington, Civil Engineering Dept., February 1990.

Jones, B., L. Janssen, B. Sebranke, and F.L. Mannering, Generation and Assessment of Incident Management Strategies. Volume 1: Summary Report, TransNow, Transportation Northwest, University of Washington, Civil Engineering Dept., February 1990.

Jones, B., L. Janssen, B. Sebranke, and F.L. Mannering, Generation and Assessment of Incident Management Strategies. Volume 3: Analysis of Freeway Incidents in the Seattle Area, TransNow, Transportation Northwest, University of Washington, Civil Engineering Dept., February 1990.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Judycki, D.C. and J.R. Robinson, Managing Traffic During Nonrecurring Congestion, ITE Journal, 1992.

Judycki, D.C., Innovative Safety and Operations Highway Projects in the United States, ITE Journal, December 1992.

Kelly, D.M., The Development of a Traffic Surveillance and Control System For The Ayalon Freeway in Israel, IEE Conference on Road Traffic Monitoring and Control, April 1992.

Khisty, C.J. and M. Wong, Freeway Incident Management for Medium-Sized Urban Areas (Phase II), Washington State University, Washington State Department of Transportation, and Federal Highway Administration, June 1991.

Koehne, J. and F.L. Mannering, Development of Incident Management Systems: The Seattle Case Study, University of Washington, Washington State Department of Transportation, and Federal Highway Administration, July 1991.

Koehne, J.L., F.L. Mannering, and M.E. Hallenbeck, Framework for Developing Incident Management Systems, Washington State Transportation Center (TRAC), Washington State Transportation Commission, U.S. Department of Transportation, August 1991.

Korpal, P.R., Incident Management: The Key to Successful Traffic Management in Toronto, ITE Journal, March 1993.

Lohman, T. and M. Coemet, Towards a Better Use and Less Congestion. The Traffic Management Program for the Primary Road Network in the Netherlands, Proceedings of the First Would Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems, November 1994.

Louie, M. and F.L. Mannering, Development of an Emergency Response Guide for Washington State Department of Transportation Highway Maintenance Engineers, University of Washington, Washington State Department of Transportation, and Federal Highway Administration, February 1993.

Mannering, F.L., B. Jones, and B. Sebranke, Generation and Assessment of Incident Management Strategies. Volume 5: Seattle Area Incident Management: Assessment and Recommendations, TransNow, Transportation Northwest, University of Washington, Civil Engineering Dept., February 1990.

Mannering, F.L., D.H. Garrison, and B. Sebranke, Generation and Assessment of Incident Management Strategies. Volume 4: Seattle-Area Incident Impact Analysis: Microcomputer Traffic Simulation Results, TransNow, Transportation Northwest, University of Washington, Civil Engineering Dept., February 1990.

Mannering, F.L., Generation and Assessment of Incident Management Strategies: Summary Report, Department of Civil Engineering, University of Washington and Washington State Transportation Center (TRAC), August 1989.

Mannering, F.L., Generation and Assessment of Incident Management Strategies: Volume I: Management, Surveillance, Control and Evaluation of Freeway Incidents: A Review of Existing Literature, Department of Civil Engineering, University of Washington and Washington State Transportation Center (TRAC), August 1989.

Massachusetts Incident Management Conference Proceedings, June 6, 1991, US Department of Transportation, 1992.

May, Adolf D., Monitoring Detector Information and Incident Control Strategies, Institute of Transportation Studies, University of California, Berkeley, August 1, 1985.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

Mounce, John M., Robert W. Stokes, Robert Q. Brackett and William R. McCasland, Guidelines for Utilization of Police Officers in Traffic Control and Enforcement on Urban Freeways, Texas Transportation Institute, Texas A & M, Texas State Department of Highways and Public Transportation, Report No. FHWA/TX-86/75+410-7F, September 1986.

National Incident Management Coalition, Incident Management-Developing Consensus Through an Educational and Promotional Conference, a report prepared by the ATA Foundation, Reemford, Rhode Island, 1992.

Open Roads, A Look at Freeway Incident Management, U.S. Dept. of Transportation, Federal Highway Administration, Washington, D.C., 1991.

Open Roads, A Look at Freeway Incident Management, Video, Federal Highway Administration, 1991.

Paesani, Gordon F., Considerations in Establishing Freeway Incident Management Programs, Michigan Department of Transportation, January 1985.

PRC Voorhees, A Freeway Management Handbook, Federal Highway Administration, 1983.

Proposed Program of Freeway Management Improvements for the Tampa/St. Petersburg Area, Tampa/ St. Petersburg Freeway Management Team, March 1987.

Reay, M. and J. Kiljan, A Needs Assessment for Advanced Rural Transportation Systems: A Colorado Perspective, Proceedings of the IVHS America 1993 Annual Meeting, 1993.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Robinson, T., F.Y.C., Sin, R. Aitken, and D. Nash, Integrated Traffic Management System in Melbourne, Australia, Traffic Technology International '94, 1994.

Roper, David H., Synthesis - Freeway Incident Management, NCHRP Project 20-5, Topic 8-08, Draft, December 1987.

Scheuernstuhl, George J., Mobilizing for Incident Management in The Denver Region, ITE Compendium of Technical Papers, September 1993.

Schofield, M.J., Traffic Management on the Motorway Network, Highways and Transportation, September 1990.

Shepard, F.D., Incident Management in Virginia: A State of the Practice Report, Virginia Transportation Research Council, Virginia Department of Transportation, and Federal Highway Administration, November, 1991.

Shuldiner, R.W., Cost Effective Investment Strategies for Incident Management on a Section of the Massachusetts Turnpike, Massachusetts University, July 1994.

Siegfried, Robert H. and Nitin Vaidya, Automated Incident Management Plan Using Geographic Information Systems Technology for Traffic Management Centers, Available Through the National Technical Information Service, Springfield, VA., August 1993.

Survey Results: Incident Response Programs Vary Widely, Urban Transportation Monitor, September 1990.

The National Incident Management Coalition, ITE Journal, 1992.

The Pennsylvania Turnpike Commission's Incident Management Team, Pennsylvania Turnpike Commission, U.S. Dept. of Transportation, January 1993.

The Twin Cities Incident Management Community: A New Coalition for Innovative Solutions: Draft, Office of Freeway Operations and Office of Financial Management, Minnesota Department of Transportation, November 1989.

Traffic Information Center, Fairfax County Police Department, March 1988.

TRB Freeway Operations Committee Status Reports, June 1989.

Ulmer, Robert, et al., Analysis of the Dismounted Motorist and Road Worker Model Pedestrian Regulations, DOT-HS-806-445, National Highway Traffic Safety Administration, August 1982.

Wells, S.R., The Feasibility of Planning, Establishing and Implementing a Freeway Incident Management Program, ITE 1994 Compendium of Technical Papers, 1994.

Wohlschlaeger, S.D. and Ullman G.L., Catalog of Transportation Management Activities for Major Emergencies, Texas Transportation Institute, March 1992.

Wohlschlaeger, Steven D. and Kevin N. Balke, Incident Response and Clearance in the State of Texas: Case Studies of Four Motorist Assistance Patrols, Texas Transportation Institute, October 1992.

Zeller, R.S. and F.L. Mannering, Incident Management System Demonstration, Washington State Transportation Center, Washington State Department of Transportation, and Federal Highway Administration, November 1993.

ACCIDENT INVESTIGATION SITES

Dudek, Conrad, et al., Promotional Issues Related to Off Site Accident Investigation, Report No. FHWA-RD-87-036, January 1987.

ADMINISTRATIVE TRAFFIC MANAGEMENT TEAMS

McDade, J.D., Personnel: The Critical Element in Successful Incident Management, ITE Journal, March 1993.

Scheuernstuhl, George J., Mobilizing For Incident Management in The Denver Region, ITE Compendium of Technical Papers, September 1993.

Shuldiner, R.W., Cost Effective Investment Strategies for Incident Management on a Section of the Massachusetts Turnpike, Massachusetts University, July 1994.

The Pennsylvania Turnpike Commission's Incident Management Team. A Technology Sharing Reprint, Pennsylvania Turnpike Commission, January 1993.

Wohlschlaeger, Steven D. and Kevin N. Balke, Incident Response and Clearance in the State of Texas: Case Studies of Four Motorist Assistance Patrols, Texas Transportation Institute, October 1992.

ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS)

Abdel-Aty, M.A., et al., Understanding Traveler Responses to Advanced Traveler Information Systems, International Symposium on Automotive Technology & Automation, 1993.

Adler, Jeffrey L. and Michael G. McNally, In-Laboratory Experiments to Investigate Driver Behavior Under Advanced Traveler Information Systems, Transportation Research, September 1994.

Adler, Jeffrey L., Wilfred W. Recker, and Michael G. McNally, In-Laboratory Experiments to Analyze Enroute Driver Behavior Under ATIS, Berkeley, University of California Transportation Center, 1993

Al-Deek, H.M., The Role of Advanced Traveler Information Systems in Incident Management, California PATH Program, Institute of Transportation Studies, University of California at Berkeley, 1992.

Al-Deek, Haitham and Adib Kanafani, Incident Management With Advanced Traveler Information Systems, Society of Automotive Engineers Conference on Vehicle Navigation & Information Systems, October 1991.

Bhat, Chandra R. et at., Driver Recruitability for Advanced Traveler Information System Experiments, Transportation Research, December 1993.

Boyce, D.E., A. Kirson, and J.L. Schofer, Design and Implementation of ADVANCE: The Illinois Dynamic Navigation and Route Guidance Demonstration Program, 1991 Vehicle Navigation & Information Systems Conference, 1991.

Brus, John, TravTek: Exploring the Future of Advanced Driver Information Systems, General Motors Corporation, Research Laboratories, May 1992.

Catling, Ian and Richard Harris, Advanced Traveler Information Systems in Europe, Vehicle Systems for Roads, 1993.

Chen, K. and S.E. Underwood, Research on Anticipatory Route Guidance, 1991 Vehicle Navigation & Information Systems Conference, 1991.

Dehoux, P. and L. Toint, Some Comments on Dynamic Traffic Modeling in the Presence of Advanced Driver Information Systems, DRIVE Conference, 1991.

Hadi, M.A. and C.E. Wallace, A State of the Art for Intelligent Vehicle-Highway Systems in Florida, Florida University, Transportation Research Center, and Florida Department of Transportation, August 1992.

Ivan, John N., Arterial Street Incident Detection Using Multiple Data Sources: Plans for ADVANCE, Pacific Rim TransTech Conference, July 1993.

Jayakishnan, R., Michael G. McNally, and Michael I. Cohen, Simulation of Advanced Traveler Information Systems (ATIS) Strategies to Reduce Non-Recurring Congestion From Special Events, University of California Transportation Center, 1993

Koutsopoulos, Harris N., Design Parameters of Advanced Driver Information System: The Case of Incident Congestion and Small Market Penetration, Society of Automotive Engineers Conference on Vehicle Navigation & Information Systems, October 1991.

Raghvan, S., et al., California Advanced Driver Information System II(CADIS II): Extended Tests of Audio and Visual Route Guidance Displays, Davis, Calif.: Institute of Transportation Studies, University of California, 1995.

Rajendra, K. and R.E. Maki, The IVHS Strategy in Michigan, Proceedings of the IVHS America 1993 Annual Meeting, 1993.

Rillings, James H. and M.K. Krage, TravTek, An Operational Advanced Driver Information System, International Congress on Transportation Electronics, 1992.

Rillings, James H., Advanced Driver Information Systems, IEEE Transactions on Vehicular Technology, February 1991.

Wheeler, William A., et al., Predicting Driver Behavior Using Advanced Traveler Information Systems, Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 1994.

ADVANCED VEHICLE CONTROL SYSTEMS

Development and Test Results for a Vision-Based Approach to Advanced Vehicle Control Systems (AVCS), International Symposium on Automotive Technology and Automation, Automotive Automation Limited, 1993.

Douglas, Randall K. et al., Fault Detection and Identification with Application to Advanced Vehicle Control Systems, PATH Research Report UCB-ITS-PRR-95-26, Institute of Transportation Studies, University of California, Berkeley, 1995.

Gartner, Nathan H, et al., Advanced Traffic Control Strategies for Intelligent Vehicle Highway Systems, Intelligeht Vehicle Highway Systems, Society of Photo-optical Instrumentation Engineers, 1995.

Hedrick, J. Karl, Advanced Vehicle Control Systems, Department of Mechanical Engineering, University of California, Berkeley, 1992.

Shladover, Steven E., Advanced Vehicle Control Systems (AVCS), Vehicle Electronics in the 90's, Society of Automotive Engineers, 1990.

Shladover, Steven E., Issues in Communication Standardization for Advanced Vehicle Control Systems, Transportation Research Record No. 1324, Transportation Research Board, 1991.

Shladover, Steven E., Potential Freeway Capacity Effects of Advanced Vehicle Control Systems, Applications of Advanced Technologies in Transportation Engineering, Proceedings of the Second International Conference, American Society of Civil Engineers, New York, 1991.

Shladover, Steven E., Research and Development Needs for Advanced Vehicle Control Systems, IEEE Micro, Vol. 13, No. 1, February 1993.

Shladover, Steven E., Review of the State of Development of Advanced Vehicle Control Systems (AVCS), Vehicle System Dynamics, Vol. 24, No. 6-7, July 1995.

Vehicle Routing, Traveler ADIS, Network Modeling, and Advanced Control Systems, Transportation Research Record No. 1358, Transportation Research Board, 1992.

Yanakiev, Diana, Analysis, Design, and Evaluation of AVCS for Heavy-Duty Vehicles: Phase I Report, PATH Working Paper UCB-ITS-PWP-95-12, Institute of Transportation Studies, University of California, Berkeley, 1995.

AIRCRAFT PATROL

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

District 7 Action Plan - Major Incident Traffic Management Team, CalTrans, District 7, Los Angeles, CA.

ALTERNATIVE ROUTE PLANNING

Albert, Stephen, Robert Siegfried and Steven Levine, Application of Geographic Information System to Houston Freeway Incident Management Program, ITE Compendium of Technical Papers, 1990.

Cragg, C.A. and M.J. Demetsky, Simulation Analysis of Route Diversion Strategies for Freeway Incident Management, Virginia Transportation Research Council & Virginia Department of Transportation, February 1995.

Freeway Incident Management Plan: Draft, Division of Traffic, Maryland State Highway Administration, December 1985.

Gaj, Stephen J., Michigan's Department of Transportation District 6 Incident Management Program: Special Report, Federal Highway Administration, April 1985.

I-75 Emergency Re-routing Plans, Department of Police, City of Dayton Ohio, January 1989.

Janko, J., An Algorithm for an Incident Management in a Route Guidance System, Control, Computers, Communications Information, 1990.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Lepofsky, Mark, Mark Abkowitz, and Paul Cheng, Transportation Hazard Analysis in Intergrated GIS Environment, Journal of Transportation Engineering, March 1993.

McDonald, William H., Connecticut I-95 Incident Management System, Pacific Rim Conference, July 1993.

Northern Virginia Freeway Management Team Operating Manual: A Regional Plan for Traffic Management on Northern Virginia Freeways, JHK and Associates and Virginia Department of Transportation.

Ran, Bin, Honk K. Lo, Stein Weissenberger, and Bruce Hongola, Predicting Dynamic Travel Times Under Incidents in Transportation Networks, Proceedings of the 1994 Annual Meeting of IVHS America, 1994.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

TRANSCOM Incident Management Plan, I-287, New York State Thruway Through Rockland County: Draft, TRANSCOM, May 1989.

AUTOMATIC TRUCK WARNING SYSTEM

McGee, Hugh, et al., Feasibility of an Automatic Truck Warning System, Office of Safety and Traffic Operations R&D, Federal Highway Administration, September 1993.

AUTOMATIC VEHICLE IDENTIFICATION (AVI)

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

Hadi, M.A. and C.E. Wallace, A State of the Art for Intelligent Vehicle-Highway Systems in Florida, Florida University, Transportation Research Center, and Florida Department of Transportation, August 1992.

Hallenbeck, Mark E., Tim Boyle, and Jennene Ring, Use of Automatic Vehicle Identification Techniques for Measuring Traffic Performance and Performing Incident Detection, Washington State Transportation Commission and Transportation Northwest, October 1992.

Lay, J.L., Intelligent Vehicle-Highway Systems and Incident Management, ITE Journal, March 1992.

Levine, Steve Z., William R. McCasland, Monitoring Freeway Traffic Conditions with Automatic Vehicle Identification Systems, ITE Journal, Vol. 64, No. 3, March 1994.

Marshall, K.R. and Tom Batz, TRANSMIT: TRANSCOM's System for Monitoring Incidents and Traffic, ITE Compendium of Technical Papers, October 1994.

Mierzejewski, Edward A., Michael C. Pietrzyk, William L. Ball, Analysis of Automatic Vehicle Identification Technology and Its Application on Florida's Turnpike, Applications of Advanced Technologies in Transportation Engineering, Proceedings of the Second International Conference, 1991.

Parkany, A. Emily and David Bernstein, Using VRC Data for Incident Detection, Pacific Rim TransTech Conference, July 1993.

Parkany, Emily and David Bernstein, Design of Incident Detection Algorithms Using Vehicle to Roadside Communication Sensors, Transportation Research Board, 1995.

Sethi, Vaneet, Arterial Incident Detection Using Fixed Detector and Probe Vehicle Data, Transportation Research, Vol. 3, No. 2, 1995.

Sommerville, F., Applications of Automatic Vehicle Identification Technology, Transport Reviews, Vol. 11, No. 2, April-June 1991.

Vincent, J., Smart Technology for Toll Roads, Traffic Technology International, 1994.

AUTOMATIC VEHICLE LOCATION (AVL)

Abousalem, Mohamed A., A Quality Control Approach for GPS-Based Automatic Vehicle Location and Navigation Systems, Proceedings of the 4th Vehicle Navigation and Information Systems Conference, IEEE, 1993.

Automatic Vehicle Location for Measurement of Corridor Level-of-Service: Statewide Feasibility Analysis, Center for Urban Transportation Research, University of South Florida, 1994.

Banks, K.M., Integrated Automatic Vehicle Location and Position Reporting System, Second International Conference on Road Traffic Monitoring, Institution of Electrical Engineers, 1989.

Bergan, A.T. et al., Electronic License Plate Technology: Automatic Vehicle Location and Identification, Compendium of Technical Papers, 58th Meeting of the Institute of Transportation Engineers, 1988.

Ciconte, Marie, Tracking Vehicles, Metro, Vol. 83, No. 2, March/April 1987.

Denaro, R.P., GPS-Based Automatic Vehicle Location (AVL) and Fleet Management Systems: Robust and Affordable for the 90s, Royal Institute of Navigation Conference, Paper No. 10, 1990.

Fernandez, Mario Cid, GPS Navigation Subsystem for Automatic Vehicle Location Systems, Royal Institute of Navigation Conference, Paper No. 35, 1990.

Gravelle, K.P., Applications of Two Way, Full Speed AVI Technologies, AVI Technology for Toll Collection, International Bridge, Tunnel and Turnpike Association, 1990.

Gray, Tony, Automatic Vehicle Location: the Current State of the Art, International Conference on Road Vehicle Automation, 1993.

Gregg, Donald, Automatic Vehicle Location System Design Considerations, E-Systems, Greenville Division, 1994.

Levy, Dan, The Use of Automatic Vehicle Location for Planning and Management Information, Strategic Transit Research Program, No. 4, 1991.

Lowe, G.D., Automatic Vehicle Location for Metropolitan Ambulance Service's Computer-Aided Dispatch System, Australian Road Research Board, 1988.

Pawley, A.J.R., Automatic Systems for Vehicle Location, Traffic Signal Priority and Passenger Information, International Conference on the Bus, Institution of Mechanical Engineers, 1986.

Perkinson, Dennis G., Using Automated VEhicle Location Data to Monitor Congestion: Fuzzy Set Theory, ITE Journal, Vol. 64, No. 2, February 1994.

Perlstein, Dan, Automatic Vehicle Location Systems: a Tool for Computer Aided Dispatch Systems of the Future, Vehicle Navigation and Information Systems Conference, IEEE, 1989.

Riter, Stephen, Automatic Vehicle Location: an Overview, IEEE Transactions on Vehicular Technology, Vol. VT-26, No. 1, February 1977.

Saldin, Neil P., Magnavox Automatic Vehicle Location Pilot System for the Toronto Department of Ambulance Services, Vehicle Navigation and Information Systems Conference, IEEE, 1989.

Strandberg, Keith, Automated Vehicle Location Technology Adds Capabilities, Mass Transit, Vol. 19, No. 6, November/December 1993.

Watje, John M., Vehicle Location Technologies in Automatic Vehicle Monitoring and Management Systems, IVHS Journal, Vol. 1, No. 3, 1994.

Wilson, Geoffrey D., Selection Factors for Police Automatic Vehicle Location Systems, Carnahan Conference on Crime Countermeasures, 1977.

Workshop on Automatic Vehicle Location and Control, Proceedings, Canadian Urban Transit Association, 1987.

Zografox, Kostas G., Integrating Geographic Information System (GIS) and Automatic Vehicle Location (AVL) Technologies for Improving the Emergency Response Capabilities of Electric Utilities, Proceedings, Second Vehicle Navigation and Information Systems Conference, IEEE, 1991.

CELLULAR TELEPHONES

Arch, J.P., Recreational Applications of IVHS in New Jersey, Proceedings of the IVHS America 1994 Annual Meeting, 1994.

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

IDOT Taps Cellular Samaritans: Information Release, Illinois Department of Transportation, March 28, 1990.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

Rajendra, K. and R.E. Maki, The IVHS Strategy in Michigan, Proceedings of the IVHS America 1993 Annual Meeting, 1993.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Star 999, A Friend on the Road: Press Release, Illinois Department of Transportation.

CENTRAL INFORMATION PROCESSING AND CONTROL SITE

Beaubien, Richard and Clay Collier, Information and Control Networks for Traffic Management, ITE Compendium of Technical Papers, September 1993.

Chang, E.C. and K. Huarng, Corridor Analysis for Reconstruction Activities, Traffic Control Strategies, and Incident Management Techniques: Task B, Development of Expert Systems for Freeway Incident Management: Microcomputer User's Guide. Final Report, Texas Transportation Institute, February 1991.

Chang, Edmond Chin-Ping and Kunhuang Huarng, Freeway Incident Management Expert System Design, Transportation Research Record, 1993.

Chang, G.L., J. Wu, and H. Lieu, Real-Time Incident-Responsive System for Corridor Control: Modeling Framework and Preliminary Results, Transportation Research Record, 1994.

Chen, C.H. and G.L. Chang, A Self-Learning System for Real-Time Incident Detection and Severity Assessment: Framework and Methodology, International Symposium on Automotive Technology & Automation, 1993.

Chen, Chao-Hua and Gang-Len Chang, A Dynamic Real-Time Incident Detection System for Urban Arterials - System Architecture and Preliminary Results, Pacific Rim TransTech Conference, July 1993.

Deeter, Dean L. and Stephen G. Ritchie, A Prototype Real-Time Expert System for Surface Street Traffic Management and Control, Pacific Rim TransTech Conference, July 1993.

Differt, D.H. and R. Stehr, Reflections on Traffic Management Experience in Minnesota, ITE Journal, March 1992.

Gangisetty, R. and D.W. May, Traffic and Incident Management System for I-95 in the Philadelphia Area, ITE Journal, February 1992.

Gilmore, J.F., K.J. Elibiary, and H.C. Forbes, Knowledge-Based Advanced Traffic Management System, Proceedings of the IVHS America 1994 Annual Meeting, April 1994.

Hanchey, C.M. and J.A. Smith, A Medium-Size City's Approach to IVHS—Jackson's Traffic Management System, ITE Journal, May 1995.

Karimi, A., Arti Gupta, G. Wheeler, and G. Massarano, Application of Knowledge-Based Expert Systems to Incident Management in the Santa Monica Smart Corridor System, Compendium of the International Conference on Artificial Intelligence Applications in Traffic Engineering, Engineering Foundation Conference, June 1992.

Karimi, Ashkan and Arti Gupta, Incident Management System for Santa Monica Smart Corridor, ITE compendium of Technical Papers, September 1993.

Kay, J. and S. Shapiro, Southeast Florida Intelligent Corridor System Vision Design Summary, Proceedings of the Advanced Traffic Management Conference, Federal Highway Administration, October 1993.

Kelly, D. M., The Development of a Traffic Surveillance and Control System For The Ayalon Freeway in Israel, IEE Conference on Road Traffic Monitoring and Control, April 1992.

Khattak, A.J., J.L. Schofer, and Mu-Han Wang, A Simple Time Sequential Procedure for Predicting Freeway Incident Duration, IVHS Journal, May 1995.

Kuciemba, S.R., CHART: Chesapeake Highway Advisories Routing Traffic, Proceedings of the IVHS America 1994 Annual Meeting, 1994.

Lay, J.L., Intelligent Vehicle-Highway Systems and Incident Management, ITE Journal, March 1992.

Maryland Starts Project Managing I-95, ENR, September 1992.

McDermott, J.M., Advanced Technology Applications in Chicago-Area Freeway Traffic Management Program, Journal of Transportation Engineering, May 1992.

McDonald, William H., Connecticut I-95 Incident Management System, Pacific Rim Conference, July 1993.

Nelson, Donna C., A Survey of Traffic Monitoring and Surveillance in the Los Angeles Area, Australian Road Research Board Proceedings, November 1992.

Neudorff, Louis G. and John Dovel, A Freeway Surveillance and Control System for Dade County, Florida, ITE Compendium of Technical Papers, 1990.

Pearce Vincent P., TransGuide Leads the Way in Innovative Transportation Management, Public Roads, Summer 1995.

Perez, C., G. Hall, B. Grasso, and M. Ward, Support Systems for Advanced Traffic Management Systems Control Centers, Proceedings of the IVHS America 1994 Annual Meeting, 1994.

Prosser, N.A., and S.G. Ritchie, Real-Time Knowledge-Based Integration of Freeway Surveillance Data, Transportation Research Record, 1991.

Ritchie, S.G. and N.A. Prosser, Real-Time Expert System Approach to Freeway Incident Management, Transportation Research Record, 1991.

Ritchie, Stephen G. and Robert Stack, A Real-Time Expert System For Freeway Incident Management in Orange County, California, Computing in Civil and Building Engineering, 1993.

Robinson, T., F.Y.C., Sin, R. Aitken, , and D. Nash, Integrated Traffic Management System in Melbourne, Australia, Traffic Technology International '94, 1994.

Roseman, David, Incident Manager Control Concept Multi-Agency Coordinated Traffic Management Santa Monica Freeway Smart Corridor, ITE Compendium of Technical Papers, October 1994.

Sha'aban, A.M., K.M. Jehanian, R. Gangisetty, and G. Hobeika, The Mobile Satellite Communications Platform for Incident Management, Proceedings of the First World Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems, November 1994.

Shekhar, Shashi and Peter A. Hancock, A Traffic Data Management System for Navigation, Collision Detection, and Incident Detection, Minnesota Dept. of Transportation, Office of Research Administration, 1994.

Siegfried, R.H. and N. Vaidya, Automated Incident Management Plan Using Geographic Information Systems Technology for Traffic Management Centers, Texas Transportation Institute, July 1993.

Smith, B.L. and J.S. Miller, Analysis of the Capabilities and Operations of the Northern Virginia Traffic Management System. Technical Assistance Report, April 1994.

Snell, A., F.Y.C. Sin and J.Y.K. Luk, Freeway Incident Management in Melbourne: An Initial Appraisal, Australian Road Research Board Proceedings, November 1992.

Stack, R. and S.G. Ritchie, CALTRANS District 12 Real-Time Expert System for Freeway Incident Management, California University and California Department of Transportation, December 1993.

Stephanedes, Yorgos J. and A. Chassiakos, Improved Incident Detection for Adaptive Control in IVHS Systems, International Symposium on Automotive Technology & Automation, 1992.

Zhang, Hongjun and Stephen G. Ritchie, Real-Time Decision-Support System For Freeway Management and Control, Journal of Computing in Civil Engineering, January 1994.

CITIZENS' BAND (CB) RADIO MONITORING

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

Baxter, D. H., T.C. Werner and R.M. Gardeski, The Integrated Motorist Information System: The Ideal and the Real, New York State Department of Transportation, March 1987.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Albert, Stephen, Robert Siegfried and Steven Levine, Application of Geographic Information System to Houston Freeway Incident Management Program, ITE Compendium of Technical Papers, 1990.

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

Berg, Tom, Traffic Patrol Rides to the Rescue in Chicago, Transport Topics, 1991.

Contract Special Provisions for Service Patrols on the Reconstruction of I-95 in Broward County, Florida Department of Transportation.

Cuciti, P. and B. Janson, Courtesy Patrol Pilot Program, Colorado University, Colorado Department of Transportation, and Federal Highway Administration, August 1993.

Cuciti, Peggy L. and Bruce N. Janson, Incident Management Via Courtesy Patrol: Evaluation of a Pilot Program in Colorado, Transportation Research Board, 1995.

Finnegan, S.A., Estimating Freeway Service Patrol Assists: An Analysis of the Los Angeles County Metro Freeway Service Patrol, Dissertation, UCLA, 1992.

Introduction to the Illinois Department of Transportation Emergency Traffic Patrol, Emergency Traffic Patrol Headquarters, Illinois Department of Transportation, March 1, 1989.

Kohlbeck, G. G., State Police Motorist Assistance Program: July 1, 1989 - June 30, 1990, Virginia Department of State Police.

Mannering, F.L. and Hallenbeck, M.E., Incident Management Systems Framework: Impacts of Service Patrols. Final Summary Report, University of Washington, Washington State Department of Transportation, and Federal Highway Administration, March 1991.

McDade, Jonathan D., Freeway Service Patrols: A Versatile Incident Management Tool, Traffic Management and Systems Division, Federal Highway Administration, July 1989.

McDermott, J.M., Advanced Technology Applications in Chicago-Area Freeway Traffic Management Program, Journal of Transportation Engineering, May 1992.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

Morris, M. and K.B. Hord, Communications and Intelligent Transportation Systems for Freeway Service Patrols, Transportation Research Board, January 1995.

Morris, M. and W. Lee, Survey of Efforts to Evaluate Freeway Service Patrols, Transportation Research Record, 1994.

Responding to Freeway Incidents, Texas Transportation Researcher, 1993.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Samaritan Program Overview, SAMARITANIA, Inc..

Skabardonis, A., Freeway Service Patrol Evaluation, Institute of Transportation Studies, University of California, Berkeley, February 1995.

Streff, F.M., Cars, Motorcycles, and Traffic Law Enforcement: Evaluation of Police Patrol Motorcycle on Urban Freeways, UMTRI Research Review, January 1994.

Streff, F.M., Evaluation of the Michigan State Police Motorcycle Pilot Project: Analysis of Police Activity and Attitudes, University of Michigan Transportation Research Institute, October 1993.

Wohlschlaeger, Steven D. and Kevin N. Balke, Incident Response and Clearance in the State of Texas: Case Studies of Four Motorist Assistance Patrols, Texas Transportation Institute, October 1992.

Zografos, Kostas G., Teti Nathanail and Panos Michalopoulos, Analytical Framework For Minimizing Freeway-Incident Response Time, Journal of Transportation Engineering, July 1993.

DEFINING PROPER TRAFFIC CONTROL TECHNIQUES

Manual on Uniform Traffic Control Devices for Streets and Highways, U.S. Department of Transportation, Federal Highway Administration, 1978.

Mounce, John M., Robert W. Stokes, Robert Q. Brackett and William R. McCasland, Guidelines for Utilization of Police Officers in Traffic Control and Enforcement on Urban Freeways, Texas Transportation Institute, Texas A & M, Texas State Department of Highways and Public Transportation, Report No. FHWA/TX-86/75+410-7F, September 1986.

Stokes, R. W., Literature Review - Traffic Enforcement Requirements for Highway Maintenance, Construction and Other Traffic Management Functions, SDHPT Study No. 2 18-84-410, Unpublished Report, September 1984.

TRANSCOM Incident Management Plan, I-287, New York State Thruway Through Rockland County: Draft, TRANSCOM, May 1989.

ELECTRONIC LOOP DETECTION

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

Baxter, D. H., T.C. Werner and R.M. Gardeski, The Integrated Motorist Information System: The Ideal and the Real, New York State Department of Transportation, March 1987.

Differt, D.H. and R. Stehr, Reflections on Traffic Management Experience in Minnesota, ITE Journal, March 1992.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Kelly, D. M., The Development of a Traffic Surveillance and Control System For The Ayalon Freeway in Israel, IEE Conference on Road Traffic Monitoring and Control, April 1992.

May, Adolf D., Monitoring Detector Information and Incident Control Strategies, Institute of Transportation Studies, University of California, Berkeley, August 1, 1985.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

McDermott, Joseph M., Freeway Operations Activities in the Chicago Area, March 9, 1987.

McDermott, Joseph M., Update: Chicago Area Freeway Operations, January 11, 1988.

McDonald, William H., Connecticut I-95 Incident Management System, Pacific Rim Conference, July 1993.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Chang, Edmond Chin-Ping, A Neural Network Approach to Freeway Incident Detection, Vehicle Navigation and Information Systems Conference, 1992.

Chassiakos, Athanasios P. and Yorgos J. Stephanedes, Smoothing Algorithms for Incident Detection, Transportation Research Record No. 1394, 1993.

Cohen, Simon and Zoe Ketselidou, A Calibration Process for Automatic Incident Detection Algorithms, Fourth International Conference on Microcomputers in Transportation, 1992.

Cohen, Simon and Zoe Ketselidou, DAISI, a Calibration Tool for Automatic Incident Detection Algorithms: Application on the Paris Ringway, Sixth International Conference on Road Traffic Monitoring and Control, 1992.

Cohen, Simon, Comparative Assessment of Conventional and New Incident Detection Algorithms, Seventh International Conference on Road Traffic Monitoring and Control, 1994.

Coordinated Operation of Ramp Metering and Adjacent Traffic Signal Control Systems, Federal highway Administration, 1988.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Hall, Fred L., Yong Shi, and George Atala, On-line Testing of the McMaster Incident Detection Algorithm Under Recurrent Congestion, Transportation Research Board, 1993.

Hsiao, Chien-Hua, Ching-Teng Lin, and Michael Cassidy, An Application of Fuzzy Set Theory to Incident Detection, Transportation Research Board, 1993.

Ivan, John N., Arterial Street Incident Detection Using Multiple Data Sources: Plans for ADVANCE, Pacific Rim TransTech Conference, July 1993.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Masters, Philip H., Joseph K. Lam, and Kam Wong, Incident Detection Algorithms for COMPASS, an Advanced Traffic Management System, Vehicle Navigation & Information Systems Conference Proceedings, 1991.

McDermott, Joseph M., Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

McDermott, Joseph M., Freeway Operations Activities in the Chicago Area, March 9, 1987.

Zografos, K.G. and C. Douligeris, Integrating Geographic Information System (GIS) and Automatic Vehicle Location (AVL) Technologies for Improving the Emergency Response Capabilities of Electric Utilities, Vehicle Navigation and Information Systems, 1991.

HAZARDOUS MATERIALS MANUAL

1993 Emergency Response Guidebook, Research and Special Programs Administration, October 1993.

A Guide to the Safe Handling of Hazardous Materials Accidents, Second Edition, ASTM Manual 10, American Society of Testing and Materials, 1990.

Abkowitz, M., P. Alford, A. Boghani, J. Cashwell, E. Radwan, and P. Rothberg, State and Local Issues in Transportation of Hazardous Materials: Toward a National Strategy, Transportation Research Record, 1991.

Albert, Stephen, Robert Siegfried and Steven Levine, Application of Geographic Information System to Houston Freeway Incident Management Program, ITE Compendium of Technical Papers, 1990.

Anders, C.D. and J.C. Olsten, Comparative Risks of Transporting Hazardous Materials on the State Highway System in Arizona, Dames and Moore, Arizona Department of Transportation, and Federal Highway Administration, February 1993.

Chiang, C.K., E.J. Cantilli, and S.T. Ying, Assessing Community Safety for Hazardous Materials Transport. State and Local Issues in Transportation of Hazardous Waste Materials: Towards a National Strategy, Proceedings of the National Conference on Hazardous Materials Transportation, 1991.

Conlon, P.C., Hazardous Materials Emergency Response Training: A Case Study of a Private Industry Initiative, HAZMAT Transport '91: A National Conference on the Transportation of Hazardous Materials and Wastes, June 1991.

Eversole, J., A Firefighter's Perspective on Training and Emergency Response, HAZMAT Transport '91: A National Conference on the Transportation of Hazardous Materials and Wastes, June 1991.

Geyer, S., HAZMAT on the Highway, Traffic Safety (Washington), April 1991.

Hancock, K., M. Abkowitz, and M. Lepofsky, Assessing Hazardous Materials Emergency Response Capability: Methodological Development and Application, Transportation Research Board, 1993.

Handling Hazardous Materials. 1994 Edition, American Trucking Associations, 1994.

Hazardous Materials Shipment Information for Emergency Response, Transportation Research Board Special Report, 1993.

Lepofsky, Mark, Mark Abkowitz, and Paul Cheng, Transportation Hazard Analysis in Intergrated GIS Environment, Journal of Transportation Engineering, March 1993.

List, G.F., Siting Emergency Response Teams: Tradeoffs Among Response Time, Risk, Risk Equity and Cost, HAZMAT Transport '91: A National Conference on the Transportation of Hazardous Materials and Wastes, June 1991.

Morris, J.R., Hazardous Materials Shipment Information for Emergency Response: TRB Report Study Findings, TR News, May 1993.

Novak, T.L., Local Government Views: Hazardous Materials Transport Legislation. State and Local Issues in Transportation of Hazardous Waste Materials: Towards a National Strategy, Proceedings of the National Conference on Hazardous Materials, 1991.

Price, K., Dangerous Goods Emergency Response: The Western Australian Experience.

Radwan, A.E. and H. Mushtaq, Hazardous Material Incident Reporting System, Arizona State University, Arizona Department of Transportation, and Federal Highway Administration, January 1990.

Read, J.A., Implementation of Emergency Response Plans, 1992 OECD Meeting, 1993.

Reed, J.B., State Legislative Concerns Relative to Federal Hazardous Materials Transportation Regulation. State and Local Issues in Transportation of Hazardous Waste Materials: Towards a National Strategy, Proceedings of the National Conference on Hazardous Materials, 1991.

Roberts, A.I., New Legislation: The Hazardous Materials Transportation Uniform Safety Act of 1990, 1992 OECD Meeting, 1993.

Russel, E.R. Sr., Highway Maintenance Procedures Dealing With Hazardous Material Incidents, NCHRP Synthesis of Highway Practice, 1994.

Some HAZMAT Facts, Transafety Reporter, November 1991

Spencer, D., Fire Service Emergency Response - Hazardous Goods by Road, 1992 OECD Meeting, 1993.

State and Local Issues in Transportation of Hazardous Waste Materials: Towards a National Strategy, Proceedings of the National Conference on Hazardous Materials, 1991.

Williams, D.L. and F. Kaikumba, Developing a HAZMAT Incident Evaluation Program. State and Local Issues in Transportation of Hazardous Waste Materials: Towards a National Strategy, Proceedings of the National Conference on Hazardous Materials, 1991.

Wilson, F.R., L. Cantin, and B.G. Bisson, Emergency Response System for Dangerous Goods Movements by Highway, Journal of Transportation Engineering, December 1990.

HIGHWAY ADVISORY RADIO

Arch, J.P., Recreational Applications of IVHS in New Jersey, Proceedings of the IVHS America 1994 Annual Meeting, 1994.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Lay, J.L., Intelligent Vehicle-Highway Systems and Incident Management, ITE Journal, March 1992.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

Overview of the Metro Area Highway Advisory Radio Program, St. Paul, Minnesota Department of Transportation, March 1991.

Picha, Dale L., Enhancing Highway Advisory Radio as an Effective Advanced Driver Information System Interface, Graduate Student Papers on Advanced Surface Transportation Systems, Texas Transportation Institute, 1994.

Rajendra, K. and R.E. Maki, The IVHS Strategy in Michigan, Proceedings of the IVHS America 1993 Annual Meeting, 1993.

IMPROVED MEDIA TIES

Baxter, D. H., T.C. Werner and R.M. Gardeski, The Integrated Motorist Information System: The Ideal and the Real, New York State Department of Transportation, March 1987.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Traffic Information Center, Fairfax County Police Department, March 1988.

INCIDENT PHONE LINES

Star 999, A Friend on the Road: Press Release, Illinois Department of Transportation.

INCIDENT RESPONSE MANUAL

Harris, F.R., Inc., Freeway Incident Management, Operational Guidelines, Florida Department of Transportation, April 1991.

Incident Response Guide Revised, Washington State Transportation Center (TRAC), Washington State Transportation Commission, U.S. Department of Transportation, September 1991.

Introduction to Freeway Management, Operational Guidelines for Freeway Management, Overview for New Team Members, Video, Florida Department of Transportation, 1991.

McCasland, W.R., M.A. Ogden, J.M. Mounce, G.L. Ullman, and D.R. Middleton, Guidelines for Response to Major Freeway Incidents Response Manual. Interim Report, Texas Transportation Institute, April 1994.

Northern Virginia Freeway Management Team Operating Manual: A Regional Plan for Traffic Management on Northern Virginia Freeways, JHK and Associates and Virginia Department of Transportation.

Reiss, R.A. and W.M. Dunn Jr., Freeway Incident Management Handbook, Dunn Engineering Associates and Federal Highway Administration, July 1991.

Tanemura, Lisa and F.L. Mannering, Incident Response Guide, Field and Office Reference, Washington State Transportation Center (TRAC), Washington State Transportation Commission, U.S. Department of Transportation, September 1991.

Ullman, G.L. and N.D. Trout, Planning Guidelines for Major Transportation Emergencies, Texas Transportation Institute, November 1991.

INCIDENT RESPONSE TEAMS

District 7 Action Plan - Major Incident Traffic Management Team, CalTrans, District 7, Los Angeles, CA.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

MOTORIST AID CALL BOXES/TELEPHONES

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

Churchill, Bruce W., Motorist Aid Systems-Intelligent Roadside Controllers, Proceedings of the ASCE Third International Conference on Applications of Advanced Technologies in Transportation Engineering, July 1993.

Dahms, L.D., Partners Join Forces to "JUMP START" San Francisco Bay Area Traffic. Transportation Engineering in a New Era, Issue Papers for the ITE 1992 International Conference, Monterey, California, ITE, 1992.

Differt, D.H. and R. Stehr, Reflections on Traffic Management Experience in Minnesota, ITE Journal, March 1992.

Kelly, D. M., The Development of a Traffic Surveillance and Control System For The Ayalon Freeway in Israel, IEE Conference on Road Traffic Monitoring and Control, April 1992.

Legg, Bill, A Discussion on Motorists Aid Call Boxes With Recommendations for Their Application in Washington State, Washington State Department of Transportation, November 1993.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Robinson, T., F.Y.C. Sin, R. Aitken, , and D. Nash, Integrated Traffic Management System in Melbourne, Australia, Traffic Technology International '94, 1994.

PERSONNEL TRAINING PROGRAMS

Incident Command System for Law Enforcement, Massachusetts State Police, 1991.

Introduction to Freeway Management, Operational Guidelines for Freeway Management, Overview for New Team Members, Video, Florida Department of Transportation, 1991.

McDade, J.D., Personnel: The Critical Element in Successful Incident Management, ITE Journal, March 1993.

Preparation of Incident Management Plans, Texas Transportation Researcher, 1993.

POLICY REQUIRING FAST VEHICLE REMOVAL

Wohlschlaeger, Steven D. and Kevin N. Balke, Incident Response and Clearance in the State of Texas: Case Studies of Four Motorist Assistance Patrols, Texas Transportation Institute, October 1992.

PROPERLY DEFINED TRAFFIC CONTROL TECHNIQUES

Manual on Uniform Traffic Control Devices for Streets and Highways, U.S. Department of Transportation , Federal Highway Administration, 1978.

Mounce, John M., Robert W. Stokes, Robert Q. Brackett and William R. McCasland, Guidelines for Utilization of Police Officers in Traffic Control and Enforcement, on Urban Freeways, Texas Transportation Institute, Texas A & M, Texas State Department of Highways and Public Transportation, Report No. FHWA/ TX-86/75+410-7F, September 1986.

Stokes, R.W., Literature Review - Traffic Enforcement Requirements for Highway Maintenance, Construction, and Other Traffic Management Functions, SDHPT Study No. 2 18-84-410, Unpublished Report, September 1984.

TRANSCOM Incident Management Plan, I-287, New York State Thruway Through Rockland County, Draft, TRANSCOM, May 1989.

PUSH BUMPERS

Push Bumper Programs for Incident Management in the Atlanta Metropolitan Area, Federal Highway Administration - Georgia Division Office, October 1990.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

RADAR FOR AUTOMATIC INCIDENT DETECTION

Lion, Didier and Jean-Claude Roussel, Radar for Automatic Incident Detection and Traffic Analysis, Traffic Technology International, 1995.

RADIO DATA SYSTEMS

Rajendra, K. and R.E. Maki, The IVHS Strategy in Michigan, Proceedings of the IVHS America 1993 Annual Meeting, 1993.

RESPONSIVE TRAFFIC CONTROL SYSTEMS

Balke, Kevin N., An Evaluation of Existing Incident Detection Algorithms, Texas Transportation Institute, 1993.

Chang, Edmond Chin-Ping and Kunhuang Huarng, Incident Detection Using Advanced Technologies, Transportation Research Board, 1993.

Chang, Edmond Chin-Ping and Su-Hua Wang, Improved Freeway Incident Detection Using Fuzzy Set Theory, Transportation Research Board, 1994.

Chang, Edmond Chin-Ping, A Neural Network Approach to Freeway Incident Detection, Vehicle Navigation and Information Systems Conference, 1992.

Chassiakos, Athanasios P. and Yorgos J. Stephanedes, Smoothing Algorithms for Incident Detection, Transportation Research Record No. 1394, 1993.

Cohen, Simon and Zoe Ketselidou, A Calibration Process for Automatic Incident Detection Algorithms, Fourth International Conference on Microcomputers in Transportation, 1992.

Cohen, Simon and Zoe Ketselidou, DAISI, a Calibration Tool for Automatic Incident Detection Algorithms: Application on the Paris Ringway, Sixth International Conference on Road Traffic Monitoring and Control, 1992.

Cohen, Simon, Comparative Assessment of Conventional and New Incident Detection Algorithms, Seventh International Conference on Road Traffic Monitoring and Control, 1994.

Coordinated Operation of Ramp Metering and Adjacent Traffic Signal Control Systems, Federal highway Administration, 1988.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Hall, Fred L., Yong Shi, and George Atala, On-line Testing of the McMaster Incident Detection Algorithm Under Recurrent Congestion, Transportation Research Board, 1993.

Hsiao, Chien-Hua, Ching-Teng Lin, and Michael Cassidy, An Application of Fuzzy Set Theory to Incident Detection, Transportation Research Board, 1993.

Ivan, John N., Arterial Street Incident Detection Using Multiple Data Sources: Plans for ADVANCE, Pacific Rim TransTech Conference, July 1993.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Masters, Philip H., Joseph K. Lam, and Kam Wong, Incident Detection Algorithms for COMPASS, an Advanced Traffic Management System, Vehicle Navigation & Information Systems Conference Proceedings, 1991.

McDermott, Joseph M., Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

McDermott, Joseph M., Freeway Operations Activities in the Chicago Area, March 9, 1987.

McDermott, Joseph M., Update: Chicago Area Freeway Operations, January 11, 1988.

Robinson, James and Mark Doctor, Ramp Metering in North America: Final report, Office of Traffic Operations, Federal Highway Administration, September 1989.

Stephanedes, Y.J., E. Kwon, K. Chang, and N. Vairamidis, Development and Application of On-Line, Intergrated Control Strategies for Optimal Metering, Incident Management and Driver Guidance in Freeway Networks. Summary of Phase I Report. Enhancements and Field Testing of Enhanced Rate-Selection, Control-Simulation Method, Minnesota University, April 1993.

Yagoda, Randi N., Choosing the Right Incident Logic in IVHS: False Alarm Rates vs. Speed of Detection, ITE Compendium of Technical Papers, 1991.

TOTAL STATION SURVEYING EQUIPMENT

Accident Investigation with Total Stations in Washington State, Video, Washington State Transportation Center, College of Engineering, University of Washington, Seattle, Washington.

Agent, Kenneth R., John A. Deacon, Jerry G. Pigman, and Nikiforos Stamatiadis, Evaluation of Advanced Surveying Technology for Accident Investigation, Kentucky Transportation Center, College of Engineering, University of Kentucky, Lexington, Kentucky, August 1994.

Jacobson, L.N., B. Legg, and A. O'Brien, Incident Management Using Total Stations, Washington State Transportation Center, College of Engineering, University of Washington, Seattle, Washington, August 1992.

Nee, Jennifer, Jodi Koehne, and Bill Legg, The Use of Total Station Surveying Equipment for Accident Investigation: A National Perspective, Washington State Transportation Center, College of Engineering, University of Washington, Seattle, Washington, June 1995.

TOW TRUCK/REMOVAL CRANE CONTRACTS

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Speckman, James, Public Agencies' Utilization of Private Wrecker Services, FHWA, April 1988.

TRAFFIC BREAKS FOR VEHICLE REMOVAL

Wilber, Sgt. Lee and Mr. David Van Hire, The Freeway Closure Plan: Slide Presentation, Michigan Department of State Police and Michigan Department of Transportation.

VARIABLE MESSAGE SIGNS

Arch, J.P., Recreational Applications of IVHS in New Jersey, Proceedings of the IVHS America 1994 Annual Meeting, 1994.

Baxter, D. H., T.C. Werner and R.M. Gardeski, The Integrated Motorist Information System: The Ideal and the Real, New York State Department of Transportation, March 1987.

Dudek, C.L., Guidelines on the Selection and Design of Messages for Changeable Message Signs, Texas Transportation Institute, November 1992.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Gangisetty, R. and D.W. May, Traffic and Incident Management System for I-95 in the Philadelphia Area, ITE Journal, February 1992.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Kelly, D. M., The Development of a Traffic Surveillance and Control System For The Ayalon Freeway in Israel, IEE Conference on Road Traffic Monitoring and Control, April 1992.

Lay, J.L., Intelligent Vehicle-Highway Systems and Incident Management, ITE Journal, March 1992.

McDermott, Joseph M. Chicago Area Freeway Traffic Management, Division of Highways, Illinois Department of Transportation, January 5, 1990.

McDonald, William H., Connecticut I-95 Incident Management System, Pacific Rim Conference, July 1993.

Miller, J.S., B.L. Smith, B.R. Newman, and M.J. Demetsky, Development of Manuals for the Effective Use of Variable Message Signs. Final Report, February 1995.

Roll-Up Signs Help Incident Management Programs, Better Roads, January 1993.

TRANSCOM Incident Management Plan, I-287, New York State Thruway Through Rockland County: Draft, TRANSCOM, May 1989.

Venglar, Steven P., Using Changeable Message Signs on Arterial Streets for Incident Management, Graduate Student Papers on Advanced Surface Transportation Systems, 1993.

Wohlschlaeger, Steven D. and Kevin N. Balke, Incident Response and Clearance in the State of Texas: Case Studies of Four Motorist Assistance Patrols, Texas Transportation Institute, October 1992.

VIDEO AND CLOSED-CIRCUIT TV

Balke, K.N. and G.L. Ullman, Method for Selecting Among Alternative Incident Detection Strategies, Texas Transportation Institute, February 1992.

Differt, D.H. and R. Stehr, Reflections on Traffic Management Experience in Minnesota, ITE Journal, March 1992.

Ewell, Wallace E., Freeway Corridor Surveillance and Control Systems in Fort Worth, April 1987.

Gangisetty, R. and D.W. May, Traffic and Incident Management System for I-95 in the Philadelphia Area, ITE Journal, February 1992.

Judycki, D. and J. Robinson, Freeway Incident Management, FHWA, March 1988.

Kelly, D. M., The Development of a Traffic Surveillance and Control System For The Ayalon Freeway in Israel, IEE Conference on Road Traffic Monitoring and Control, April 1992.

Lay, J.L., Intelligent Vehicle-Highway Systems and Incident Management, ITE Journal, March 1992.

McDonald, William H., Connecticut I-95 Incident Management System, Pacific Rim Conference, July 1993.

Robinson, J., What's New In...Freeway Incident Detection and Response, FHWA, July 1989.

Robinson, T., F.Y.C. Sin, R. Aitken, and D. Nash, Integrated Traffic Management System in Melbourne, Australia, Traffic Technology International '94, 1994.

Snell, A., F.Y.C. Sin and J.Y.K. Luk, Freeway Incident Management in Melbourne: An Initial Appraisal, Australian Road Research Board Proceedings, November 1992.

Wohlschlaeger, Steven D. and Kevin N. Balke, Incident Response and Clearance in the State of Texas: Case Studies of Four Motorist Assistance Patrols, Texas Transportation Institute, October 1992.

VIDEO IMAGE PROCESSING

Blosseville, J.M., Automatic Incident Detection Using Computer Vision Techniques, DRIVE Conference, February 1991.

Blosseville, J.M., Automatic Incident Detection Using Image Processing, ASCE Proceedings on Applications of Advanced Technologies in Transportation Engineering, August 1991.

Blosseville, J.M., J.M. Morin, and Pascale Lochegnies, Video Image Processing Application: Automatic Incident Detection on Freeways, Pacific Rim TransTech Conference, July 1993.

Dalgleish, Michael and Neil Hoose, IMPACTS Incident Detection System in Glasgow, Scotland, IVHS America, 1994.

Dodd, Daniel, Video, Digital Imaging, and an Automatic Vehicle Classification System, Compendium of Technical Papers, 64th Meeting of the Institute of Transportation Engineers, 1994.

Guillen, S., Field Trials on Video Based AID Achievements and Evaluation Issues, Proceedings of Information Technologies and Industries and Telecommunications on Advanced Transport Telematics, March 1993.

Guillen, S., Knowledge Based System for Traffic Monitoring and Incident and Congestion Detection, Using Image Processing and Computer Vision Data, Sixth International Conference on Road Traffic Monitoring and Control, 1992.

Hoose, Neil, M. Vicencio, and X. Zhang, Incident Detection in Urban Roads Using Computer Image Processing, Traffic Engineering & Control, April 1992.

Johnson, A.S., B.M. Bird, Evaluation of an Automatic Number-Plate Recognition System for Real-Time Automatic Vehicle Identification, 24th International Symposium on Automotive Technology and Automation, May 1991.

Kyte, Michael, et al., Using Machine Vision (Video Imaging) Technology to Collect Transportation Data, Transportation Research Board, 1993.

Lall B.K., K.D. Dermer, and R.E. Nasburg, Application of New Technologies Traffic Data Collection and Management, 17th ARRB Conference, August 1994.

Lay, J.L., Intelligent Vehicle-Highway Systems and Incident Management, ITE Journal, March 1992.

Martinez, J.J., Evaluation of a Computer Vision Based Automatic Incident Detection System, World Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems, 1995.

McOwen, P.A. and J. Collura, Technology Considerations For a Fault-Tolerant, Windowed Video Computer Control System for Fast-Response Incident Management, Proceedings of the IVHS America 1992 Annual Meeting, 1992.

Michalopoulos, Panos G., Automatic Incident Detection Through Video Image Processing, Traffic Engineering & Journal, February 1993.

Michalopoulos, Panos G., Incident Detection Through Video Image Processing, ASCE Conference on Applications of Advanced Technologies in Transportation Engineering, 1991.

Michalopoulos, Panos G., Robert Fitch, and Blake Wolf, Development and Evaluation of Breadboard Video Imaging System for Wide Area Vehicle Detection, Transportation Research Record No. 1225, Transportation Research Board, 1989.

Michalopoulos, Panos G., Richard D. Jacobson, and Craig A. Anderson, Development and Field Deployment of a Machine Vision Based Incident Detection System, IVHS America, 1994.

Michalopoulos, Panos G., Richard D. Jacobson, and Craig A. Anderson, Field Implementation and Testing of a Machine Vision Based Incident Detection System, Pacific Rim TransTech Conference, July 1993.

Sethi, Vaneet, Arterial Incident Detection Using Fixed Detector and Probe Vehicle Data, Transportation Research, Vol. 3, No. 2, 1995.

Stephanedes, Y.J. and A.P. Chassiakos, Development and Application of Incident Detection Techniques to Improve Incident Management in Freeway Corridors, Minnesota University, January 1993.

Zhang, X., Implementation of Automatic Incident Detection Systems in Europe: AID Task Force Produces Guidelines, World Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems, 1995.

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