

**AN ANALYSIS OF INCIDENT MANAGEMENT
PROGRAMS IN NORTH AMERICA**

by

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SUMMARY

As congestion continues to clog the arteries of highways all over North America, more and more traffic agencies are looking toward incident management programs. Incident management programs, when properly operated can help to alleviate a major part of delay caused by nonrecurrent congestion. Nonrecurrent congestion is congestion that is caused by incidents on the roadway that are unpredictable and decrease the capacity of the roadway. Incident management is an attempt to reduce nonrecurrent congestion on the roadway. Incident management is composed of several steps: detection, verification, response, removal, traffic management, and information to motorists. If these tasks are performed in an efficient manner an incident management program should be successful.

The objective of this paper was to review several incident management programs in North America and to determine the best techniques for incident management. To accomplish this objective, surveys were faxed to several incident management programs in North America. The survey asked the agencies to describe their programs and the benefits they have realized as a result of these programs. From these responses, recommendations were made as to the best techniques to use when beginning an incident management program. These recommendations were:

1. Start small and allow the program to grow. By starting out small, agencies can determine what works best for their program and avoid some of the problems in the system before the program becomes too large.
2. Target the most common types of incidents. Targeting the most common types of incidents, should show the greatest benefits.
3. Target the most congested areas. The most congested areas will have the most room for improvement.
4. Establish relationships between all the agencies involved. It is important to establish relationships between the various agencies involved prior to the actual initiation of the program. A strong relationship among agencies can make a program run much more efficiently.
5. Pre-plan for various types of incidents. Pre-planning allows for better handling of incidents, by setting up a specific procedures that should be followed for various types of incidents. It also helps in the coordination and cooperation among agencies as it determines the roles of everyone involved, prior to the occurrence of an incident.
6. Establish a Traffic Management Center. A Traffic Management Center should act as a headquarters for the incident management program.

7. Gain public support. It is essential that the public be aware of the program and where to find traffic information. By keeping the public informed, secondary accidents can be reduced. Gaining public support will also help in the future funding of the program.
8. Use service patrols. Service patrols are able to perform several incident management functions. They are able to detect, verify, respond and remove minor incidents, which make up the majority of the incidents on freeways. They also help to gain public support as people can see the benefits they provide.
9. Visit existing programs. It is important that an agency that is planning on starting an incident management program learn from the experience of others. This will allow the agency to see how others are dealing with similar problems.

If an incident management program is carefully planned, it has a much better chance of showing significant benefits.

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OBJECTIVE

Although many agencies would like to begin incident management programs, it is not quite clear as to the best techniques to use. There are numerous incident management programs in North America all with various levels and methods of incident management. It is the objective of the research to review several incident management programs in North America and to determine what benefits have been seen as a result of these programs. Each program will be analyzed to determine what its most beneficial aspects are. From this analysis, recommendations will be made as to the best techniques for incident management. Conclusions will be drawn as to the best procedures for starting an incident management program and what should be avoided.

BACKGROUND

Nonrecurrent Congestion

In 1987 freeways made up only 2.6 percent of the total roadway mileage in the U.S., yet accounted for over 31 percent of the total vehicle miles of travel (1). The statistics in Table 1 are from a study of the nation's 37 largest metropolitan areas where freeway congestion was responsible for an estimated two billion vehicle-hours of delay at a cost of \$16 billion (1). According to the Federal Highway Administration, nonrecurrent congestion accounts for 60 percent of this delay (2). This equates to nearly 10 billion dollars in delay costs due to nonrecurrent congestion on freeways. By the year 2005 this number could reach 62 billion dollars annually (2). These estimates are based on cost for a passenger car of six dollars per hour of delay and a cost to a delivery truck of 25 dollars an hour (3). Nonrecurrent congestion is congestion that is caused by incidents on the roadway that are not predictable and cause a decrease in the capacity of the roadway which leads to congested conditions. Figure 1 shows a schematic of how traffic flow is affected during an incident. Figure 2 shows the costs in vehicle hours of delay for various types of incidents and the proportion of the types and location of various incidents that occur on a freeway. As can be seen from these figures, even the smallest incident on the shoulder of a road can cause a great amount of delay.

Other costs of nonrecurrent congestion are not as easily measured. There is an obvious impact to the environment due to the pollutants released by the vehicles in the congestion. There is a safety risk as well. Not only are the people involved in the incident in danger, but anyone who responds to the incident (police, firemen, tow services, etc.) are also put in jeopardy. Twenty percent of all fatalities occurring on the highway have been pedestrians or were the result of accidents involving a vehicle stopped on the shoulder (6). A more subtle consequence of nonrecurrent congestion is the frustration caused by the inherent randomness of incidents. Drivers are not able to plan for nonrecurrent congestion as they are for recurrent congestion, such as rush hour traffic, and this unexpected delay magnifies driver frustration.

Table 1. Urban Freeway Congestion Statistics (1).

	1984	1987	2005 (using 1984 data)	2005 (using 1987 data)
Freeway Miles	15,335	16,097	15,335	16,907
Vehicle-Miles of Travel (billions)	276.6	337.4	411.0	492.5
Recurring Delay (million vehicle-hours)	485	728	2,049	3,030
Nonrecurring Delay (million vehicle-hours)	767	1,287	4,858	7,978
Total Delay (million vehicle-hours)	1,252	2,015	6,907	11,008
Total Wasted Fuel (million gallons)	1,378	2,206	7,317	11,638
Total User Costs (billion dollars)	9.2	15.9	50.5	88.2

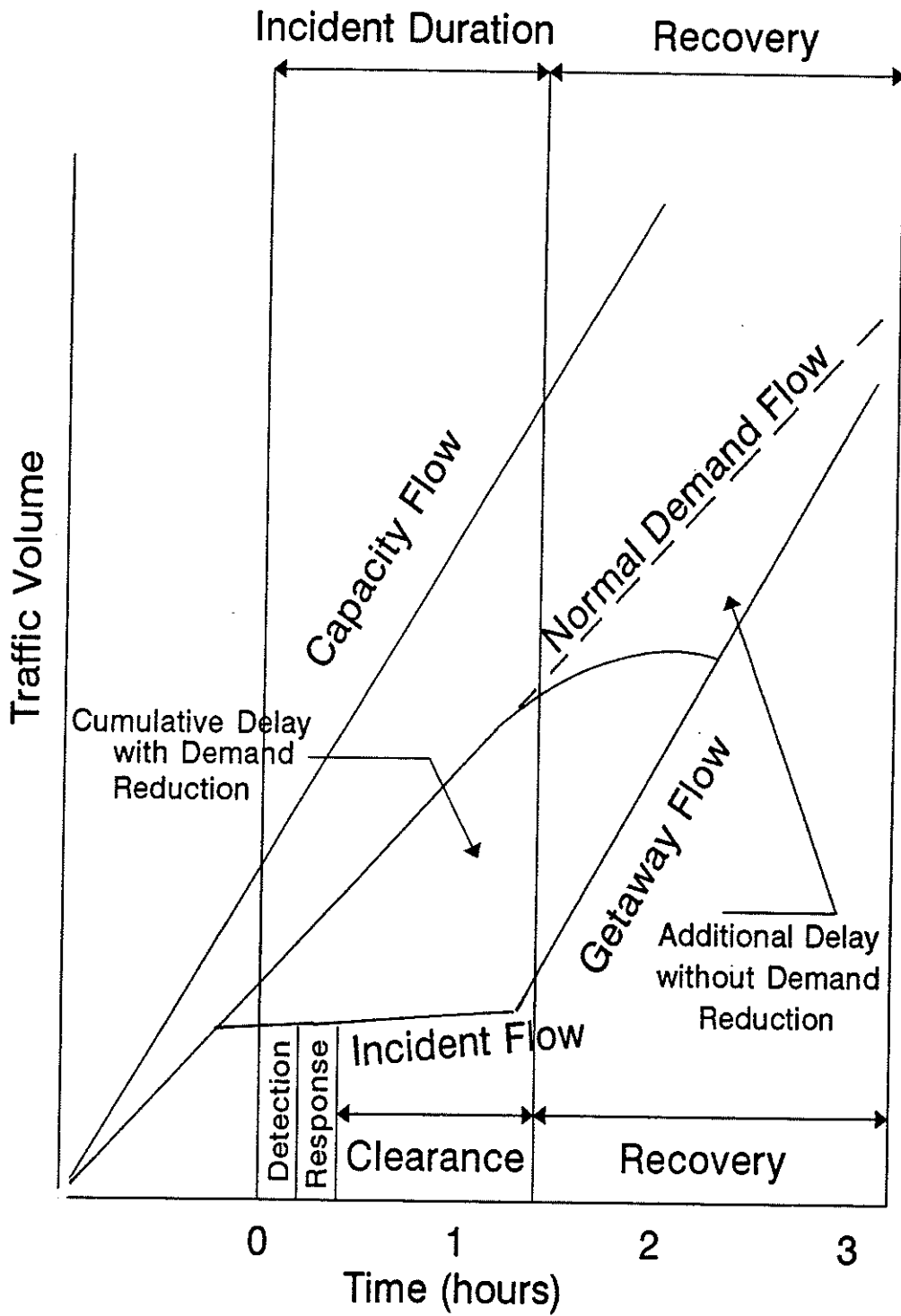


Figure 1. Schematic of traffic flow during an incident (4).

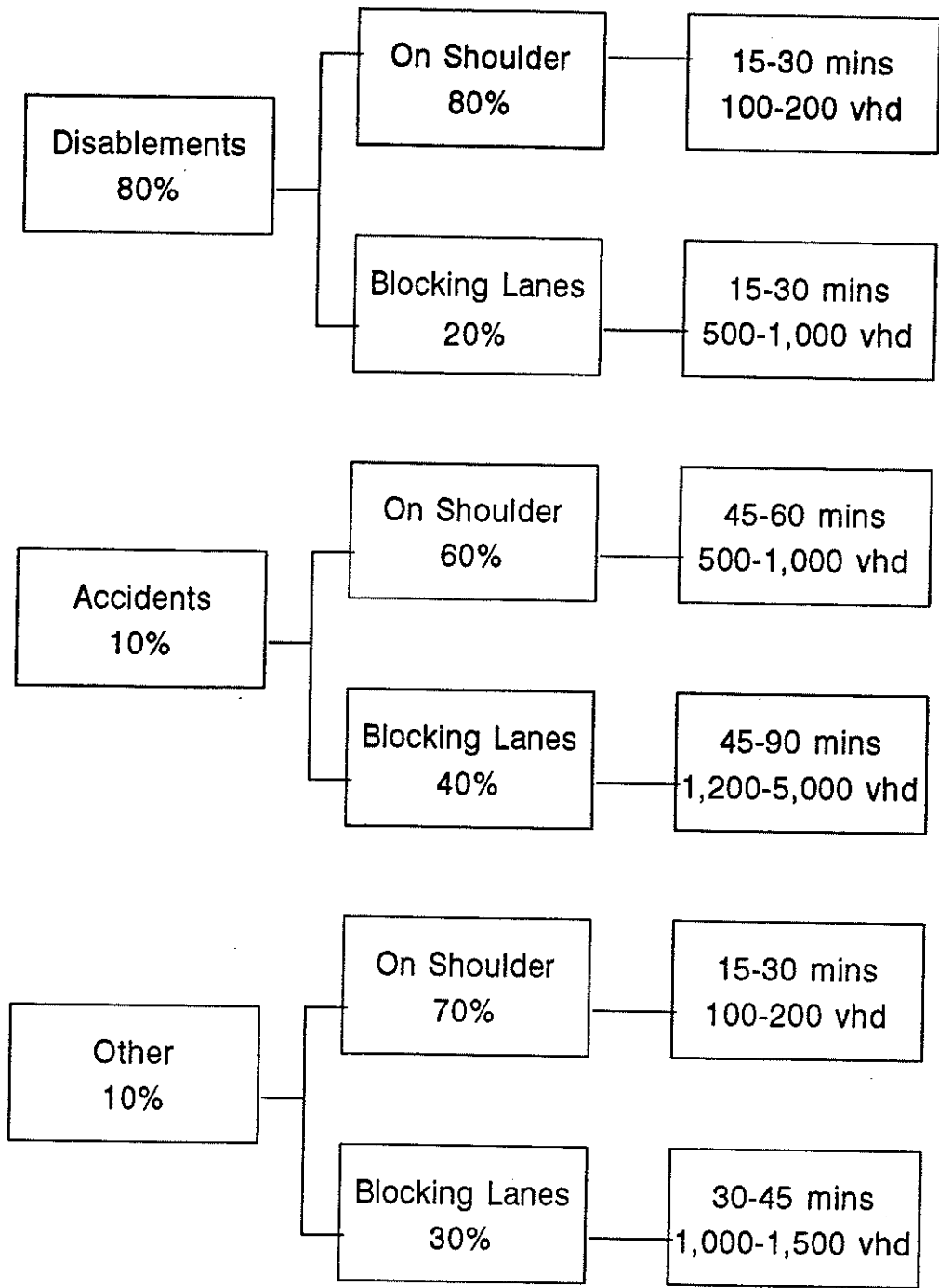


Figure 2. Composite profile of reported incidents by type (5).

STUDY DESIGN

It was the purpose of this investigation to evaluate the current incident management programs in North America and determine how the various agencies handled incidents and what seemed to be working the best. From this information, conclusions and recommendations were to be made as to the best techniques to use when beginning an incident management program. The following agencies were contacted:

- Arizona Department of Transportation
- California Department of Transportation (Los Angeles)
- California Department of Transportation (Orange County)
- Illinois Department of Transportation
- Minnesota Department of Transportation
- New Jersey Turnpike Authority
- North Carolina Department of Transportation
- Ontario Ministry of Transportation
- Pennsylvania Department of Transportation
- Washington Department of Transportation

A questionnaire regarding incident management was faxed to each agency. The questionnaire was designed to give an overview of the agencies incident management program and how well the program was working. The following are the questions that were asked:

1. How long has your program been in operation?
2. Briefly describe the operations and size of your program.
3. What size area does your program cover?
4. What was the estimated start up cost of your program? Additional expansion costs?
5. What is the cost to operate and maintain your program?
6. What benefits have you realized as a result of your program?
7. Has a benefit/cost analysis been done on your program? If so, who conducted the study and what were their findings?
8. What have been the pitfalls in the design, planning and operation of your program?
9. What are your plans for the future of your program?

10. What are the interactions between the public and private sectors within your program and how is the cooperation and coordination between all the agencies involved handled?
11. Describe the process of how an incident (i.e. an overturned, leaking tanker truck) would be detected and handled.
12. What would be your advice to an agency that is just establishing an incident management program?

Any supplemental material that the agencies could provide (such as brochures, reports, etc.) were also requested. The responses varied greatly, which made the dissemination of the information complicated. The remainder of this paper will report on the findings from the various agencies individually and then propose recommendations based on these findings.

INCIDENT MANAGEMENT

Reiss (3) defined incident management as, "the spectrum of activities involved in detecting responding to and clearing roadway incidents." The unpredictable timing and nature of incidents makes them difficult to manage (1). An incident not only reduces capacity in the direction of the incident, but can also have a significant impact on traffic in the opposing lane due to rubber necking. An efficient, well-organized incident management program can help to reduce the effects of incidents on freeways.

In most cities where incident management programs are not in place, the majority of incidents on the freeway are usually handled by the police (2). Unfortunately, most police departments do not have the equipment or the personnel to handle all the incidents that occur. It is therefore important for cities to have a means of dealing with incidents. A comprehensive, well-organized incident management program can only benefit a community. Incident management programs that are already in operation have shown numerous benefits such as reduced delay and more predictable travel times (7,8,9,10,11). The question then becomes how does a city go about developing an incident management program that will produce these types of benefits.

Functional Needs of an Incident Management Program

Management of an incident is generally agreed to have several stages: detection, verification, response, removal, traffic management and information to motorists (1). It is how well these stages are performed that determines how effective an incident management program is going to be.

Detection

The quick detection of an incident is essential to the success of an incident management program. Major incidents are usually detected within five to fifteen minutes of its occurrence. Minor incidents, which make up the majority of freeway incidents, however, may go thirty minutes without being detected (2). During off-peak travel periods, each minute an incident remains on the roadway results in four to five minutes of additional delay. When the traffic flow is near capacity, the resulting delay can grow at a rate of 8.5 miles per hour, or after one hour the back-up will be 8.5 miles long (6). The typical capacity reduction caused by various incidents can be seen in Table 2. These numbers show the obvious need for speedy detection.

Table 2. Typical Capacity Reduction on Three-Lane Freeway Sections. (12)

Incident Type	Capacity Reduction (Percent)
Normal Flow (Three Lanes)	-----
Stall (One Lane Blocked)	48
Noninjury Accident (One Lane Blocked)	50
Accident (Two Lanes Blocked)	79
Accident on Shoulder	26

There are numerous ways to detect an incident. The most common way incidents are detected are by police patrols. Other means of incident detection include: citizen's band radio, call boxes, cellular phones, automatic vehicle detectors, closed circuit television cameras, and service patrols.

Many times citizen's band (CB) radios, call boxes (which are located on the sides of some freeways) and cellular phones allow the roadway user to report incidents (either to the incident management team or the police) far before other methods could detect the incident. This quick detection is becoming more of a resource as more and more vehicles are equipped with cellular phones. Some incident management programs already have free cellular numbers for users to call if they detect an incident.

Automatic vehicle detectors include such technologies as loop detectors and video imaging systems. Loop detectors are wires that are imbedded in the pavement and can sense the presence of a vehicle above it. Video imaging systems are a newer technology that can sense when a vehicle is in its scope. Both of these automatic vehicle detection systems are used in conjunction with computer algorithms to determine areas of the freeway where flow has stalled and thus detect an incident. Closed circuit television can be used to detect incidents from a central control center. The operator in the control center monitors several camera locations along the freeway and can visually confirm when an incident happens.

An often overlooked method of incident detection is the use of service patrols. These are actual employees of the incident management team that drive a "beat" along the freeway, looking for incidents. These service patrols are usually made up of vehicles (such a tow trucks) that are equipped to provide assistance at the scene of an incident. Service patrols have the advantage of being able to not only detect the incident but to verify it and in the cases of minor incidents (which are the majority of incidents) respond and remove the incident, thus performing the entire incident management process on their own.

Verification

Verification is the determination of the precise location and nature of an incident (3). This information can then be accurately reported to the appropriate agencies. Techniques used in verification of an incident include closed circuit television, police patrols, and service patrols. The accuracy of information received from these sources is imperative for planning the strategy to deal with the incident.

Response

"Response is the activation, coordination and management of the appropriate personnel, equipment, communication links and motorist information media as soon as there is a reasonable certainty that an incident is present (3)." The time saved in response can help to remove the incident faster and thus bring the roadway back up to its original capacity quicker. This is important as studies have shown that even for an accident that blocks only one lane, a two minute reduction in response time can save over 400 vehicle-hours of delay (12).

Depending on the incident type various responses may be required. Most minor incidents (i.e. flat tires, out of gas, fender benders), which make up an estimated 50-60 percent of incident in urban areas (2), can be handled by service patrols or by the police dispatching private services to the site.

Larger incidents, however, call for the coordination of several agencies to respond effectively. Thus it is important to pre-plan for major incidents so that all the agencies involved know their specific role. The following organizations are likely to be involved in the response to a major incident:

- State Department of Transportation
- Police Departments
- Highway Patrol
- Fire
- Rescue
- Emergency Services
- Towing Services
- Independent Authorities

For extremely major incidents, such as a hazardous materials spill, even more agencies may need to respond. These agencies may include the following:

- Environmental Protection Agencies
- Hazardous Materials Control Team

The interactions among these groups must be thought out and roles and communication links established so that a quick, efficient response is possible.

Removal

Removal is the safe and timely clearance or termination of the incident and restoration of the roadway to its full capacity (6). Removal should also be pre-planned. Various scenarios should be set up for different incidents. Again, arrangements should be made between the various agencies that may be involved. A study by the Federal Emergency Management Agency found that problems in response to incidents were in general not those of technology or resources, but in fact due to poor coordination and confused authority relationships (14). These problems should be discussed prior to an incident so that each agencies involved knows their role and their authoritative responsibilities during the response to an incident.

Liability is probably the major issue in the removal of vehicles from the roadway. This can become especially complicated when commercial vehicles are involved. This however seems to be more of a perceived problem than an actual one. The courts have generally upheld removal actions, and few have been challenged (3).

When removal is possible by the motorists involved it usually does not occur as most drivers feel that even in the case of just a minor "fender bender", they should not move their vehicles until the police arrive. Drivers should be informed through a publicity campaign that they are allowed to move their vehicles and that they should move them to a safe location or an accident investigation site if one exists.

Accident investigation sites are an excellent idea to help remove the incident from the roadway. They are essentially areas where the vehicle(s) can be moved, out of the view of the users of the freeway, so the police may investigate what happened. Accident investigation sites should be set up in areas of high accident risk, should be easily accessible and well marked. Benefits of accident investigation sites include (3):

- reduced delay
- reduced vehicle emissions
- reduced secondary accidents
- reduced pedestrian accidents
- more efficient use of public agencies personnel

Traffic Management

Traffic management is the application of traffic control measures at the site of an incident (3). The primary functions of traffic management at incident sites is to increase the capacity around the incident site (i.e. using a shoulder as a lane) and reduce the demand on the freeway segments affected by the incident (i.e. diverting traffic to an alternative route). When incidents occur during low volume periods the following measures should be considered: using freeway shoulders as an additional lane to move traffic around the site, re-timing or manually controlling frontage road signals, and contraflow operations, in special situations. During high volume periods, steps should be made to divert all the traffic possible to alternative routes. A quick analysis should be performed to determine the remaining capacity on the freeway and the available capacity for the rerouting of traffic.

The necessary traffic should then be diverted to recreate free flow past the incident. . Alternative routes should be preplanned so the incident can be handled in a more efficient manner.

The coordination of all the agencies involved in an incident can become very complicated, especially during a major incident or when several incidents need to be managed at the same time (which is common during peak periods). A traffic management center is therefore an essential element in the managing of an incident. The traffic management center should serve as the headquarters for the incident management team.

Information to Motorists

The final step in managing an incident is to inform the motoring public that an incident has occurred. Studies have shown that motorists have greater tolerance for delay if they are kept informed of what has happened (3). Accurate and timely information can allow the motorist time to choose an alternate route or plan for additional travel time. A study in Minnesota found that 13 percent of all peak period accidents on one Minneapolis freeway were caused by a previous incident. The dissemination of information helps to reduce the occurrence of secondary accidents by forewarning vehicles approaching the congested conditions created by the incident. Techniques for informing the motorist include:

- Changeable Message Signs
- Highway Advisory Radio
- Commercial Radio
- Print Media
- Citizen's Band Radio
- Cable Television
- Cellular Telephone

As many of these techniques as possible should be used to reach the majority of the users of the freeway. Motorist who receive information on traffic conditions and suggested adjustments to normal travel patterns will also have a better appreciation for the effectiveness of an incident management program.

INCIDENT MANAGEMENT PROGRAMS

Arizona Department of Transportation

Arizona incident management program has been in effect for five years. It consists of four 3/4 ton pick-up trucks with traffic control devices that are on 24 hour call. The area patrolled covers the Phoenix Metro Area. The start up costs for the program was absorbed by other programs. Personnel have primary duties other than incident management and are paid overtime when needed. Benefits of the program have not yet been quantified, but, the program has resulted in a greater relationship between the Arizona Department of Transportation and the Highway Patrol. This relationship has enhanced both parties efficiency during freeway incidents and has led to the formation of a combined Incident Management Team. The main pitfalls in the development of their program have been institutional barriers. Arizona recommends that any agency that is beginning a program start small with a group of interested personnel.

California Department of Transportation (Los Angeles)

Eight of the nations ten busiest freeway interchanges are located in Los Angeles County. This includes the nations busiest, the East Los Angeles interchange which accommodates 570,000 vehicles a day. About half of all the congestion on the 597 miles of freeway in the Los Angeles area is caused by incidents. The delay caused by incidents is believed to cost four million dollars a day.

Caltrans recently began a Freeway Service Patrol (FSP) in July of 1991. The FSP consists of a fleet of tow trucks that operate during rush hour periods to help move disabled vehicles off the freeway. The FSP is operated jointly by Caltrans, the Highway Patrol and the Metropolitan Transportation Authority. Since its inception, FSP drivers have assisted more than 280,000 motorists. Average response times per incident have been reduced from more than 20 minutes to about 7-10 minutes. A benefit cost analysis was performed on the FSP which returned results ranging from 12 to 15:1.

In the future Caltrans intends to add more electronic surveillance along its entire freeway network. This electronic surveillance will include loop detectors, CCTV's and a fiber optic communications network. In addition a new 71,000 square foot Traffic Management Center is scheduled to open in October of 1995.

California Department of Transportation (Orange County)

California Department of Transportation (Caltrans) officially started its incident management program for Orange County in January of 1991. A Traffic Management Center was established that consists of Caltrans Engineers, Caltrans Maintenance Personnel, and CHP Officers who monitor the freeways in Orange County. Besides the people in the center, Caltrans has a 13-person Traffic Management Team who responds when an incident occurs. Loop detectors, closed circuit television, cellular phone and the roving tow trucks

are all utilized to detect incidents. Caltrans has also established a Highway Advisory Radio unit to inform motorists of incidents.

Benefits that have been seen from Caltrans' program include:

- Fast response to incidents
- More information to traveling public
- Reduced secondary accidents
- Reduced congestion
- Reduced delays
- Reduced air pollution associated with delays
- Increased safety for public and employees
- Increase public image

In the future, Caltrans plans to totally upgrade their system, including more changeable message signs, and closed circuit televisions. Caltrans recommends that an agency just starting an incident management program should make sure that there is a close interaction with all the public and private sectors involved, and to purchase quality equipment.

Illinois Department of Transportation

Illinois is considered by many to have the most comprehensive incident management program in North America. Their Emergency Traffic Patrol (ETP), or "Minutemen" as they are called, have been responding to incidents since 1960. The program was initially started with a couple pick-up trucks with push bumpers. The fleet has now grown to 35 emergency patrol vehicles (each equipped with relocation tow rigs), 9 light 4x4's, three heavy duty tows, one crash crane, one tractor-retriever, a sand spreader, a heavy rescue and extrication truck, and four trailer mounted changeable message signs. The staff currently consists of 58 Minutemen and a support staff. They currently provide service to 79 centerline miles or 718 lane miles including ramps of the Chicago-Area expressway system 24 hours a day 7 days a week. In 1992 the EPV fleet logged more than 1.7 million miles, handling 102,704 incidents or assists. The cost of the system (based on 1990-1993 figures) was \$3.5 million dollars a year in actual operating costs with an additional \$5.5 million dollars a year in overhead costs. This equates to \$115,000 per centerline mile or \$12,600 per lane mile annually.

Although these costs may seem high, the benefits that IDOT has seen as a result of this program far outweigh these costs. A study by the Cambridge Systematics in 1990 showed an overall benefit to cost ratio of 17:1. Benefits listed by IDOT in describing their program include:

- reduced congestion
- reduced secondary accidents
- improved public awareness and information
- improved overall freeway system performance

IDOT recommends that an agency should start small and remain flexible. The program should be shaped to fit the needs of the area. They feel that the best start up component is a service patrol.

Minnesota Department of Transportation

Minnesota Department of Transportation's incident management program has been in operation for 20 years. In the fall of 1973, 17 miles of detection and 20 closed circuit television cameras covering 13 miles of freeway were brought on line. The current program includes:

- 2,000 loop detectors on 96 miles of freeway
- 108 closed circuit television cameras covering 104 miles of freeway
- 316 ramp meters
- 25 lane control signals
- 34 changeable message signs
- Metro wide highway advisory radio
- Six "Highway Helper" trucks on 80 mile routes
- State Patrol responsible for on site management
- Private tow trucks
- Aerial surveillance via partnership with two private aircraft
- 20 accident investigation sites
- Traffic management center

The traffic management center has an operations room staff of four people and operates from six a.m. to seven p.m. Monday through Friday, and during special events or to support maintenance activities. The total system covers 104 miles with partial systems covering an additional 60 miles. The coverage area of the total system will be expanded to 330 miles within the next five years, the system will then cover the entire Metro Area. During this five year expansion, the implementation of integrated corridor traffic management, to optimize the use of freeways and other routes, will also be initiated.

The initial cost of the program in 1972 dollars was \$4 million. Since then an additional \$25 million has been spent including \$16 million since 1990. The estimated total cost will reach approximately \$44 million in 1993. The cost to operate the program per year is \$7.5 million dollars.

The following benefits have been realized as a result of the total traffic management plan in Minnesota, of which incident management has been an integral part.

- 25 to 40 percent reduction in accidents on various sections of highways
- 25 to 30 percent increase in traffic volume through bottlenecks
- 20 to 25 percent increase in average peak period speeds
- Large decrease in congestion, fuel consumption, and emissions

Actual benefit cost analysis has been done on a few of the large systems, but documentation is limited.

MN DOT listed several pitfalls in developing their program. In the early development of the system, design decisions were often made without the benefit of experience. Development of traveler information systems has been a problem due to the lack of effective means to evaluate alternatives. The final pitfall listed by MN DOT was generating the cooperation between agencies.

Coordination and cooperation between various agencies has been established and is working well. The Traffic Management Center operators coordinate with commercial radio stations for traveler information. The State Police coordinate with private towing companies for response and removal.

MN DOT's recommendations to anyone starting an incident management program are:

- Establish cooperation with enforcement agencies and other agencies that have traffic engineering staffs.
- Use "Highway Helper" type emergency response vehicles for rapid removal of stalls and incident response assistance.
- Establish dispatching of private (or public) tow vehicles before police arrive on the scene.
- Emphasize traveler information via area wide radio, changeable message signs, cable television, etc.
- Develop integrated corridor traffic control to efficiently handle traffic diversion.

New Jersey Turnpike Authority

The New Jersey Turnpike Authorities incident management program has been in effect since 1951, when the facility first opened. The program currently involves a number of departments including 230 member of the New Jersey State Police who patrol the facility, 1,200 toll collectors at 27 interchanges, 650 maintenance workers, operations department staff, as well as a public relations staff. Incidents are reported to the Traffic Operations Center either by State Police, maintenance workers, or motorists. The information is then conveyed to the appropriate responders. Responders include fire, first aid squads, and wreckers which are dispatched from communities through which the Turnpike passes.

The program covers the entire 122 miles of the New Jersey Turnpike, as well as an additional six mile extension linking the N.J. Turnpike to the Pennsylvania Turnpike, an eight mile extension linking the N.J. Turnpike to the Holland Tunnel, and a twelve mile western alignment extension. Thus the program covers a total of 148 miles of freeway.

Benefits that have been realized as a result of the program include:

- Improved traffic safety
- Reduced congestion
- Quicker clearance times
- Improved operational efficiency

In the future, the Turnpike Authority plans to focus more attention on improving the rapid detection and verification of incidents.

The incident management program on the New Jersey Turnpike requires substantial interaction with other agencies such as the New Jersey Highway Authority, the New Jersey Department of Transportation, the Port Authority of New York and New Jersey, and other in the northeast region where many independent agencies operate different facilities. Other interactions include full-time and volunteer fire squads, first aid squads, wrecker services, and hazardous material responders, among others.

The New Jersey Turnpike Authority recommends that an agency interested in beginning an incident management program observe an existing program such as their own.

North Carolina Department of Transportation

North Carolina's program began in 1992. Charlotte was identified as the pilot project area. An inter-agency agreement between the North Carolina Department of Transportation and the State Highway Patrol was established. Also created were an Incident Management Task Force and a traffic operations center, which opened in December of 1992. A Motorist Assistance Patrol (MAP) was begun in the Charlotte/Mecklenburg area in December of 1991. The MAP program began with two vehicles patrolling from 6:00 AM to 8:00 PM on Monday through Friday, and 11:00 AM to 7:00 PM on Saturday and Sunday. The MAP program now covers 51 centerline miles of roadway in North Carolina.

North Carolina's Incident Management Program operates as a statewide program focussing on both urban and rural areas. The current focus of the program is aimed at urban areas over 50,000 with congested interstate or freeway facilities. The initial start up cost for the Charlotte pilot project was a total of \$2,852,160.

The primary benefit from this investment is the positive public response to the Motorist Assistance Patrol. A benefit to cost analysis showed a benefit to cost of operating the Motorist Assistance Patrol of 7.6:1. This ratio used reduction of delay at the benefit. Other benefits that have been realized are positive cooperation between agencies which has reduced the time to detect, react to and clear incidents.

Future plans for the program include expanding the program into rural areas, and investigating new technologies for the detection and response to incidents. The pitfalls of North Carolinas program can be related to obtaining necessary funding and the impact that lack of funds can have on other activities such as signing and equipment. North Carolina recommends that anyone trying to start an incident management program should first contact and visit other states that already have programs in place. A second recommendation is to obtain the support of the top management of all the agencies that will be involved. Since it is the top management that makes funding decisions, obtaining their support is critical in the development of the program. Finally, North Carolina recommends that an area should be selected as a pilot project. North Carolina believes that initializing

a program with a pilot program is beneficial in that it sets the stage for identifying what works well and what doesn't for the particular agencies involved.

Ontario Ministry of Transportation

Ontario began its incident management program in 1963 with emergency patrols that provided motorist assistance and some on site incident management. The first full traffic management system began operation in 1975. Ontario's program currently consists of ten 3/4 ton pickup trucks manned by 14 staff members serving an area where the driving population is estimated to be greater than three million. Two to four vehicles patrol an area of approximately 62 miles depending on time of day. The patrols operate 24 hours a day. The patrols respond to debris and lane blocking incidents and provide for removal or lane closure and motorist assistance as required. The operations center which dispatches the patrols also operates 24 hours a day. The cost to operate and maintain the service patrol is approximately \$1.4 million (Canadian dollars) a year.

Benefits realized by Ontario as a result of this program include:

- reduction in delay
- reduction in secondary accidents
- reduced fuel consumption
- good public relations
- increased visibility and credibility to help promote traffic management

Based on the reductions in delay, secondary accidents, and fuel consumption, benefit to cost ratios of 30:1 have been calculated on some sections and all sections showed at least a 2:1 benefit to cost ratio.

To help coordinate efforts between the public and private sectors, local police and transportation representatives meet with a recently formed association of private operators on a monthly basis. The meetings are divided into groups: one for small tow operators, which would handle minor incidents, and another group for large tow operators and cleanup specialists which may be needed in the event of a major incident. Another group of only public sector agencies consisting of police, fire, ambulance and transportation representatives also meet on a monthly basis to discuss various operations. This interaction among agencies allows for a more efficient operation when incidents occur.

Future plans for expansion of the include:

- privatizing the basic motorist assistance program
- improving coordination and communication with other emergency agencies
- increasing public awareness of the motorist assistance patrols
- develop specific operational procedures

Pitfalls that Ontario has encountered in the design, planning and operation of their program include:

- not establishing mandates
- not establishing criteria to determine highest priority areas
- not establishing service levels and other performance measures
- not developing specific operational procedures

Ontario recommends in beginning an incident management program an agency should start small with a narrow focus, possibly limited to improving the coordination and communication of the existing services and agencies available. It is important to establish a program that can respond to the most frequent type of incidents. Performance measures and goals should be set up to determine the effectiveness of the program. Also, Ontario recommends establishing support from all participating agencies, both public and private.

Pennsylvania Department of Transportation

The Pennsylvania Department of Transportation has been providing a customer service operation to motorists on three tunnels in the Pittsburgh Area for over 30 years. This operation consists of one large and one small tow truck permanently stationed at each tunnel to provide clearance of any vehicles that may break down inside the tunnels. The service operates 24 hours a day, 7 days a week, 365 days a year. "Safe Areas" have been established on the outside of the tunnels. Disabled vehicles are towed or pushed to these "safe areas" where the drivers may contact a private towing service via phones located on-site.

The cost to operate and maintain the program is approximately \$4,000,000 per year. The estimated start up cost for the program includes the purchase of two Mack tow trucks in 1978 at \$44,287 each and the purchase of two additional smaller tow truck in the late 1980s at a cost of 33,250 each. Other expenses include the salaries for the 40 tunnel maintainers and 13 supervisors at an average salary of approximately \$30,000 to \$35,000 per year. Benefits from the program include reduction in delay and user support.

The Pennsylvania Department of Transportation is just beginning new incident management programs in the two most populous areas of the State: Philadelphia and Pittsburgh. The Philadelphia program will go on-line in September of 1993, with the Pittsburgh area going on-line two years later in 1995.

A Traffic and Incident Management System (TIMS) is planned as part of phase 1 in the Philadelphia area. This TIMS will cover 115 miles of the District 6-0 Interstate System. The start up cost for phase 1 is estimated as \$20,000,000 with its full-build scenario being a 10 year \$100,000,000 project. The Philadelphia TIMS will include 12 TV cameras, four changeable message signs, and four fixed and one mobile satellite stations on a six mile section of I-95. The TIMS program will also include eight TV cameras and ramp metering of I-476, with additional cameras, changeable message signs and ramp metering on I-676. A Freeway Surveillance and Control System (FSCS) will be implemented in the Pittsburgh area in September of 1995. The estimated cost of the first phase of the FSCS project is

\$4,500,000. In both areas, a cellular hot line will be set up for the reporting of incidents as well as the use of Highway Advisory Radio.

Relationships between public and private sectors will be handled through monthly meetings. Bi-monthly meetings of a task force will also be established to review preliminary design, construction and final operations and maintenance.

Washington Department of Transportation

Washington state's incident management program began in early 1990 with a one person, the incident response engineer (IRE), with a single truck to respond to major accidents on state highways and interstates in the Seattle area. The incident response truck (IRT) is a specially equipped one ton utility box bed truck equipped to provide traffic control, communications, and minor clean up and containment. In 1992 the program was expanded to cover the greater Puget Sound region as well as the cities of Olympia, Tacoma, Vancouver, and Spokane. The current program now consists of 12 IRTs and IRE's. The total centerline miles covered in these areas by the current program is 4,678 with a the total lane milage equalling 11,957. In the future they plan to broaden their outreach to more agencies and municipalities in the region to inform them of the program and what it is doing. Also, to develop better documentation and reporting procedures for the programs operation and to standardize the operations and procedures of the program statewide.

The cost of the program includes \$50,000 dollars for each truck (which have an estimated eight year life) and an annual cost per person of approximately \$40,000 a year. Other nominal yearly costs are approximately \$100,000 for the entire statewide program. From this investment Washington has seen the following benefits:

- shorter response times to an incident
- shorter lane and roadway closures at incidents
- fewer total roadway closures
- better working relationships with other responding agencies
- better understanding of other responding agencies responsibilities and concerns at an incident

SUMMARY OF FINDINGS

The results of these surveys helps to demonstrate the need and justification for an incident management program. All of the responding agencies showed positive benefits from their programs. The benefits the various agencies reported almost always included the following items:

- reduced delay
- reduced secondary accidents
- reduced congestion
- reduced fuel consumption
- reduced air pollution
- increased safety
- increased public image
- better relations between agencies
- increased visibility to promote traffic management

Four of the agencies have performed actual cost benefit analysis all with very positive results. California Department of Transportation (Los Angeles) showed a 15:1 cost benefit, Illinois Department of Transportation 17:1, North Carolina Department of Transportation 7.6:1, and Ontario Ministry of Transportation 30:1 in their most congested areas with greater than 2:1 in all other areas.

When discussing the pitfalls in the design of their programs, most all of the agencies reported problems with interactions between agencies. It seems that when an incident management program is beginning, it is difficult to convince all the agencies involved to cooperate. However, as the program begins to grow and the various agencies see the benefits of cooperation in incident management, they are much more willing to participate. This result can be seen as the majority of the respondents listed the interaction among agencies as a pitfall in their original design, but then listed the increased cooperation between agencies as a major benefit of their program.

It is evident from these findings that if congestion exists, one excellent way to help alleviate some of it is to begin an incident management program.

RECOMMENDATIONS

Although it is easy to see the benefits of an incident management program it is often difficult to determine what are the best techniques to begin a program. The first recommendation for an agency that was just beginning a program would be to start small. It is important to begin at a level that can be easily handled. By starting small the agency will be able to determine what areas seem to be working and what needs to be strengthened. It is during this time that relationships should begin to be established between the private and public sectors involved. By starting small the agency also helps to break through some of the red tape of funding the program. It is much easier to get a small amount of funding at first for a small program, allow the program to prove itself, and the funding becomes less of a problem.

An agency just starting out should focus on their most severely congested area and the most common type of incident in this area. This area should be designated as a pilot study area. By focusing on the most common incidents, the program will be able to demonstrate the greatest results. These results will help to increase support for the program, both by the driving public as well as all the agencies involved. Goals for the program should be set and periodic evaluation should be performed. Setting goals will allow the program to stay focused and periodic evaluation will help to ensure these goals are attained.

A key factor in beginning an incident management program is gaining the support of all the various agencies that may be involved. It is essential that the cooperation and coordination between various agencies that may respond to an incident be set in place prior to the actual initiation of the program. Monthly or bi-monthly meetings of the various agencies should be arranged. These meetings should be used to pre-plan for incidents. Preliminary planning allows all the agencies involved to know their role when an incident occurs. Various incident scenarios should be discussed, and plans of action documented. Traffic management plans should also be predetermined. These plans should focus on areas of high incident experience and how traffic should be rerouted around these areas. Pre-planning makes an incident management program operate more efficiently, which can save valuable time in dealing with incidents.

A Traffic Management Center (TMC) should be set up. This center should act as a headquarters for the operations of the incident management program. Traffic Management Centers help to coordinate all the activities and interactions among agencies during incidents. They are also a location where incidents can be reported. By setting up a cellular hot-line to the TMC, travelers who detect incidents can report them directly to the TMC, thus cutting down on the detection and verification time during an incident. The TMC should contain as many official from the most commonly involved agencies (i.e. highway patrol, D.O.T., etc.). The name and number of the person to be contacted at each agency that may be involved should be stored in the TMC so that when an incident occurs the operators in the TMC know exactly who to contact and how to contact them. A well organized Traffic Management Center can greatly decrease the time involved in all the steps of incident management.

It seems the best technique of incident management may be the service patrol. Service patrols are the backbone of all of the agencies that reported benefit/cost ratios. Service patrols are beneficial because they serve a multitude of purposes. In some instances, service patrols can perform all of the functions of incident management (detection, verification, response, removal) during a minor incident. Service patrols also help to gain public support for the program. Motorist can see the advantages of the patrols and are pleased their tax dollars are going to such a worthwhile cause. Service patrols seem very conducive to a program that is just beginning. Service patrols are relatively inexpensive, can focus on major areas of incidents and can handle the most common types of incidents (which has been shown to be minor incidents (2,3,5)). Service patrols also cut down on the need for interaction between multiple agencies as they can handle most minor incidents by themselves.

Another important aspect of incident management is getting information out to the motorist. Supplying the motorist with timely, accurate traffic information is an essential part of incident management. The best way to manage an incident is by not allowing it to occur. By disseminating traffic information to the traveling public, secondary accidents can be avoided. Currently I feel the best way of supplying this information is by Highway Advisory Radio, or some other form of radio, and changeable message signs. In the future I believe the primary way of supplying information to the motorist may be via some type of in vehicle device.

Also, the public needs to be aware of the program. An extensive public awareness campaign should be undertaken so that travelers are aware of the program, where they can get traffic information, and most importantly what their role in incident management is. The driving public needs to be aware that by using some preventive maintenance on their vehicles, not rubbernecking at incident sites, and removing their vehicles from the roadway if they are involved in an incident, they can greatly reduce the effects of incidents on the roadway network.

The final recommendation I would have for any agency interested in beginning an incident management program would be to visit an existing program. By observing how a current program is being operated an agency may be able to get insights they may have overlooked in the development of their program.

In conclusion my recommendations to anyone beginning an incident management program would be to: start small and target most common problems, establish relationships early between the various agencies involved, pre-plan for incidents, establish a Traffic Management Center, gain public support, use service patrols, emphasize traveler information, and visit existing programs. If an incident management program is carefully planned, it can and will produce benefits.

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