Freeway Incident Management in the Spokane Area

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FREEWAY INCIDENT MANAGEMENT IN THE SPOKANE AREA

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16. ABSTRACT

The Washington State Department of Transportation (WSDOT) has embarked on a Freeway and Arterial Management Effort (FAME). This effort includes the collection of data, assessment of incident-related impacts, and the generation of incident management strategies across the state. This report focuses its attention on the effectiveness of existing incident management strategies applicable to the Spokane I-90 urban section, from the Four Lakes Interchange (Exit 270) on the west to the Idaho State Line on the east, covering a length of 30 miles. With direction and assistance from a technical advisory committee data and information were gathered and analyzed to include roadway and accident characteristics of this urban section of I-90 and existing incident detection, response, servicing, and coordination practiced by several agencies serving the area. From this analysis, sections of I-90 that had a high potential for incidents were identified. As a result of this research, several useful products were developed, such as maps showing existing interchanges, detour routing for potential freeway closures, etc. Based on this preliminary analysis and evaluation it was evident that it would be necessary to carry this research forward to enhance the existing incident management methods practiced in the Spokane Area. Five specific actions are recommended (i) Structure the database and, if necessary, identify and complete any missing data needed, (ii) prepare an incident management manual capable of being updated on a regular basis, (iii) form an incident management team (iv) format the data/information for use in a knowledge-based expert system (KBES) and (v) adopt a KBES for Spokane.

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SUMMARY

The purpose of this study is to investigate and evaluate the effectiveness of existing incident management strategies applicable to Interstate 90 within the Spokane Urban Region, from Four Lakes Interchange (Exit 270) on the west to the Idaho State Line on the east, covering a length of about 30 miles.

A technical advisory committee was formed, consisting of two representatives from the Washington State Department of Transportation (WSDOT) and a representative from the Washington State Patrol (WSP), to provide direction and assistance in gathering data and contacting local agencies.

Data were gathered and analyzed to include roadway characteristics, accident history, volume/capacity ratios, level of service, and traffic counts and projections. From this analysis, areas on I-90 that had a high potential for incidents were identified. The 10 mile section of I-90 from the SR 2/Airport Interchange (MP 278) to Argonne Road Interchange (MP 288) encompassed the major problem areas. This section is characterized as having narrow shoulders, many substandard weaving sections, deficient roadway geometrics, high volume/capacity ratios, and a high susceptibility for weather related accidents.

Twelve local agencies and private entities responsible for incident servicing were interviewed to investigate and record current methods of managing incidents. Although the key agencies felt they had a good understanding of response strategies and responsibilities, it was evident that there were many problems and the current system lacks a structured sequential management plan. The time spent making decisions at the scene of an incident could be used more efficiently to restore the interstate back to normal operating conditions if participating agencies were better coordinated.

As a result of this research project, several useful products were developed for potential use in an incident response manual. Maps were prepared showing the existing

interchanges, detour routes were developed for potential freeway closures, all utilities located within the I-90 corridor were listed by type and ownership with contact telephone numbers, and a contact list was developed for responding entities.

It became evident that it would be necessary to carry this project work forward if any meaningful and positive actions were to be taken to enhance the existing incident management methods in the Spokane Area. It was obvious that additional steps could be taken to enhance existing practices, improve coordination and take advantage of the extensive data collected.

Five specific actions are recommended:

(1) Structure the database and, if necessary, identify and complete any missing data.

(2) Prepare an incident response manual capable of being updated on a regular basis.

(3) Form an incident management task force.

(4) Format the data/information for use in a knowledge-based expert system (KBES).

(5) Adopt a knowledge-based expert system for the Spokane area.

CONCLUSIONS AND RECOMMENDATIONS

In order to have an effective incident management plan, all agencies involved must be aware of each other's role, and how their expertise can best be used. Incident management is a difficult task because there are so many different agencies involved. It is therefore imperative that each agency know how each perceives incident management and how their ideas can be brought together to form an efficient team to handle incidents effectively.

It is therefore recommended that the following actions be taken:

1. Structure the database for coordinating and implementing incident detection, response, and clearance tasks. Identify and complete any missing data not gathered or developed in the initial project.
2. Prepare an incident management manual as described in the discussions. This will constitute a loose leaf information document enabling information/data to be added/updated on a regular basis.
3. Form an Incident Management Task Force comprising of members drawn from: WSP, WSDOT, DOE, fire districts, towing, and news media. The team would address specific actions to be implemented as suggested in Table 1.
4. Format the information/data for use in a Knowledge-based expert system. Choice of a suitable shell will be the important decision.
5. Adopt a knowledge-based expert system for the Spokane area.

1. INTRODUCTION

Spokane County, located in Eastern Washington State, is a diversified region with a population of about 356,000. Most of the residents live within the Spokane Urban Region which is comprised of the City of Spokane and its suburban influence areas. Interstate 90 is an important east-west national highway corridor that bisects the Spokane Region. Because of this, I-90 has had a significant impact on land use and population distribution (1).

Much of I-90 within the Spokane Region was designed in the early 1950's to meet a 20-year horizon for projected traffic volumes. Since then design standards have undergone continual change and traffic volumes have increased dramatically. Most of the facility from Four Lakes to the Idaho State Line will need major repair by the year 2010. In the meantime traffic congestion on I-90 continues to rise resulting in increased accidents, commuting time, and driver frustration (2).

Freeway incident management programs in several U.S. cities have resulted in reduced levels of congestion and in tangible benefits to freeway users. The Federal Highway Administration considers the development of incident management strategies as a key to optimizing the performance of congested interstate segments.

1.1 Purpose of the Study

The purpose of this study is to investigate the effectiveness of existing incident management strategies applicable to the Spokane I-90 urban section, from Four Lakes Interchange (Exit 270) on the west to the Idaho State Line on the east, covering a length of about 30 miles. The focus of this study is to collect the necessary data for possible future use in an incident response manual and in a knowledge-based expert system (KBES). This effort is made in concert with District 6 of the Washington State Department of Transportation (WSDOT), and other agencies, such as the Washington State Patrol (WSP), and local fire districts. This study investigates and evaluates incident

management techniques in the Spokane I-90 urban section and recommends actions to initiate an incident response system in the Spokane area.

1.2 Problem Statement

Recurrent and non-recurrent traffic congestion occurs on freeways. Recurrent congestion occurs routinely during peak-periods and is predictable in both effect and duration. However, non-recurrent congestion, caused by random unpredictable incidents, such as traffic accidents, lane blockages, heavy rain or snowfall, fuel leaks or hazardous material spills, result in major traffic congestion for considerable time periods.

The WSDOT has embarked on a Freeway and Arterial Management Effort (FAME) research plan. WSDOT's District 1 and the WSP have since developed plans, procedures, and systems aimed at the management for freeway incidents more efficiently. Such work includes: collection of appropriate data; measurement of incident-related impacts; and, generation of additional incident management strategies.

This project, while attempting to determine the effectiveness of incident management strategies in general, focuses its attention to the Spokane I-90 urban section in particular, through a work effort involving data collection for possible use in a KBES. Over and above the obvious benefits in investigating and evaluating incident management techniques in the Spokane I-90 urban section, this research forms an important base for further work in Spokane and in other similar parts of the state.

1.3 Objectives

This project is part of the FAME effort. The objectives of this project are:

- To investigate and record the nature of existing and possible non-recurrent problems caused by freeway incidents under different circumstances.
- To investigate and record current methods of incident detection, response, response time, incident servicing, and motorist information on the Urban Section of I-90.

- To investigate and record current coordination (highway, public, fire, ambulance, etc.) being practiced in cases of major and minor incidents of the Urban Section of I-90.
- To develop an incident database for the evaluation of incident management options, for possible future use in a KBES.
- To develop recommendations on how to initiate an incident response system in the Spokane area.

1.4 Scope of the Study

This project focuses its attention to the Spokane I-90 urban section through a work effort involving the assessment of data needs, the data collection exercise, and an incident analysis and evaluation. A set of recommendations finally emerge from this preliminary work effort.

2. BACKGROUND

2.1 Introduction

A freeway incident--an accident, stalled vehicle, spilled load, or any other event that reduces the normal capacity of the roadway--causes motorist delay. Freeway incident management techniques are directed at reducing this delay, which varies with the detection time, traffic volume, number of lanes, and the duration of the incident (3). Also, it may be noted that delay varies with response and clearance time, traffic demand, and roadway capacity.

Incidents may be classified as follows:

1. By type
    a) accidents
    b) disabled vehicles
    c) spilled loads

d) other events

2. By impact or severity

   a) having a major impact on traffic flow

   b) having a minor impact on traffic flow

   c) having no significant impact on traffic flow

3. By importance of needed action

   a) medical action

   b) fire mitigation action

   c) hazardous material clean up action

   d) other actions.

2.2 Freeway Incidents

Figure 1 shows freeway incidents classified by impact or severity. Major incidents requiring police and/or emergency vehicles to resolve the problem are of primary concern, due to the amount of vehicle delay generated, although effective incident management strategies will also serve to reduce the impact of minor incidents. There is also the possibility of converting potentially major incidents into minor incidents.

Numerous freeway incident management strategies have been suggested and implemented in the last decade. In the case of delay causing incidents, where reduced capacity is encountered, the major requirements are to detect, respond to, and clear the incident as quickly as possible. Major incidents also require managing the demand that is approaching the incident site. In order to handle these problems an extensive system of surveillance, servicing, and information is required. Details of these tasks are given below:

A. Surveillance

Surveillance or incident detection is required to detect and evaluate the problem and to determine the appropriate action that is to be taken. Detection can be

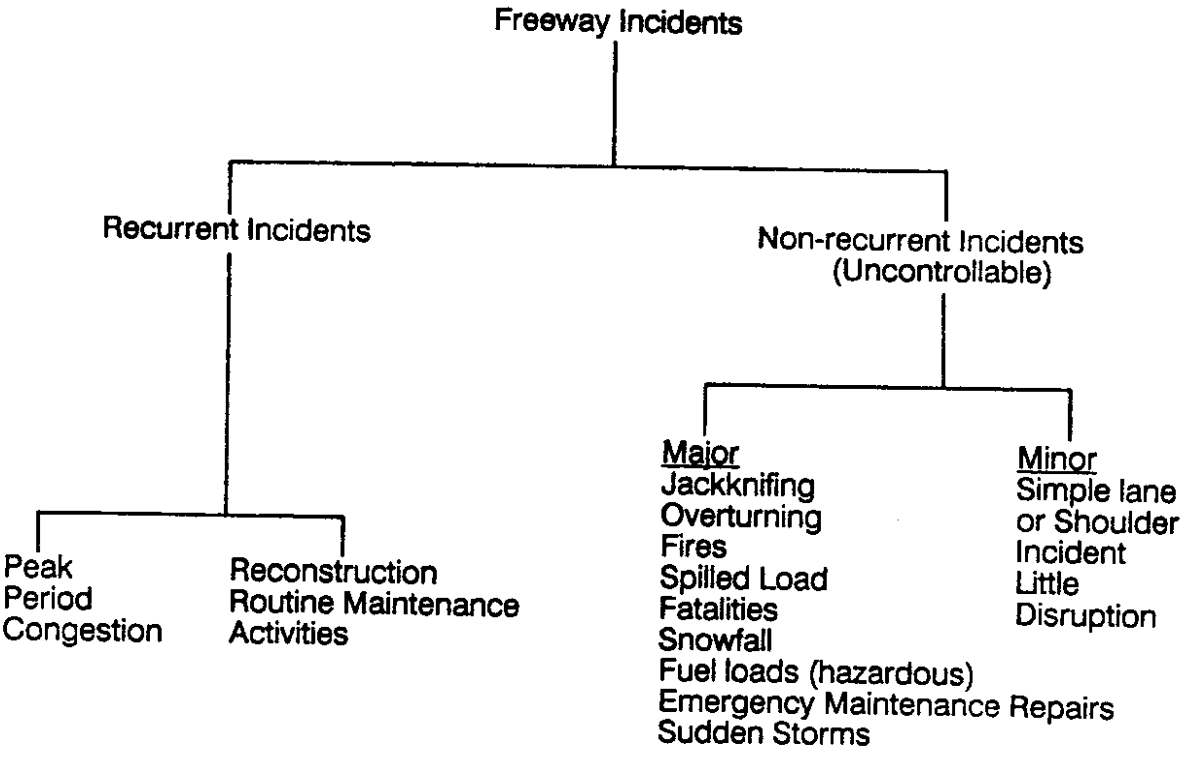

Figure 1.

accomplished through various ways, such as call boxes, electronic detectors, aerial surveillance, citizen band radios, courtesy patrols, police patrols, public radio stations, cellular telephones, closed circuit TV, and volunteer observers.

B. Incident Servicing

Once an incident is detected the key to minimizing congestion is the speed at which the incident is removed, so that the freeway is restored to full operation. The longer the duration of response, the more severe the result in congestion and delay for obtaining a given level-of-service. Consequently, an effective incident management system must include plans for early investigation and removal. Preplanned response strategies are extremely important in reducing the time it takes to service an incident.

Establishment of an incident response team that consists of representatives from the key agencies such as the WSP, fire departments, ambulance, and the WSDOT will insure coordination and help to decrease response and resolution time.

C. Information

It is very important that the public be made aware of and kept informed of problems created by incidents on the freeway. A plan should be formulated whereby some agencies of the incident management team keep the local commercial radio and television stations informed of the actions being taken on incidents. By using proper communication techniques users of the freeway can be advised of possible rerouting and diversions from the problem area.

At the present time portable variable message signs, highway advisory radio, and other similar automated methods for managing traffic congestion are not in use in the Spokane Region. Development of incident management strategies should consider use of these devices for improved communication to aid in reducing the time it takes to improve traffic flow around an incident.

2.3 An Overview of Delay Caused by Incidents

To quantify this delay, traffic volumes and incident durations can be graphically represented, as shown in Figure 2. The horizontal axis is a timeline indicating the occurrence of incident-related events and the overall duration of their impact on traffic flow. The vertical axis is the cumulative traffic volume--the sum of the vehicles passing any given point on the freeway in a defined time period.

The demand flow or volume--the total number of vehicles using the freeway at a given time--is represented by the slope of L1. When an incident occurs (Time A), the reduced roadway capacity (L2) is less than the demand flow because of lane blockage. This reduced capacity remains in effect until the incident is cleared from the freeway (Time B). At that time, the queued traffic can begin to flow at a "getaway" capacity (L3)

approaching the freeway's capacity. When the last vehicle in the queue reaches the normal flow speed and traffic resumes flowing at the demand volume (Time C), the effects of the incident are over. Methods to estimate detection time, response time, clearance time, and total delay are available including a user-friendly microcomputer model for obtaining quick results.

2.4 Factors Affecting Incident Duration

A number of factors determine the magnitude of incident-caused delay, which is represented by the shaded area in Figure 2. Only some of these factors can be influenced by freeway incident management techniques. Other factors, such as the freeway's capacity and to a certain extent demand flow, generally are fixed by external environmental circumstances such as the number of lanes and the time of day. Demand flow can be influenced to a degree by timely information to the public as well as entrance control. Unless an incident occurs just before or at the end of a peak period, or traffic is diverted during an incident, the demand flow rate is assumed to remain constant for the duration of the incident.

Two factors that can be influenced by incident management techniques are the reduced capacity past the incident and the incident's total duration. Effective on-site traffic management techniques optimize use of whatever freeway capacity remains after the incident. Graphically, this is represented in Figure 3 by an increase of the slope of the reduced roadway capacity L2 to create an improved flow rate L2'.

Another factor influencing total delay is the time from the moment the incident occurs to the time it is cleared from the freeway. This time interval AB can be expressed as the sum of the detection, response, and clearance times as shown in Figure 2. Obviously, minimizing any of these times through efficient incident management will result in less total delay (4).

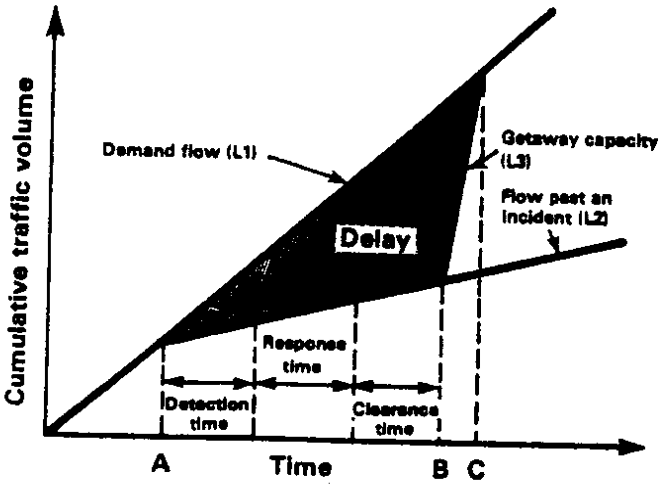

Figure 2. Qualifying Delay Caused by a Freeway Incident.

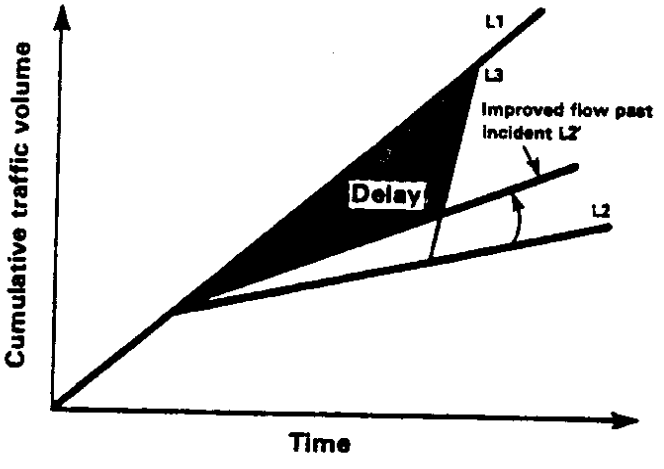

Figure 3. Delay Reduction caused by Increasing Flow Past the Incident.

2.5 Summary and Conclusions

The primary objective in freeway incident management is to minimize the incident detection time, response time, and clearance time. These factors are generally related to various conditions during light, medium, and heavy traffic volumes.

Immediate and prompt response to freeway incidents ensures the rapid restoration of congested flow to normal conditions. Such a response to urban freeway incidents essentially involves eliminating or preventing the cause, managing the demand approaching the incident, and restoring the freeway traffic flow to normal as quickly as possible.

The functional elements of a Freeway Incident Management (FIM) system include: (a) detection; (b) response; (c) on-site management; and (d) clearance.

The type and extent of freeway incident management systems depend greatly on public agencies and organizations supporting them. These include: (a) police agencies; (b) department of transportation; (c) point facilities (eg., bridge and tunnel authorities); (d) citizen groups; (e) fire districts; and (f) freeway incident management (FIM) teams that include two or more of these agencies mentioned. An FIM team or task force is the most effective organization due to the concentration of all responses and surveillance responsibilities in one administrative unit.

3. IDENTIFICATION AND COLLECTION OF DATA

3.1 Framework

The primary purpose of the data identification and collection effort was to gather sufficient information to determine existing and possible problems caused by freeway incidents, and to evaluate incident management techniques currently being practiced within the study area. Data generated by this effort was used to develop an incident related database for use in an incident response manual and possible future application in a KBES.

Through meetings with the technical committee, consisting of WSDOT and WSP personnel, available data was identified and an assessment of additional needs was recommended. Particular attention was given to currently available data that could be obtained through interviews with agencies involved in incident management on the freeway.

3.2 Available Data

Significant traffic data were available from the WSDOT for use in investigating existing and potential incident problem areas. A history of accidents over the past 5 years was made available as well as traffic information for present and future volume/capacity ratios, LOS, and traffic volumes. The WSDOT also had a variety of maps that were used to determine roadway deficiencies, utility locations and possible detour routes.

A notification flow chart used in incident management was provided by the WSP and a communication diagram was provided by the Department of Emergency Services. A complete listing of the available data including additional information developed from this data is attached in this report in Appendix A.

3.3 Data Needs

It became evident that a majority of the information needed to investigate and record current incident management techniques used on I-90 in the Spokane Region would need to be accomplished through interviews with the local entities involved. The technical committee recommended interviewing the following agencies:

1. Washington State Patrol (WSP)
2. Washington State Department of Transportation (WSDOT)
3. Fire Districts (City of Spokane)
4. Spokane County Sheriff's Department
5. Spokane Police Department

6. Washington State Department of Ecology (DOE)
7. Spokane County Department of Emergency Services (DES)
8. Spokane Transit Authority (STA)
9. KXLY News (Radio)
10. Utilities (Inland Power & Light; Washington Water Power)
11. Rouse Towing Co.
12. National Weather Service

The interviews were directed towards obtaining knowledge of how each of the above agencies are involved in current incident management strategies on the I-90 urban section, and also other areas where similar responses are necessary. Questions were raised concerning current methods of incident detection, response, response time, incident servicing, motorist information, and current coordination of other agencies required in case of assistance. Also, questions regarding the nature of existing and possible non-recurrent problems encountered while servicing an incident were asked and noted.

3.4 Data Collection Effort

The agencies or organizations that are called upon to service incidents include the Washington State Patrol, responsible for law enforcement; the Washington State Department of Transportation, responsible for traffic control and maintenance; fire and ambulance service for accidents; towing companies for vehicle removal; and the Department of Ecology for assistance in the clean up of hazardous spills. Other organizations may be notified for further support.

The information that follows is a summarization of the interviews conducted with the agencies listed previously in 3.3. Contained in each section is a discussion of the role that the agency currently has in incident management techniques on the I-90 urban section. Other information will be used in developing the data base. This section closes

with a discussion of the problem areas on the I-90 urban section as well as suggestions for improvements of the current incident management techniques.

3.4.1 Washington State Patrol (WSP)

WSP has the law enforcement responsibility for the I-90 urban section, and also the ability to close the freeway, partially or fully, at any time. They are in charge of providing temporary traffic control at an incident scene as well as assisting in the servicing of the delay causing incident. Once an incident is detected, notification to the WSP is made, and in most cases a sergeant or lieutenant responds to determine what further action may be necessary. The communication network they follow is outlined in an Unusual Occurrence Manual kept in each supervisor's vehicle and also at the dispatch office. Every attempt is made to keep the freeway lanes open to traffic. Very few closures are encountered. If needed though, traffic is diverted off the freeway onto the nearest arterial and redirected onto the freeway via the nearest available on-ramp. An officer is positioned at the exit point to direct traffic. If the closure is anticipated to last a long period of time, the WSDOT is notified to assist in the traffic diversion routing. If the diversion encounters signalized intersections, the city or county is contacted to re-adjust their traffic signals to expedite traffic flow through the area.

The WSP has a public information officer designated to notify the news media of a problem on the freeway so that it can be broadcast to motorists. If the motorists know of a problem they could find an alternate route, bypassing the incident scene.

3.4.2 Washington State Department of Transportation (WSDOT)

The role of the WSDOT maintenance personnel in incident management is to provide support, such as long term traffic control, aid in preventing the spread of hazardous material spills, restoration of the roadway, clean up of debris from the roadway, and surface maintenance during adverse weather conditions. The WSDOT also has the authority to close the freeway if it is necessary.

3.4.3 Fire Districts

The I-90 urban section study area encompasses four separate fire districts. In the event of a hazardous materials spill and/or fire, the Fire Department having jurisdiction over that area is notified to respond with a first alarm response. The fire officer in charge evaluates the nature of the incident and coordinates further response personnel. If a hazardous material has spilled, the fire officer notifies the city of Spokane Fire Department, which is the hazardous materials team, and also the Department of Ecology. If the spill is a major one, the Department of Emergency Services is notified to initiate an emergency broadcast and provide further assistance in coordinating the support agencies.

3.4.4 Spokane County Sheriff's Department

The Sheriff's Department is not considered as a primary respondent to an incident on the I-90 urban section. They are not involved with traffic control. They may be notified, however, in the event of a hazardous material spill that requires evacuation of an area nearby, and/or to assist in the diversion of traffic to the arterials.

The 911 emergency notification phone line is monitored by the Sheriff's Department. Details of an incident type could be made and appropriate responses carried out in the event of an incident.

3.4.5 Spokane City Police (SCP)

A segment of I-90 goes through the downtown area of Spokane. Therefore, if diversion of traffic from the freeway is necessary, the Spokane Police Department is called upon to assist in directing traffic on the city arterials. An incident that is limited to the freeway and/or is outside the city limits would not constitute notifying the police.

The SCP do not have an incident management plan of their own. Their procedure for servicing an incident is to classify it as a level I, II, or III type. Level I is a minor, no

injury type response, type II is a possible injury incident, and a type III would constitute an ambulatory response as well as fire protection support.

3.4.6 Washington State Department of Ecology (DOE)

In an instance where a hazardous material is spilled, the Department of Ecology is notified to respond and evaluate the risk based on public health and environmental concerns. Their role is not as an immediate emergency response team, but rather as assistants to the fire/WSP personnel. They are available on a 24 hour basis and dispatch a person to the scene as soon as possible.

It is the responsibility, though, of the DOE to notify the carrier and advise them of the spill and to instruct them to hire a contractor to clean up the spilled material. If the carrier is unable to do this, the DOE notifies the contractor. Follow up calls may be necessary to ensure that the clean up team is enroute. Spill contractors are available only in the Seattle or Portland area and they take about 8-10 hours to get to Spokane to service an incident. In the meantime, the responsibility to contain the spill lies with the WSDOT and the DOE.

3.4.7 Spokane County Department of Emergency Services

The purpose of the Department of Emergency Services (DES) is to create a team comprised of city, county, and state officials to make quick and accurate decisions in the event of a major disaster. This organization will operate out of the Emergency Operations Center (EOC) located in the City/County Building. The city and county operate a joint communication system located in the Public Safety Building. A Communications Officer, appointed by the Director of Emergency Services, is responsible for preparing operating procedures for the EOC. Duties of the Communications Officer include coordinating the Emergency Broadcast System, and supervising radio communications with public radio stations and amateur radio operators.

Two Mobile Command Vehicles, acting as emergency operation centers, can be utilized as a field command and communications center. The primary mobile command center, called the "Motor Home," is equipped with radios and telephones capable of transmitting and receiving frequencies of the base command center.

3.4.8 Spokane Transit Authority

Spokane Transit Authority (STA) operate four routes on the I-90 urban section. Two of these routes are operated going west and two going east, twice daily. They operate approximately 14 hours a day from 6:00a to 8:00p. The buses are equipped with radios that enable the drivers to communicate with their dispatch office, and are therefore able to report any incidents that they encounter. This is not an established policy for STA, but rather a helpful service that is provided without any special equipment or personnel. STA also maintain two park-and-ride lots east of the city that have public telephones.

3.4.9 KXLY News (Radio)

KXLY radio broadcasts on AM and FM frequencies, and also on television. The station sponsors a cellular phone number for motorists to call if they witness an incident. This service is broadcast over the radio but is not visually advertised by signs on the freeway.

KXLY is the primary broadcaster of the Emergency Broadcast System (EBS) for the Spokane region. This may be initiated by the DES in times of major disasters. The station will, at times, request information from the WSDOT regarding road conditions in times of poor weather and then alert motorists of the adverse conditions. Routine peak period traffic surveillance and reporting is not currently practiced.

3.4.10 Utilities (Inland Power & Light; Washington Water Power)

Several utility companies have their services on or near I-90 . In cases where downed power lines or ruptured water or gas lines affect the traffic on I-90 , the utilities can be contacted to respond. Maps are available through the WSDOT indicating where these utilities are located and the person responsible for servicing.

3.4.11 Rouse Towing Co.

Several towing companies are used on a rotational basis for vehicle removal. In the case of an incident involving a large truck, only three of these companies qualify for notification. These are Rouse Towing, Alexander's, and Slims. Rouse has a large boom truck for large-vehicle removal that is available 24 hours per day. Each of their trucks carry the necessary equipment for servicing an incident as well as the basic traffic warning devices such as flares and signs. They also operate a van that carries additional equipment if needed. It is very important that these companies have the proper flagging equipment and reflective clothing and adhere to established traffic control techniques.

3.4.12 National Weather Service

Basic climatological data can be obtained for possible prediction of weather conditions, that would assist in planning. Cloud seeding is done at Fairchild AFB and Spokane International Airport which are both located adjacent to I-90 between MP 272 to MP 276. This procedure, when done, can cause slippery road conditions on the section of I-90 from Four Lakes Interchange (MP 270) to the Sunset Hill (MP 279). The current practice is for Fairchild to call the WSDOT when the cloud seeding is to be conducted so that protective measures can be taken.

3.5 Summary and Conclusions

Valuable information regarding incident management strategies was obtained through the interview process. However, insufficient information was available to determine average response times and length of time to service and clear an incident. Responding agencies do not keep logs of incidents in sufficient detail to provide this data. Agencies interviewed did indicate that fatal accidents can take as long as four hours to clear the roadway due to the need for extensive site investigation. Accidents involving hazardous spills and damaged cargo were also reported as taking extensive time to clear.

Very candid comments were made regarding current practices. The general impression of the current servicing system is that it works fairly well in most cases, except for a few flaws. However, it was made clear from some of the people interviewed, that better communication and coordination coupled with quick decision making would greatly improve the current system.

It was evident that the group of responding agencies lack a clearly set plan for incident management. Each agency realized the importance of its duties when responding to an incident, but the current system lacks a structured sequential management plan. Questions arise regarding the best way to handle a given situation. The time spent in making decisions at the scene of an incident could be used more efficiently to restore the freeway back to normal operating conditions, if participating agencies were better coordinated.

The recommendations made in this report attempt to address the problems identified through the interviews and assessment of current methods. Listed in Table 1 are a number of incident management techniques currently practiced by agencies in the Spokane area along with recommendations for other techniques that should be considered. Current techniques are marked off as being either fully practiced, which means that everyone has some current system that addresses this incident

management technique, or partially practiced, meaning that some of the agencies use this technique. Hopefully, some of the proposed techniques may be implemented to aid in improving incident management.

Some of the items proposed or recommended in Table 1 are self-explanatory, while others have been described before. Still others need to be explained, and details on these follow:

- Incident management teams (or Task Forces): These interdisciplinary teams are trained in handling large or severe incidents on the freeway. In some areas they are staffed by volunteers. Their job is to respond quickly, set up an incident management command post, determine the severity of the incident, call in appropriate help from experts, and use a resource manual to contact persons who control special equipment that may be required. They typically coordinate all responding agencies.
- Emergency vehicle access: This option calls for identification of freeway links that do not have adequate access for emergency vehicles. Movable barriers placed at key locations can reduce time by allowing fire trucks, aide cars, and the police to access incident sites.
- Advance alternative route planning: A freeway corridor can be analyzed for alternative routes in case of a lane-blocking incident. These alternative routes can be recommended to motorists through media contacts or through other information systems. In some instances route diversion is necessary and detour signs for a preplanned alternative route can be quickly posted by a road crew.
- Fast vehicle removal policy: This policy permits removal of vehicle by private wreckers within a short time period.
- Variable message signs: After an incident is detected, changeable message signs mounted on trucks or permanent fixtures may be used to close lanes, divert traffic, and warn drivers of slow traffic ahead.

Table 1 INCIDENT MANAGEMENT TECHNIQUES IN THE SPOKANE REGION (5,6)*

Item	Existing		Proposed or Recommended
	Fully	Partially	
Reducing Detection Time			
- Electronic loop detection			
- Closed circuit television			
- Call boxes			
- Service patrols		X	
- CB radio monitoring		X	
- Increased police patrol frequency		X	
- Stationing fixed observers			
- Use of cellular telephones through 911		X	
- Ties with transit and taxi companies	X		
- Aerial surveillance			
Reducing Response Time			
- Cooperative agreements between agencies	X		
- Equipment and materials locations			
- Development of key personnel resource list		X	X
- Tow trucks at strategic locations			
- Peak period motorcycle patrols			
- Freeway management manual			X
- Improved radio communication			X
- Emergency vehicle access			X
For On-Scene Management			
- Advance alternate route planning			X
- Incident management teams			X
- Implementation of flashing lights policy			
- Command posts procedures		X	X
- Development of hazardous materials manual		X	X
- Proper traffic control techniques		X	X
- Proper parking of response vehicles		X	X
- Fast vehicle removal policy		X	X
Reducing Clearance Time			
- Equipping response vehicles with equipment		X	X
- Equipping response vehicles with push bumpers		X	
- Off-freeway accident investigation sites			
- Clearly identifying locations of fire hydrants			X
- Training for all response personnel			X
For Effective Motorist Information			
- Media agreements	X		X
- Variable message signs			X
- Highway advisory radio			

4. INCIDENT RESPONSE ANALYSIS AND EVALUATION

This section begins by presenting the areas of the I-90 urban section that were perceived by the agencies interviewed to be hazardous to motorists or are difficult areas to service in times of an incident. In addition, problems associated with incident servicing are listed so that they may be addressed in suggestions for improving the current incident management techniques.

4.1 Problems Areas

An analysis of roadway characteristics, accident history, volume/capacity ratios, level of service, and traffic counts and projections indicated that there were several areas within the project limits that had a greater potential for incidents.

In general, the 10 mile section from the top of the Sunset Hill (MP 278) to the Argonne Road Interchange (MP 288) includes most of the problem areas. Traffic volumes are higher; shoulders are narrower with few opportunities to remove involved vehicles from the freeway lanes; on-off ramps are closely spaced with short weaving sections; and roadway geometrics do not meet modern standards. These factors combined with weather problems such as snow or rain result in higher accident rates and an increased difficulty in responding, servicing and clearing incidents.

Following is a brief description of the major problem areas:

- Sunset Hill (MP 277-279): The steep grade of the hill combined with winter snows create a serious potential for winter accidents. There are no parallel frontage roads or good access points in this area which makes it difficult to reach an accident site or detour traffic if the roadway is closed.
- Viaduct Section - SR 195 Interchange to Division Street (MP 279-281): Median and outside shoulders of this section are not wide enough to store a stalled vehicle. On-off connections are substandard and create a high potential for accidents. Traffic volumes at peak hours create additional problems.

- Vicinity Liberty Park/Hamilton Street Interchange to Sprague Avenue Interchange (MP 282-286): This section is characterized by narrow median shoulders, high traffic volumes, and closely spaced on-off ramps with connecting weaving lanes. Over 50% of the accidents in this section are related to the ramp connections with the mainline. Nearly any incident such as a stalled vehicle parked on a shoulder during peak traffic periods negatively impacts traffic flow. The potential for primary and secondary accidents is extremely high in this area. Heavy rains and winter storms result in increased accident frequency.
- Sprague Avenue Overcrossing (MP 286): The six lane roadway transitions to four lanes west of the Sprague Interchange. Roadway horizontal and vertical alignment is substandard for the design speed and ramp connections do not meet modern standards. The above factors combined with heavy traffic volumes result in the highest accident rates on the interstate in the Spokane Region.
- Argonne Road Interchange (MP 287) and Pines Road Interchange (MP 289): Both of these interchanges experience high accident rates due to design and capacity problems. A good percentage of the accidents occur at the ramp terminal intersection with the crossroads.

4.2 Problems Associated with Incident Servicing

From the interviews, many problem areas were identified that are discussed in this section. Most of the problems can be solved by purchasing additional equipment, providing better training, developing of an incident response manual or forming an incident response team. It is intended that the following problems be addressed by the team as a starting point for improving incident management in the Spokane Region.

- The need for improved communication, cooperation and coordination in responding, servicing and clearing incidents was made clear by agencies interviewed.

- Suitable maps for identifying detour routes and servicing incidents are currently unavailable.
- Improved methods and training are needed to deal with hazardous spills.
- Key vehicles need mobile telephones that include "LEARN" and "OSCAR" networks.
- Weather conditions are difficult to predict. There is a need for advanced warning to both prevent incidents from occurring and to help reduce potential for secondary incidents once an incident has resulted in traffic congestion.
- Binoculars are needed in key vehicles to help identify spills from a distance.
- Sound decision making is currently based on the ability and experience of leaders at the site. Interviews indicated that decisions are sometimes questioned.
- The WSDOT is responsible for traffic control for longer term incidents. For incidents of short duration there is often inadequate traffic control and lack of trained personnel to flag traffic.
- Interviews indicated that at times it was uncertain who was in command in servicing an incident.
- There is a lack of adequately planned evacuation techniques.
- Absorbent has been stockpiled in small quantities along the interstate, however, there are problems with finding adequate or timely disposal sites.
- Problems occur with fatigue in servicing some incidents that require long durations to clear.
- News media personnel sometimes create interference with efforts to service an incident.
- Agency roles are not clearly defined for all situations.
- Problems are encountered with insurance companies in clearing the roadway when salvageable materials are involved.

- Some spill cleanup is hampered due to lack of 24-hour emergency response, such as availability of waste oil pick-up companies.
- Quick clearance of the roadway for some incidents is hampered when fatalities are involved which require careful investigation and documentation.

The problems identified above are certainly not all inclusive, and many of the agencies may question whether they are "factual" or "perceived." A review of these issues would be a good starting point for discussion and resolution by an incident management task force.

5. DISCUSSION ON NEED FOR FURTHER WORK

This section discusses the need to carry this work forward by: (1) structuring the database for coordinating and implementing incident detection, response, and clearance tasks; (2) preparing an incident response manual with all available data; (3) establishing a well-organized incident management task force; and (4) formatting the available data for possible use in a suitable expert system. Each of these items is elaborated on below.

5.1 Structuring the Database

An effective and efficient process to manage freeway incidents and to reduce the resulting delay depends heavily on effective incident response. This is a demanding task given the relative lack of incident management experts, and the insufficient coordination among the various transportation and other service agencies. As mentioned before, the outcome of this first phase of the freeway incident management project on I-90 in the Spokane area is not intended as a final product. Developing a comprehensive database to cover a wide variety of incidents is thus necessary.

A basic structure to suit the I-90 section in the Spokane area is shown in Figure 4. This framework reduces the complexity of the domain into well defined and manageable units. These components include: (a) accidents, (b) disabled vehicles, and (c) spilled

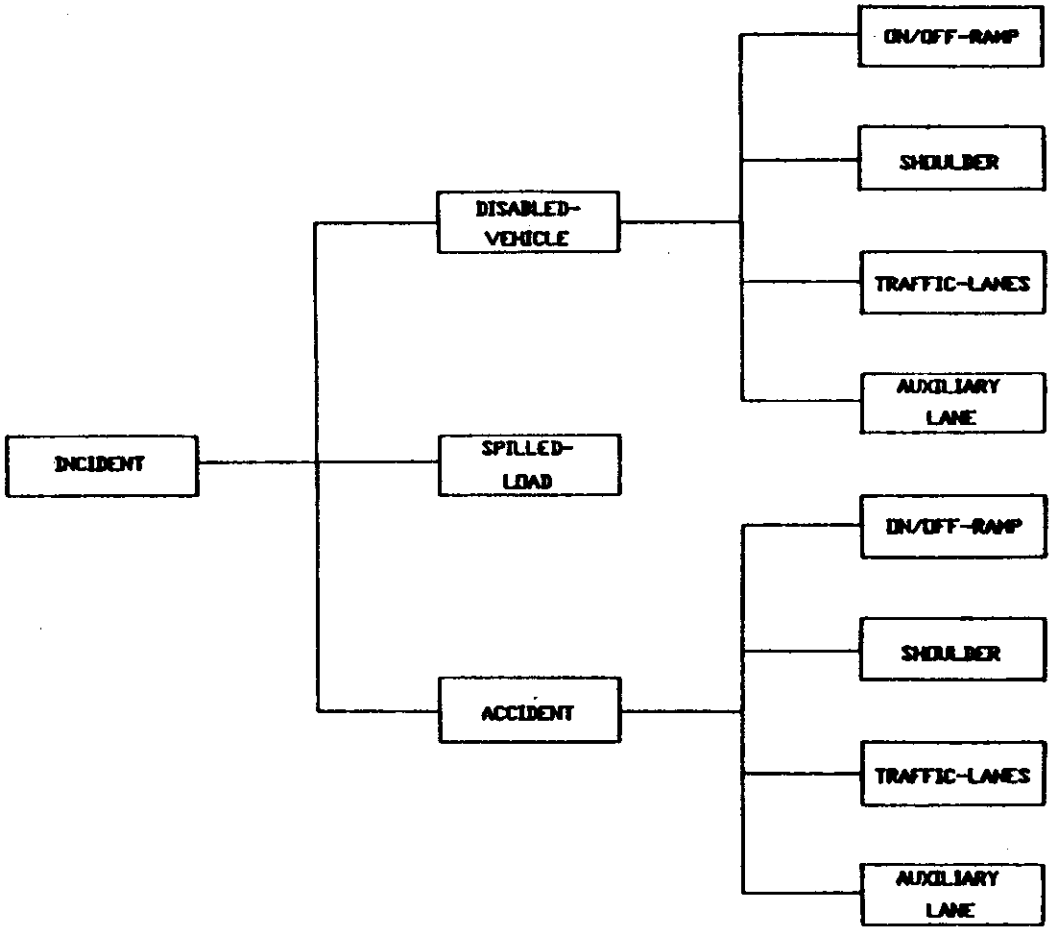

FIGURE 4 FRAME STRUCTURE Source (3)

loads; and these components are further subdivided on the basis of the location of the incident, such as in-lane, on/off ramp, shoulder, and auxiliary lane (3).

To be effective the database needs to be structured and organized for efficient search and application. Although most of the data is currently available, it needs to be represented and used in a form that can be used for "reasoning" in an expert system. Several standard techniques for organizing a database are available, the most common being the "rule-based" representation (3). In this representation, "rules" describe the logical relationships between parameters. In addition, they indicate what additional data needs to be added or deleted from the database.

5.2 Preparing an Incident Management Manual

At this time, incident management relies heavily on the experience of current agency managers responsible for response. When key individuals are not available, there are insufficient and imprecise established procedures in place to insure prompt action.

One of the most effective methods of formulating courses of action to assemble all available data, including policies and procedures, is to put together a loose-leaf guidelines manual. This incident response manual will include names, titles, work and residential phone numbers, and the geographical jurisdictions and responsibilities of all personnel connected with incident management, directly or indirectly. The manual would also contain maps of the area showing possible detour routing. The chain of command in case of an incident would also be included.

The manual would include what type of action would be necessary under a spectrum of incidents in varied locations. This inclusion would only be a first step. Ultimately it would be imperative to resort to a computerized system so that a dispatcher would go through a series of menus that would guide him/her through a step-by-step

process for contacts and response strategies, if and when a call came in regarding an incident.

5.3 Establishing an Incident Management Task Force

An incident management task force formed in cooperation with agencies such as WSDOT, WSP, and the Fire Districts is a logical way to formalize courses of action. They could initially meet bi-monthly or semi-annually to discuss concerns and objectives, to better coordinate each others efforts, to critique past incidents, and to update current practices based on new information and data. Again, the idea here is to bring representatives of various agencies concerned with freeway incidents together. The team would naturally be responsible for updating the loose-leaf incident management manual from time to time.

The core of the incident management team would consist of representatives from:

- Washington State Department of Transportation
- Washington State Patrol
- Spokane Fire Department
- Fire Districts 1, 3, & 10
- Department of Ecology

Other supporting participants would be included as needed.

The level of team members and their role in the team would be decided appropriately, as and when this project gets underway.

5.4 Adopting a Suitable Expert System

Ultimately, it would be desirable to computerize the system with the goal of having a system in place for incident response. This would involve mainly in systematically formalizing into a knowledge base the processes by which expert engineers and administrators interpret data in the context of incident management, determine a range of feasible strategies, and then develop and refine these strategies making

recommendations for optimizing the situation. This work will include the testing and selection of a suitable shell from among a range of products now available in the public and private domain.

As of this writing two examples of the application of expert systems to freeway incident management have been documented, although scores of applications across the county are in the works. The first such application is reported by the State of Texas, Department of Highways and Public Transport (SHDPT). Currently, several major districts of SDHPT are developing expert systems (7). The second application is reported by the Minnesota Department of Transportation. In addition, the California Department of Transportation (CALTRANS) operates the Traffic Accident Surveillance and Analysis System (TASAS) which has the capability of offering new dimensions through a knowledge-based expert system (8).

5.5 Summary

The structuring of the database, the preparation of an incident management manual, the formation of an incident management team, and finally the application of an expert system would enhance the value of the preliminary work described in the earlier part of this report.

6. RECOMMENDATIONS

In order to have an effective incident management plan, all agencies involved must be aware of each other's role, and how their expertise can best be used. Incident management is a difficult task because there are so many different agencies involved. It is therefore imperative that each agency know how each perceives incident management and how their ideas can be brought together to form an efficient team to handle incidents effectively.

It is therefore recommended that the following actions be taken:

1. Structure the database for coordinating and implementing incident detection, response, and clearance tasks. Identify and complete any missing data not gathered or developed in the initial project.
2. Prepare an incident management manual as described in the discussions. This will constitute a loose leaf information document enabling information/data to be added/updated on a regular basis.
3. Form an Incident Management Task Force comprising of members drawn from: WSP, WSDOT, DOE, fire districts, towing, and news media. The team would address specific actions to be implemented as suggested in Table 1.
4. Format the information/data for use in a Knowledge-based expert system. Choice of a suitable shell will be the important decision.
5. Adopt a knowledge-based expert system for the Spokane area.

7. IMPLEMENTATION

This research found that several incident management techniques are practiced by agencies in the Spokane area that reduce detection time, reduce clearance time, practice conventional on-scene management techniques, and utilize some of the conventional methods for informing the public. While the current system works fairly well in most cases, there is clearly a need for better communication and coordination amongst various agencies. Also, structuring the database together with proper formatting is necessary for use in a knowledge-based expert system.

A second phase of research is obviously necessary. The objective of this proposed research is: (1) to structure the database for implementing and coordinating action, (2) to prepare an incident response manual with all available data, (3) to form an incident management task force, and (4) to format the available data for possible use in a suitable expert system.

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APPENDIX A FAME Project Database

Accomplishment of this project required the collection and analysis of available data. Based on the analysis, additional information was developed for use in an incident response manual and KBES. Following is an inventory of available data that was either collected or generated by this project:

AVAILABLE DATA:

Accident History 1-1-83 to 6-30-88: This listing records all accidents reported within the project limits for the period listed. The report is sorted by mile post, by date, and by accident type.

I-90 Volume/Capacity Ratios and LOS: This information is generated for the years 1985, 1994, and 2010 and includes peak and off-peak volumes.

Traffic and Speed Data: Includes ADT's (1985, 1994, 2010), DDHV's.

Traffic Counts: Includes data from permanent recording stations located at MP 275.50 (Westbound and Eastbound) and MP 284.45 Havana Street (Westbound and Eastbound).

Washington State Patrol Notification Flow Chart: Includes contact list for incident management.

Department of Emergency Services Communication Diagram: Provides contact list for significant emergencies.

I-90 Study and Draft EIS for Four Lakes to Idaho State Line: These documents provide extensive information about existing conditions and future proposals for improvements to I-90 within the project area.

GENERATED DATA RESULTING FROM THIS PROJECT:

Accident rates for "severe accidents" and "total accidents" by mile generated from the accident history.

Maps of the Spokane Region that highlight the interchanges for better clarification of available access and potential for providing detour routes.

Listing of detour routes for both Eastbound and Westbound directions to reroute traffic around incident sites. Listing includes identification of the exit, segment road/street names, and distances for each segment.

Listing of utilities located within the I-90 right of way by mile post, description of utility, and utility owner. Telephone numbers are provided for each utility for emergency contact.

Contact list for agencies and organizations responsible for incident response.