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TRAFFIC MANAGEMENT AND PLANNING FOR FREEWAY EMERGENCIES AND SPECIAL EVENTS

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A REPORT ON A SPECIALTY CONFERENCE HELD ON JANUARY 13, 1985
PREPARED BY SAMUEL C. TIGNOR AND KAY COLPITTS

SPONSORED BY: COMMITTEE ON FREEWAY OPERATIONS,
COMMITTEE ON TRAVELERS SERVICES

OPERATION, SAFETY & MAINTENANCE OF TRANSPORTATION FACILITIES

GROUP 3 COUNCIL
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Foreword

Two TRB Committees, the Committee on Freeway Operations and the Committee on Travelers Services, jointly decided in 1984 that a specialty conference was needed to focus attention on the operational and management problems associated with freeway incidents and special events. A conference planning committee, co-chaired by Ronald C. Sonntag, Wisconsin Department of Transportation, and Samuel C. Tignor, Federal Highway Administration, organized the conference.

The objective was to create an understanding of the actions and planning that can be undertaken to reduce the impact of congestion due to freeway incidents and special events. The problems of such nonrecurrent congestion are not nearly as well recognized as the regular peak-hour congestion problems. Emphasis was placed on the discussion of (a) nonrecurrent congestion resulting from incidents and (b) the control of incidents and traffic generated by special events. The conference included technical presentations, group work analysis, and discussion of case studies involving freeway incident management.

Conference speakers included: E. N. Burns, E. N. Burns and Associates; S. C. Tignor, Federal Highway Administration; C. L. Dudek, Texas A&M University; J. M. McDermott, Illinois Department of Transportation; D. H. Roper, California Department of Transportation; H. E. Haenel, Texas State Department of Highways and Public Transportation; J. M. Barnett, California Highway Patrol; S. Z. Levine, Texas State Department of Highways and Public Transportation; B. W. McKay, City of Cincinnati (for T. E. Young); R. L. Freeman, Florida Department of Transportation; C. L. Kurtzweg, Washington State Department of Transportation; G. F. Paesani, Michigan Department of Transportation. In addition, three case studies were reviewed and discussed by attendees, after which the respective agency representatives presented the procedures that were actually followed.

This circular does not provide verbatim transcripts of the proceedings, because of the large number of presentations and the extensive informal discussion. It does provide a summary of the conference that should be of interest to practicing traffic engineers, high-level managers, administrators, elected officials, law enforcement representatives, and fire and rescue personnel who are in positions to influence program priorities.

SCOPE OF THE TRAFFIC PROBLEM GENERATED BY INCIDENTS AND SPECIAL EVENTS

C. L. Dudek, Texas A&M University

Introduction

Urban transportation is the movement of persons, goods, and services into, within and out of the urban area. Any system that provides adequate mobility for the compact concentrations of persons and goods within a relatively small area will necessarily be extremely complex. Urban mobility to a large extent depends upon the effective utilization of urban streets and freeways.

There are many events, however, that result in operational problems that adversely affect mobility and thus require our attention in order to preserve mobility. These operational problems are manifested in the form of recurrent and nonrecurrent traffic congestion, and congestion due to special events.

Recurrent Problems

Recurrent problems occur routinely during peak-periods when traffic demand exceeds capacity, even for relatively short time periods. Peak-period congestion occurs daily and is quite predictable in both effect and duration. This problem has received considerable attention during the past 20 years, leading to the development of freeway ramp control systems that have proved their effectiveness in reducing recurrent peak-period congestion. Freeway corridor control systems under development are expected to further improve conditions.

Nonrecurrent Problems

Nonrecurrent problems are caused by random, unpredictable incidents such as traffic accidents, temporary freeway blockages, maintenance operations, overweight trucks, etc. Environmental problems such as rain, ice, snow, fog, etc., might also fall into this category.

Accidents or other lane-blocking incidents on a freeway significantly reduce capacity. Freeway incidents occur randomly, are unpredictable, and result in congestion.

Although maintenance activities are planned by the operating agency, they are unexpected by the driver, and therefore the effects of maintenance lane closures can be as severe as accidents. Some maintenance activities require complete closure of a freeway section.

Overweight-truck accidents at underpasses not only damage the structures but also result in congested freeways, when maintenance on the damaged structures requires closure of freeway lanes.

When a major incident causes a bottleneck, significant freeway congestion results even though unused capacity may exist on parallel routes within the freeway corridor. Not all incidents result in significant delay; however, each creates queueing on the freeway, which can be a serious traffic hazard to uninformed motorists and may even lead to accidents.

Adverse weather conditions reduce capacity as well as create safety hazards. Occasionally, conditions may warrant partial or total closure of highway facilities. Major storms often require the movement of large numbers of people within relatively short time periods.

Special Events

Special events (e.g., ballgames, parades, etc.) often generate large volumes of traffic that are somewhat predictable in nature. Generally, congestion occurs on certain freeway segments at or near the generator. In many cases, alternate routes are available but are unused because drivers either are unaware of them or have no knowledge of the severity of congestion on their primary route to the special event.

Although the effects of many special events can be predicted by traffic planners from historical data and are expected by drivers who regularly attend the event, the congestion that develops is unexpected by drivers traveling to other destinations. Irregular event dates and variable starting times contribute to the driver's inability to predict traffic conditions.

Operational studies (1, 2) have shown that managing traffic during special events will result in extremely high payoffs in terms of reduced congestion and delay.

There are other types of special events that occur infrequently but have a profound impact on our transportation facilities. The Olympics or a world's fair are examples. Traffic control planning for these events is much more complex because no local historical data relative to these events are available to help the agencies involved with planning and traffic control.

Frequency and Characteristics of Freeway Incidents

Information on the frequency and characteristics of freeway incidents is documented in numerous reports (3-8). Studies of a 6-mile section of the Gulf Freeway in Houston (ADT = 120,000) revealed that approximately 13 lane-blocking incidents occurred per week between 6 a.m. and 7 p.m. (3). On the average, at least one major incident occurred per week from 6:00 to 8:30 a.m. on the inbound lanes of the freeway. Approximately 80 percent of the incidents reduced the directional capacity of the freeway by at least 50 percent. High rates of freeway incidents also have been reported by other authors.

The effects of a lane-blocking incident are significant. Goolsby (4) reported a one-lane blockage on a three-lane section of freeway reduced the capacity by 50 percent, although the physical reduction in usable lanes was only 33 percent. (Table 1). An accident that blocks two of three lanes (67 percent) reduces the capacity by 79 percent. The capacity reduction caused by a stalled car was found to be as great as that due to a lane-blocking accident.

The time of day an incident occurs is also important. For example, an incident occurring at the beginning of the peak period will cause more delay than one occurring at the end of a peak period. Figure 1 shows the periods of the day a typical six-lane (3 lanes inbound) urban freeway is susceptible to congestion due to an incident.

Another factor that influences the amount of congestion and delay that develops is the duration of the incident. The longer the duration, the more severe are the resulting congestion and delay for a given level of demand.

The consequences of incidents are congestion, delay shock waves in the traffic stream that lead to induced accidents, and other adverse effects. The following hypothetical incident on the inbound Gulf Freeway illustrates some of the relationships involved. It is assumed in Figure 2 that a stalled vehicle requiring police assistance occurs on a lane of the inbound Gulf Freeway at 7 a.m., the beginning of the peak period. The total delay that results is the area between the normal traffic demand curve and the capacity curve. When the stall occurs, the slope of the capacity curve drops, reflecting a reduction in freeway capacity from approximately 5,600 to 2,880 vph. The slope of the capacity curve returns to normal when the disabled vehicle is removed 18.3 min. later (the average duration for a stalled vehicle on the Gulf Freeway). This hypothetical incident would result in 800 vehicle-hours of delay and an average delay per vehicle of approximately 8 min.

These results show that the frequency and duration of incidents occurring on a freeway are primary factors in determining the operating conditions of the freeway. The more frequently incidents occur, the more frequently congestion will result. The longer the duration of the incident is, the more likely severe delay is to occur.

Accidents and stalled-vehicle incidents that require police assistance oftentimes block traffic for considerable time periods. Studies conducted by TTI (4) indicate that an average accident requiring police assistance takes 19 min. from the moment the accident occurs until it is removed from the freeway. An additional 25 min., on the average, is required to complete the accident investigation. [Figure 3 shows the duration of incidents observed on the Gulf Freeway. In earlier studies,] Lynch and Keese (9) observed that an average of 45 min. was required to remove damaged vehicles from the freeway when emergency vehicles were required.

Roadwork

Our highways require continuous maintenance in order to provide acceptable levels of service to the motoring public. Maintenance occasionally requires the closing of one or more lanes of the primary facility for long periods of time. Thus, while normal capacity on an urban freeway would be expected to be between 1,800-2,000 vphpl, roadwork reduces it to 1,200-1,500 vphpl depending on the type of closure (10).

Solution Approach

When an incident occurs on the freeway, the vehicles must be removed as quickly as possible, freeway demand must be intercepted before it reaches the reduced capacity caused by the incident, and the demand must be redirected to areas of available capacity in the freeway corridor. Additionally, from a safety standpoint, drivers approaching the queue area should be warned of the slow traffic.

Incident management 1) consists of the method to detect the incident, 2) offers a means by which the scope and needs are identified, and 3) provides the appropriate response to minimize the adverse effects of the incident. Corridor surveillance, control, and information is required to accomplish these objectives.

The surveillance function is required to 1) detect and evaluate the nature of the operating characteristics, 2) detect any unusual conditions, and 3) determine the appropriate operational control strategy. The control function provides the response in terms of incident removal, motorist aid, and adjustment to the traffic controllers located at freeway ramps and intersections along alternate routes that will accommodate the short-term changes in traffic patterns. Driver information systems perform a critical role in the successful operation of real-time freeway traffic control systems. They provide information that will enable drivers to select and follow the best alternative course of action, from rerouting through the corridor to diverting to another major facility.

Incident Detection

Vehicular incidents can be detected through

1. Electronic surveillance
2. Closed-circuit television
3. Aerial surveillance
4. Emergency call boxes
5. Emergency telephones
6. Cooperative motorist aid systems
7. CB radio, and
8. Patrol vehicles (police, mechanical service, maintenance.

Advantages and disadvantages of each method are discussed by Everall (11) and will not be elaborated on here. It is apparent that some methods provide better detection capabilities; others allow more detailed analysis of the scope and the required assistance. Cost-effectiveness analysis pursuant to the objectives of any proposed system would be necessary to determine the best approach or combination of approaches.

Incident Response

Response time. How quickly do we need to respond to an accident? The answer lies in the relationship between required response time and system designs. The speed of response is dictated in part by the objectives of the system. If the system is designed to warn approaching motorists of stopped vehicles on the freeway, then the response time must be short.

Response time includes the time required to detect the incident; it also includes dispatching assistance and removing the involved vehicles. Response time is dictated by the requirements of the system and consequently will affect the cost. A system objective to remove all incidents from freeways during the peak period within 10 min. after they occur will cost more than a system permitting a 20-min. response time. The relationship between response time and cost for alternative designs must be determined.

Type of Response. Incidents may be serviced by police and highway patrol vehicles, tow trucks, or state-operated maintenance vans. Normally, more than one department of an agency or more than one agency is involved. Successful incident management cannot be accomplished in isolation. It requires the full cooperation of several government groups.

Incident response also involves balancing traffic demands to the available reduced capacity due to the incident. Approaches to demand balancing include entrance ramp controls and motorist information. Real-time motorist information displays, which give motorists on-the-spot accurate and timely information, play an important role in achieving effective urban traffic management (12).

Advance Planning

Advance planning for handling traffic when emergency lane closures or freeway closures occur, when emergency environmental conditions dictate, or when special events occur is essential to the orderly movement of traffic. Adequate advance planning minimizes incident effects on highway traffic, and reduces the normal congestion that develops because of these incidents.

Summary

The scope of the problems relative to incidents, roadwork and special events has been briefly discussed. The following are a few challenges that, if considered, help ensure traffic management systems are implemented and operated with effectiveness.

1. What are the optimal system configurations for incident detection and response?
2. What are the trade-offs between response time and cost?
3. What are the total benefits of freeway patrols, call boxes, closed-circuit television, etc. and how do we evaluate these on a common basis so that alternatives can be considered from a cost-effectiveness standpoint?
4. What level of reliability can be expected from the various alternatives, and what maintenance problems and costs are involved?
5. How can government agencies and others establish priorities, plan, and coordinate activities for effective incident management?

References

1. Dudek, C. L., Weaver, G. D., Hatcher, D. R., and Richards, S. H. Field Evaluation of Messages for Real-Time Diversion of Freeway Traffic for Special Events. Transportation Research Board 682, 1978.

2. Dabney, J. C., and Dudek, C. L. Driver Response to a Highway Advisory Radio System in New Braunfels, Texas. Transportation Research Board 808, 1981.

3. Messer, C. J., Dudek, C. L., and Loutzenheiser, R. C. A Systems Analysis for a Real-Time Freeway Traffic Information System for the Inbound Gulf Freeway. Texas Transportation Institute, Research Report 139-5, April 1971.

4. Goolsby, M. E. Influence of Incidents on Freeway Quality of Service. Highway Research Record 349, 1971.

5. Goolsby, M. E., and McCasland, W. R. Evaluation of an Emergency Call Box System. Texas Transportation Institute, Research Report 132-IF, December 1969.

6. DeRose, F., Jr. An Analysis of Random Freeway Traffic Accidents and Vehicle Disabilities. Highway Research Record 59, 1964.

7. Kuprijanow, A., Rosenzweig, S., and Warskow, M. A. Motorists' Needs and Services on Interstate Highways. NCHRP Report 64, 1969.

8. Shufflebarger, C. L., and Bergsman, S. W. Shoulder Usage on an Urban Freeway. John C. Lodge Freeway Traffic Surveillance and Control Research Report, Study 417, January 1962.

9. Lynch, F. L., and Keese, C. J. Restoring Freeway Operation After Traffic Accidents. Texas Transportation Institute, Bulletin 28.

10. Dudek, C. L., and Richards, S. H. Traffic Capacity Through Urban Freeway Work Zones in Texas. Transportation Research Record 869, 1982.

11. Everall, P. F. Urban Surveillance and Control: The State of the Art. U.S. Department of Transportation, Federal Highway Administration, November 1972.

12. Changeable Message Signs. NCHRP Synthesis of Highway Practice 61. July 1979.

FILM: TRAFFIC MANAGEMENT FOR FREEWAY INCIDENTS

S. C. Tignor, Federal Highway Administration

As a further introduction to both the problem and solutions in traffic management a new film produced by the Federal Highway Administration was shown. This 17-minute film promotes the rapid removal of freeway incidents, and describes lower-cost solutions that highway, police, fire, and other local agencies can use to improve traffic management, safety, and control at incident sites.

While freeways account for only 2 percent of the total miles of highways, they carry about 26 percent of the total travel. In urban areas, freeway incidents are highly visible disruptions, and they typically account for one-half of all freeway congestion.

This 16mm film, which is also available in a videotape format, illustrates how a pre-planned, coordinated interagency approach between traffic engineers, police, fire, media, and other local agencies can be implemented quickly when the need arises. Traffic management approaches are illustrated for both simple and complex incidents. The film incorporates footage from Chicago, Minnesota, Los Angeles, San Antonio, and other locations. The film is of interest to Federal, State, city, and local traffic engineers.

INCIDENT DETECTION AND RESPONSE

J. M. McDermott, Illinois Department of Transportation

The occurrence of traffic incidents on urban freeways presents a most challenging problem to operating agencies. Such incidents vary in severity and nature, and occur on a random basis at any time and any place. Lane-blocking accidents should be detected as soon as possible to effect vehicle removal and restoration of traffic service. Other incidents, such as the motorist with a disabled vehicle, are more subtle. Depending on when, where, and under what circumstances they occur, they may or may not be hazardous situations for other motorists.

To indicate the frequency of incidents on the 135-mile Chicago area freeway system, a daily average of 43 police accident reports were produced in 1983. The Illinois Department of Transportation emergency traffic patrol fleet averaged 203 assist reports (mostly for disabled vehicles) per day in that same year for the most heavily traveled half of the network.

The need for detecting and handling freeway incidents is most critical where the motorist in trouble can cause serious traffic and safety problems, due to roadway geometrics, traffic characteristics, and/or isolation from self-helping techniques. In fact, it is the nonrecurrent congestion caused by the incident that, in many cases, triggers the response mechanism. The objectives of detecting incidents can be stated as: 1) to initiate the earliest response and removal of the incident to keep traffic moving; 2) to aid motorists in trouble; and 3) to reduce the impact of temporary hazards.

One of the methods for detecting incidents is electronic surveillance. This technique typically uses induction-loop vehicle-presence detectors imbedded in the pavement at points along roadways to monitor traffic flow characteristics. In the Chicago area, detectors are provided in each lane every three miles along the freeway. Flow is also sampled in one of the center lanes at half-mile intermediate points. All ramps are monitored to produce a closed subsystem every three miles. The actual field location of detectors usually depends upon the availability of utility service, usually readily available around urban interchange areas. All surveillance (and control) points in a particular service area are brought to a roadside cabinet, through aerial or underground interconnect systems.

Each roadside cabinet contains detector amplifiers, power supplies, and telemetry equipment for coding detector signals onto leased telephone lines, or other interconnect modes. The interconnect lines transmit detector signals to the Surveillance Center, located centrally to minimize communications costs. The tone telemetry equipment in the Surveillance Center decodes and identifies each detector signal and interfaces each pulse into a known position in the surveillance computer.

The surveillance digital computer continuously scans the status of each traffic detector at regular intervals, such as 60 times a second. Since all detectors are of the presence type, for each scan the computer interrogates the binary status of each detector: "YES" or "NO," is there a vehicle present or not? By keeping track of the changes of state from "YES" to "NO" and back again, the computer records vehicle detection data and calculates the traffic flow characteristics for each detection point.

When presence-type detectors are used, the basic measurement at each surveillance point is lane occupancy: the percentage of time the detection zone is occupied by a vehicle. The loop detection equipment for measuring lane occupancy also produces lane volume. Although speed is not measured directly, unless a pair of loops are used to form a short speed trap, speed can be calculated from the lane volume and lane occupancy by assuming an average vehicle length for vehicles in the particular lane.

Lane occupancy is a convenient measurement since it is a summary parameter that includes all the basic aspects of the traffic stream. It considers the volume, the speed, and the composition (vehicle lengths) of the traffic stream as a whole. Lane occupancy can range from 0 percent, when there is no traffic present, up to 100 percent, when there are vehicles continuously in the zone of detection. There should always be some traffic, even at 4:30 a.m., such that the normal operational range is above 0 percent. It is rare to reach 100 percent lane occupancy, even under stoppage conditions, since there are always gaps between vehicles and some movement of the traffic stream.

Lane occupancy gives an indication of traffic stream operations at each detection point. With detectors along each freeway roadway at regular intervals, sampling the flow at points along the route gives an estimate of overall system operations. Typically, optimum peak-period flow occurs with a lane occupancy of 20 percent, where traffic speeds near the speed limit coincide with the highest flow rates. Occupancies less than 20 percent indicate flow generally near the speed limit; the corresponding volumes represent traffic demands ranging from zero up to the maximum. This 0-20 percent range of flow conditions is referred to as "GREEN" or "free flow."

In order to sustain the ideal rush-period 20-percent lane occupancy, 80 percent of the traffic stream must have large enough gaps to keep vehicles moving at high volume and high speeds. Although volume can maintain its maximum throughput, and increase in lane occupancy from 20 percent to 30 percent causes speed decreases due to fewer and shorter gaps, the increasing difficulty of lane changing, and more restrictive flow conditions. These 20-30 percent flow conditions are referred to as "YELLOW" or "impending congestion." In excess of 30 percent lane occupancy, traffic flow conditions are referred to as "RED" or "congested." Speeds continue to degenerate, with volume also decreasing from the maximum. In this "RED" zone, the higher the lane occupancy, the worse the situation. Lane occupancy at the high end of the scale indicates serious serious operational problems, i.e., an accident, a disabled vehicle, or other obstruction to the traffic stream. A major incident would produce very high "RED" conditions at upstream detectors, and the downstream detectors would show very low "GREEN" conditions, indicating the location of serious trouble somewhere between the two condition points.

The "GREEN-YELLOW-RED" zones of operation are used as a convenient on-line expressway surveillance output. The central computer system is used in real time to operate map displays showing the "GREEN-YELLOW-RED" zones along each roadway. The map display gives a quick overview of current operations for an entire instrumented route. In off-peak periods, all roadways should be operating in the "GREEN" zone. Any exceptions are clues to freeway incidents requiring response. In rush periods, a normal pattern of congestion is expected at recurrent bottlenecks. Abnormal patterns help locate operational incidents. Sometimes an incident in one direction can produce flow disruptions in both directions, through the "gaper's block" phenomenon, and help pinpoint problem locations.

Although traffic status displays are monitored by operational personnel, further traffic data, both current and prior, can be retrieved for analysis, by using CRT devices and printers. Automatic incident detection uses the computer to analyze data and signal the occurrence and location of a traffic incident. Computerized incident detection logic attempts to automatically detect incidents with: 1) the highest possible detection rate; 2) the fastest possible response time; 3) the lowest possible false alarm rate; and 4) the minimum manual input. Most logic uses traffic pattern similarity to find significant differences in traffic flow characteristics between adjacent detector stations.

Once the location of an incident has been signaled, it is necessary to find out what the incident is. This can be done by dispatching a standby response vehicle, or a patrol vehicle, or additional electronic surveillance can be used to inspect the nature of the incident. Ground or aerial closed-circuit television could be provided for visual verification of the incident and its problems. With TV cameras to transmit incident pictures back to the traffic management center, personnel can make incident-handling and traffic management decisions.

Roadside motorist aid phones, call boxes, organized Citizen's Band radio networks, motorists with cellular telephones, and various mobile radio-equipped vehicles have been used to help detect and verify traffic incidents. Roving service patrols and police patrols are valuable for providing incident response services.

Selective remote monitoring of CB units stationed at regular roadway intervals is also useful. When combined with electronic roadway detectors, the nearest CB station can be dialed up upon suspected incident detection to selectively listen (only) to conversations on Channel 19. The local CB information is used to verify the nature and details of incidents, with the information increasing as the severity of the traffic problem increases.

Regardless of the incident detection and verification technique used, operating agencies must be prepared with people and equipment to initiate the proper response. This requires communications systems and facilities between all units involved, definition of agency responsibilities, coordination of response activities, and considerable advance planning for handling the range of incidents that occur.

One method for handling incidents is a fleet of service patrol vehicles, either publicly or privately operated. By providing these vehicles with trained drivers, radios, and the proper equipment, most minor and some major incidents can be handled soon after detection. Essential equipment needed includes gas cans, water cans, pressurized air tanks, fire extinguishers, first aid kits, various tools, jacks, brooms, and so forth. Tow rigs are useful for relocating vehicles (and other items) to sites not interfering with traffic flow. Towing is usually for a very short distance; towing to garages or service stations is the responsibility of the vehicle owner, once an initial relocation has been made.

The establishment of traffic regulations is essential to permit operating agencies to remove vehicles from traveled lanes. The use of inconspicuous accident investigation sites is one method for relocating minor accident vehicles.

Without a special patrol or response force, minor incidents are usually handled by nearby commercial operators, upon notification by police or highway agencies.

For major incidents, special units and equipment become involved when called upon. Jackknifed or overturned trucks may require several tow units or heavy wreckers. In many truck incidents the truck load may also need removing from the roadway. Sometimes the load may be salvageable by having highway maintenance workers remove it to a storage site where the owners can claim it upon reimbursement of incident damages and cleanup costs.

Spilled loads can be bulky, troublesome, and very time-consuming to clean up. Some incidents may force closing lanes or whole roadways for several hours, such as for hazardous material spills or flooding conditions. Fire units may be needed for fires or spilled gas washdowns. Some incidents requrire fire, police, towing and ambulance units, as well as cleanup forces and equipment.

To reiterate, the important points in managing incidents are providing people and equipment, communications facilities between all units involved, definition of agency responsibilities, coordination of response activities, and advance planning for all types of incidents that could occur.

For many incidents, considerable effort is needed to control traffic safely and efficiently. Timely and well-planned responses keep roadways operating at the highest reduced capacities circumstances permit. Diversion measures and pre-planned detours may be needed for any major long-lasting incidents. And, finally, incident information should be broadcast to the public to help manage the traffic approaching or planning to use roadways tied up with incidents. The shifting of vehicle trips to other routes, to other modes, or to other time periods, helps relieve traffic pressure at the incident site. Radio and TV traffic reporting, changeable message signing, and highway advisory radio can be used by the operating agencies involved.

ROUTE DIVERSION PLANS AND FREEWAY INCIDENT MANAGEMENT TEAMS

D. H. Roper, California Department of Transportation

Once an incident has been detected, steps must be taken to deal with the problem -- to remove the obstructions as quickly as possible, to restore roadway capacity, to detour traffic as needed, to keep the motoring public informed of the situation. In short, the incident needs to be managed to minimize delays to traffic.

It is essential that advanced planning for incident management take place. Detour plans need to be developed, teams need to be organized, equipment assembled, and procedures established. These all need to be in place in order to respond quickly and effectively.

Virtually every segment of the freeway and street system should be closely analyzed to determine how traffic will be diverted, and to which surface streets it will be detoured. Working together, the State and local enforcement and traffic engineering agencies need to examine such things as diversion routings, signal timing, manually controlling intersections, and parking restrictions, and to develop a plan to handle detoured traffic. As a part of this planning phase, it is essential that involved agencies "buy in" to the plan, and commit to implementing their portion of the overall plan when the need arises. Periodically, these plans need to be reviewed and updated as street patterns and traffic conditions change.

Many agencies are (and should be) involved in managing most incidents. To be effective, a team approach is essential -- and organization of the teams and development of procedures and working relationships is vital. At every major incident, enforcement, traffic engineering, and highway maintenance agencies are invariably involved; these agencies, then, become the nucleus of the team. Other agencies -- fire, ambulance, tow truck, toxic materials control, etc. -- then join the team as called for by conditions at any particular incident.

The team has the responsibility to assess the situation at each incident, and, using the advance-planned alternate route map and the collective expertise of the various representatives, to make decisions on precisely how the incident should be handled: where traffic will be detoured, how and when the wreckage will be cleared, how and when repairs to the roadway will be made, when roadways can be partially opened, etc. Each agency can then carry out its part of the overall plan.

Experience in the Los Angeles region has demonstrated clearly the value of establishing an on-site command post for the team. Each agency involved assigns a representative to the command post; in this way, the individual actions can be blended together into an overall, coordinated incident management team.

The primary responsibility of the Caltrans traffic engineer team member is to expedite the safe and orderly movement of traffic through and around the incident. As a first step, he will take a lead role in determining the alternate routes to use; he then carries much of the responsibility to implement the selected detour plan. Appropriate barricading must be placed, changeable message signs (both truck-mounted and stationary) need to be activated to divert traffic, signs need to be placed along the detour to reassure motorists, and intersection controls must be implemented. Traffic conditions then need to be continuously monitored, and appropriate adjustments in the plan made, if needed.

In Los Angeles, the Caltrans/Highway Patrol traffic operation center becomes a key tool in managing traffic at the incident. Traffic conditions on the freeway system are monitored and relayed to the team, changeable message signs to support the incident management plan are activated, traffic advisories are sent to radio stations for broadcast, and helicopter surveillance of the incident site can be initiated.

As a final step in managing any particular incident, a critique of the operation is conducted. Deficiencies in the "system" are noted, and steps are taken to strengthen techniques. Adjustments are continuously made to improve incident management capabilities.

The same kind of incident management can be effectively used at "planned" incidents -- major events attracting large crowds, recurring spot congestion locations, and construction/maintenance activities. Use of many of the same techniques and procedures (teams, alternate route plans, diversion, etc.) can produce significant reduction in delays that result from these events.

Incidents on the freeway system cannot be eliminated; nor can the delays associated with those incidents. Delays and secondary accidents due to congestion <u>can</u> be markedly reduced, however, using well-thought-out, proven incident management techniques. That's exactly what's happening in Los Angeles -- and it's paying off.

TRAFFIC MANAGEMENT TEAMS

H. E. Haenel, Texas State Department of Highways and Public Transportation

Introduction

What is a traffic corridor? This question was asked of traffic engineers, police officers, and transit personnel at a Corridor Management Team Seminar in Texas. After considerable discussion, it was agreed an urban traffic corridor consists of two or more arterials that move people and goods between two points. Traffic corridors may cross each other and can change with time. Corridors can be either freeway corridors involving a freeway and one or more parallel streets, or street corridors consisting of two or more streets with the same basic origin and destination points.

Transportation is this country's lifeline and the urban freeway and street network is an important part of this lifeline. Mobility assures continued economic benefits for the urban area. The lack of mobility causes an economic loss to the community through increased accidents, motorist delay, fuel consumption and vehicle wear. Delay is a direct cost for added time needed for people to make appointments, provide services, and deliver goods. The Houston Chamber of Commerce estimated that delay due to lack of mobility cost the citizens of Houston $1.9 billiion during 1981.

Limited funds and rights-of-way encourage the highest and safest utilization of freeway and urban street corridors in urban areas. This can often be achieved through nominal-cost improvements having high benefits. Operational improvements include High Occupancy Vehicle (HOV) operations, ride sharing, staggered work hours, adequate police enforcement, and traffic handling. Physical improvements include geometric, traffic signal, and freeway control and surveillance along corridor arterials and retiming and rephasing of traffic signals. Benefit/cost ratios from 5/1 to 16/1 have been obtained from geometric improvements, freeway control and surveillance, and traffic-responsive signal systems.

Achievement of improved operations and safety has been difficult due to the number of agencies involved (e.g., city, county, state, and transit authority) and the number of organizations within these agencies (e.g., traffic, public works, and police for cities and traffic, maintenance and design for states). Too often, funds from the various organizations have been fragmented into uncoordinated improvements resulting in reduced overall benefits. Also, the movement of traffic around major incidents and maintenance and construction activities has been frustrating to the motorist due to lack of coordination. It is possible to achieve a better and safer operating corridor network by using the corridor traffic management team.

Purpose and Organization of Corridor Management Teams

The corridor management team (or traffic management team as it is also called) has the basic purpose of optimizing the movement of persons and goods within urban areas. Its objectives are achieved by: 1) improving communications, cooperation, and coordination between agencies; 2) utilizing available multi-agency traffic operations expertise and finances to obtain benefits to the road user; and 3) managing traffic along corridors. These objectives are accomplished through members of the agencies actively working together in a team effort. In Texas cities with metropolitan areas of 300,000 and more, the teams normally meet on a monthly basis to work at, and discuss progress and needs for solving problems between these meetings. Of the 10 corridor and traffic management teams in Texas, seven have metropolitan area populations of 300,000 and above. To be successful the teams must meet regularly at a set date and time and the same team member (no substitutes) must attend the meetings.

The teams consist of personnel who can speak with organizational authority and who can agree to improvements requiring personnel and financial help. The team members are not the top administrators for the agency but are persons involved with the responsibility of carrying out activities assigned to them by the administrator.

The team improves communications between agencies and accumulates expertise and knowledge for studying problems from different points of view. Enforcement officers, for instance, may see operational problems from different perspectives than traffic engineers. When an enforcement agency has to give too many tickets to enforce traffic control, there is probably something wrong with the traffic control and/or the design. The enforcement team representative often can make a practical suggestion based on observation of traffic and on experience from past solutions to similar problems.

In Texas, the teams are not all alike as to representatives. As shown in Table 1, they vary in size and representation from three members to twelve members with an average of six members. Normally, teams should be kept small in membership (e.g., 5-7 members) with guests invited to attend meetings on subjects involving their organizations (e.g., planning, satellite cities, railroads).

Team Activities and Applications

The teams are involved with the planning and review of traffic operations and safety. Typically, team activities include:

1. Analysis of traffic conditions along corridor arterials and/or at isolated problem locations, with special attention to locations with congestion and high accident rates.

2. Development of improved design for congested and high-accident locations through utilization of agency personnel. (This can also include increased enforcement.)

Table 1 - List of Agencies Represented in Teams

	District									
	2	3	5	6	12	14	15	16	20	24
SDHPT										
Traffic	X	X	X	X	X	X	X	X	X	X
Planning		X	X						X	
Maintenance	X							X		
Design	X									
CITY										
Traffic	X	X	X	2	X	X	X	X	X	X
Police	X	X	X	2	X	X	X	X	X	X
Transit	X				X		X			
Public Works					X					
Fire					X					
Department of Public Safety		X		X	X			X		
COUNTY										
Engineer				X	X		X	X		
Sheriff		X			X			X		
Commissioner		X								
OTHER										
Naval Air Station										
Traffic Safety Association					X					
Railroad Association					X					
Trucking Association					X					
Total Team Members:	6	7	4	7	12	3	5	8	5	3

District/Major City

2	Fort Worth	14	Austin
3	Wichita Falls	15	San Antonio
5	Lubbock	16	Corpus Christi
6	Midland & Odessa	20	Beaumont
12	Houston	24	El Paso

3. Traffic management planning for major incidents along freeways and major arterial street corridors.

4. Traffic management for special events and inclement weather conditions.

5. Traffic management, through and around construction work zones and during maintenance operation activities.

Examples of general team activities are listed in tabular form in Table 2. Specific examples from four teams are given below:

1. Beaumont is a seaport for petroleum products and agricultural goods. It is also the county seat for Jefferson County and the largest city in southeast Texas outside of Houston, with a metropolitan area population of 345,000. In the past, unfamiliar truck drivers entering the city would have to find their own way to the port area over city streets, which caused considerable congestion. Also, trucks carrying petroleum products over I-10 to the port and along city streets have been involved in major accidents.

   The team developed a truck route using as much of I-10 as possible to the port area. Further, the team developed a design for a Highway Advisory Radio Station (HAR) along I-10, which was installed by the State Department of Highways and Public Transportation (SDHPT) and which is operated by the fire department on a

24-hour basis. The HAR is also used to advise of maintenance activities along I-10 and to provide route information for motorists traveling to the Jefferson County Fair each year. The system has worked quite well.

2. San Antonio was the first city to organize a corridor management team in Texas. The city has many narrow streets and numerous freeway sections that had reached capacity conditions prior to the organization of the team. Several special sports and fiesta-type events occur during the year. (One fiesta event lasts a full week.) The team has developed and implemented plans for routing visitors to these special events. This includes a shuttle bus service from designated park-and-ride lots as well as the installation of temporary signs along the freeway for directing traffic to park-and-ride lots and to the location of the event. The team also developed a freeway ramp metering and ramp gate control system design that ensured diverted traffic would not congest the existing corridor streets. In addition the SDHPT has revised freeway ramp locations and replaced existing traffic signal controllers at freeway frontage road-cross street interchanges with newer controllers in order to improve traffic operations.

3. Fort Worth is the western portion of the Dallas/Fort Worth Metroplex of 4,000,000 people. Fort Worth has a population of over 400,000 with a growth of 10 percent per year. The Fort Worth team has been active in managing traffic along freeway corridor arteries and to and from the freeway system along transversing corridor streets. Also, the SDHPT is designing freeway frontage road-cross street interchanges to operate efficiently for 20 years after reconstruction of the freeway has been completed. This has included a study for improving the frontage roads and city streets within each corridor, based on present and projected 20-year traffic volumes. Also, the city is developing plans for the future freeway traffic management system. The SDHPT District personnel have developed a 20-year plan for areawide freeway traffic management. This plan includes HOV priority operations. Much of the development of these plans along with the analysis of the freeway construction traffic control plans has been carried out and/or reviewed by the team. Close coordination of the city traffic signal system design and the freeway traffic management control system design has occurred because of the cooperation achieved through the corridor management team.

4. Houston has a population of 1,600,000 and a metropolitan area population of over 3,000,000. It is the third largest seaport in the United States. Because of the port and other commercial activities, the team includes representation from the railroads and the trucking industry. The large number of railroad grade crossings has caused congestion and made it difficult for buses to maintain their schedules. The team has been active at reducing the time crossings are blocked, which has improved mobility and allowed buses to meet their schedules.

The team has coordinated activities to improve traffic operations and safety around and through construction and maintenance work zones. It also has worked to advise motorists of alternate routes available in traveling to the Astrodome events.

In order to improve mobility along the U.S. 59 (Southwest) freeway corridor, existing ramp metering control has been extended, a freeway-to-freeway interchange design improved through use of narrow lanes, and a corridor street (Westheimer) restriped from six 12-foot-wide lanes to eight 9-foot-wide lanes.

Because of the team activities, it has been possible for the Houston Metropolitan Transit

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Table 2 - Examples of Traffic Management Activities by Corridor (Traffic) Management Teams

1. Special Events
   a. Houston - Traffic handling for the Astrodome
   b. Beaumont - County Fair - used HAR and portable signing
   c. San Antonio - Traffic handling for four types of events:
      1) Fiesta events
      2) Texan culture events
      3) Football games
      4) County livestock shows

2. Freeway Reconstruction and Maintenance
   a. Houston - Review construction and maintenance needs and manage traffic during activity:
      1) Traffic Control Plans
      2) Maintenance Operations
   b. Fort Worth, San Antonio, and Corpus Christi - Review major construction needs and coordinate traffic handling.

3. Major Incident Management and Inclement Weather
   a. The teams are working on developing traffic management during major incidents, past incidents are discussed and improved operations plans developed.
   b. San Antonio - Reviews its Ice Plan each year and develops an implementation procedure for all agencies to follow.
   c. Corpus Christi - Evacuation plan when a hurricane occurs.

4. Traffic Management
   a. Citywide freeway-city system is being developed in Fort Worth
   b. Eight freeway corridors in Houston - Plans and Specifications being developed and installation underway on two freeways.
   c. I-10 - I-35 corridor in San Antonio - Plans and Specifications being developed.
   d. I-10 in El Paso - Freeway corridor system being developed and implemented.
   e. Freeway corridor system being developed and implemented in Corpus Christi.

5. Metropolitan Traffic Management
   Conferences are being held in Amarillo, Arlington and Houston to develop improved coordination between central and satellite cities, the SDHPT and the Metropolitan Transit Agencies and to work toward improved traffic operations and safety with Metropolitan areas. Also, Traffic Management Seminars are held each year to permit members of the teams and representatives from other cities involved in traffic operations and safety to share their experience.

Authority (MTA), City of Houston, and SDHPT to work together closely in developing traffic surveillance control and communications (SC&C) systems for eight freeway corridors. This will include Authorized Vehicle Lanes within the freeway median areas, freeway control and surveillance, and frontage road and corridor street traffic-responsive traffic signal control along each corridor.

Conclusion

Corridor (Traffic) management teams can be of benefit to many cities. Over half the population in the United States lives in 39 metropolitan areas of over one-million population. Also, 90 additional metropolitan areas have populations between 300,000 and 1,000,000.

Corridor (Traffic) management teams have proven to be very useful in increasing communications, cooperation, and coordination; they have also permitted cities to focus on problems with the combined expertise and funding capability of the many governmental and public transportation agencies involved in traffic operations within the urban area.

Carl Braunig, the former traffic engineer (now retired) in San Antonio, once said that the Corridor management team reminded him of a popular beer advertisement that read "Try It, You'll Like It." Carl said he tried the Corridor management team and sure enough, he liked it. Why don't you try it; you'll like it, too.

POLICE PERSPECTIVES ON TRAFFIC MANAGEMENT OF FREEWAY EMERGENCIES

M. J. Barnett, California Highway Patrol

As the state's primary traffic law enforcement agency, the California Highway Patrol is responsible for providing traffic services to 23 million residents on over 96,000 miles of highways. In addition to traffic management duties such as routine patrol, emergency incident response, assistance to motorists and accident investigation, the Department also has responsibility for the regulation of hazardous materials transport, auto theft investigation, emergency medical services, and dignitary protection services. The State Legislature has designated the Highway Patrol as scene manager for any hazardous material incident occurring on highways under its jurisdiction. The Department also serves as the Statewide information, assistance, and notification coordinator for all hazardous material spill incidents occurring on highways and functions as State Agency Coordinator for highway spills.

The 16,000,000 motorists and complex roadway network in California make it imperative that freeway emergency incident response planning be effective and comprehensive. Comprehensive planning efforts are essential in each of the following areas in order to ensure successful management of freeway emergencies:

- Timely Response
- Scene Management
- Traffic Coordination
- Multi-Agency Communication and Coordination
- Training

Each of these areas is vital to the successful management of emergency incidents, from the most basic fender-bender to the most complex and disastrous major collision or hazardous materials incident. One of the most important considerations in planning efforts is the containment of any incident, since adequate preparation can prevent the escalation of any occurrence into a major problem.

Timely Response

Timely and appropriate response to freeway emergencies is the first step in getting the scene under control. Procedures should be established to ensure all requests for ambulance, rescue, and other emergency equipment are responded to immediately by the appropriate agency. Dispatch of personnel and equipment should occur immediately upon receipt of reasonable information that a particular need is present. It should be the responsibility of the scene manager to assess response needs and adjust resources accordingly.

Scene Management

Scene management implies general and comprehensive oversight of all operations that occur at the location of an accident or emergency incident. The scene manager assesses the scene and determines what needs to be done; i.e., parking of emergency vehicles, priorities of conflicting tasks, opening and closing of roadways, etc. Responsibilities include:

- safeguarding those at the scene, the motoring public, and all other potential victims on or off the highway;

- maintaining an awareness of the potential danger to surrounding land, air, and water and considering what steps should be taken to mitigate that danger;

- managing operations at the scene in a timely and professional manner.

CHP officers are directed to assume scene management responsibilities immediately upon arrival in order to alleviate confusion and increase effectiveness. Other response agencies are consulted at the scene to ensure proper utilization of resources.

Traffic Coordination

With respect to traffic coordination during emergency incidents, it is necessary that road conditions be properly evaluated and reported; that traffic control be initiated immediately to eliminate danger to emergency response personnel as well as to motorists; and that procedures be established to prevent unauthorized entry into the incident scene. The scene manager, in conjunction with other responding agencies, should determine the extent of needed traffic control; i.e., lane closure, freeway closure, rerouting of traffic onto local streets, etc.

Multi-agency Communication and Coordination

Coordination of multi-agency resources can be accomplished through written statements of understanding and interagency agreements. Agreements should be formulated so that a clear understanding is established regarding each agency's organizational authority, areas of responsibility, and response and equipment capabilities. In addition, all procedures and operational capabilities of involved agencies should be publicized within each planning area, to ensure that all personnel are made fully aware of available resources and expertise.

Upon arrival at the scene of major incidents, the responding officer should establish a Command Post at the best location for observation of operations and coordination with other agencies. The Command Post can be identified by placing a distinctive flag on an enforcement vehicle antenna. The use of the Command Post as a central information source can reduce confusion and delay, and improve press relations and interagency communications.

One of the methods employed by the CHP to enhance its scene management capabilities is the use of Emergency Incident Management Vehicles (EIMVs). These vehicles are used to respond to emergencies caused by major traffic accidents, disasters, significant hazardous materials incidents, and similar major events. The vehicles, which function as a Command Post location, are fully self-contained motorhome-type vehicles, equipped with wall-mounted desks, a conference table, chairs, bookcases, and sophisticated communications equipment. Also included is an assortment of manuals and reference materials, a portable public address system, mobile telephones, modular telephones, and wind direction/speed indicators.

Training

Training is one of the key elements of emergency incident response, particularly interagency hazardous materials response training. The Department's training program includes emergency incident response, scene management, and after-incident follow-up for new officers, field supervisors and managers. The CHP also conducts hazardous materials spill training for cadets, in-service officers, and sergeants, as well as conducting a statewide interagency training program for California police and other first responders. This training was developed as three modules in order to provide differing levels of instruction for the various personnel who might be involved in hazardous materials incidents. Module I consists of an eight-hour basic awareness course and is geared for officers and sergeants. Module II is designed primarily for sergeants and concentrates on the specifics of on-site tactical problems. Module III is geared for command-level personnel and is an advanced course covering scene management, use of resources, planning considerations, and post-incident evaluations.

Emergency Incident Management

Of the various types of freeway emergencies handled by the Department, some require more extensive planning and coordination than others. Based upon interpretation of various statutes, the Highway Patrol defines "Emergency Incident" as any unplanned event that results in an interruption of traffic flow and causes actual or potential property damage, injury, or loss of life; and that necessitates the mobilization of various emergency service elements to alleviate the incident and restore order. This definition is used in all the interagency training conducted statewide to ensure uniformity. Major freeway accidents and hazardous material spills place the maximum demand upon Department and allied agency resources. However, all incidents are of concern to us, not only because of the possible injuries, loss of life, and property damage, but also because of the possibility of hours of freeway downtime. Lane closures can result in numerous hours of motorist delay, which can translate to a substantial cost to the public. For example, in a recently completed study, the CHP developed an estimate of cost per hour of motorist delay in Los Angeles, Ventura, and Orange Counties as of January 1984. The value of motorist delay is estimated at $8.83 per hour, with 1,300,000 estimated hours of motorist delay documented due to truck-involved accidents between January 1979 and May 1984. This totals approximately $11,500,000 lost to the public over the 65-month period.

San Ramon Hazardous Material Spill

The following is an example of a freeway emergency incident that occurred in California. The incident is described in detail; analyzed for appropriate response and handling; and discussed with respect to the operational problems that occurred.

The San Ramon Incident occurred at noon in September of 1981, on Interstate 680, a six-lane north/south freeway in Contra Costa County. The average daily traffic volume on this roadway is 91,000 vehicles. The area is moderately populated (Est. 693,670), with several communities including San Ramon adjacent to the freeway. At the time of the spill, a multi-agency preplanning effort was underway in the County, but had not been completed. This lack of a finalized Emergency Incident Plan contributed to the operational problems that occurred in handling the incident.

An agricultural checkpoint was being conducted in San Ramon on a random basis to check for possibly contaminated fruit being taken out of the area. As a vacuum tank truck pulled slowly through the inspection lane, two Department of Agriculture officers observed that it was leaking a liquid substance and emitting an orange-colored cloud from the rear of the trailer. The truck was stopped by CHP officers and the shipping manifest examined. It was determined that large quantities of extremely toxic and hazardous corrosive acids such as nitric, sulphuric, hydrofluoric, and hydrochloric acids were present, as well as acetic acid and several heavy metals.

As a result of the leak, a potentially lethal cloud began to spread toward a residential area about 0.4 miles east of the spill. Upon arrival of the CHP shift supervisor, a Command Post was established 0.4 miles south of the spill on northbound 680. Traffic control was established at major intersections, stopping or diverting vehicular traffic in the immediate area.

Because of the toxicity of the gas and the proximity of residential development, it was determined that the immediate area (one square mile) should be evacuated immediately. The evacuation was handled by the Contra Costa County Sheriff's Department at the direction of the Scene Manager. In addition to the CHP and Contra Costa County Sheriff's, 30 other agencies responded to or were involved in handling the incident. These agencies included the California Department of Transportation (Caltrans), police, fire services, hospital services, ambulance services, and hazardous material cleanup companies.

This incident illustrates many of the problems that can occur when preliminary planning for emergency incidents is incomplete. One of the major problems encountered was the organization of the evacuation by the Sheriff's Office. The area is primarily residential and contains several primary schools. However, neither the school district nor the county had conducted evacuation planning or training. There was no evacuation plan for the community as a whole or for the individual schools. This resulted in several mixups regarding who to notify and where the children and adults should go. Media reports of the incident added to the concern of parents who rushed to the school but were unable to locate their children. At one point, some of the children being evacuated were sent in the wrong direction, toward the poisonous gas rather than away from it. The evacuation site also was changed in the middle of the operation so many parents could not locate their children. In some cases, neighbors had already transported groups of neighborhood children but since no record was kept of which children were released or to whom, there was a great deal of confusion and concern by parents.

The media, in an effort to provide up-to-the-minute reports, obtained information from sources other than the Scene Manager. This resulted in the broadcasting of inaccurate information on several occasions. On-scene personnel also had difficulty controlling media access to the area, causing danger to media and emergency personnel, as well as creating interference with on-site operations. For example, at one point a media helicopter hovered directly over the tank truck in order to obtain better footage, thereby dispersing the gas into the Command Post area. The Command Post had to be moved to another location as a result. The Helicopter crew were overcome by fumes and made an emergency landing on the freeway, further adding to the emergency.

The following are some of the conclusions reached as a result of the after-action examination of the handling of the San Ramon spill.

Planning

The county did not have a finalized plan for handling hazardous materials spills. Evacuation plans were either nonexistent or incomplete, with no provision for specific evacuation sites. Self-contained breathing equipment necessary for the safety of emergency response personnel was not available. Methods to ensure collection of potential evidence had not been established, which could have created substantial problems in the event of any liability suits.

Timely Response

Response to the scene occurred within minutes of notification that a problem existed. Initial observation of the orange cloud and leak from the tank truck occurred at 1205 hours; the Command Post was established by the Scene Manager at 1232 hours. In the intervening 27 minutes, I-680 was closed; traffic control established; the Sheriff's Office, Caltrans, fire personnel, the county office of Emergency Services, IT Corporation (chemical spill identification and cleanup company), and additional CHP officers all responded to the scene; and air traffic control over the scene was established.

Scene Management

Scene Management was handled by the CHP shift supervisor. Command Post operations suffered from a definite lack of personnel and the availability of on-site communications capabilities. This could have been avoided through the use of the Contra Costa County Sheriff's Office communications trailer; however, due to lack of planning, there was no trailer hitch available to haul the trailer to the site until the incident was nearly over. Controlling some media personnel's access to the scene also proved to be almost impossible.

Traffic Coordination

Traffic control was established almost immediately, with the occurrence of only one minor problem. Due to a communications mixup, an officer assigned to control traffic left his post, resulting in traffic temporarily being allowed to move toward the Command Post location and past the leaking vacuum truck. This problem was rectified immediately and alternate traffic routes established and maintained throughout the incident.

Multi-agency Communication and Coordination

Allied agency personnel were available at the Command Post for immediate coordination with the CHP Scene Manager throughout the incident. Cooperation with involved agencies at the Command Post was excellent, as were communications between on-site personnel. However, there were problems with off-site allied agencies. Information was being disseminated through too many agencies, resulting in confusion and the release of erroneous information. The media, while a valuable resource for dissemination of emergency information, also caused confusion and created problems at the incident scene.

Management of reporters at the Command Post and the spill scene was a full-time job for the Contra Costa Area Public Affairs Officer (PAO). On several occasions, the PAO was required to respond to the spill scene, away from the Command Post, to instruct media personnel to evacuate the area. They had climbed over the perimeter fence, walked to the spill site, and were interfering with cleanup operations. In addition to creating a health hazard to themselves, others were placed in danger because of their actions.

In the temporary absence of the PAO from the Command Post, some media personnel removed their identification and milled around the Command Post, attempting to obtain current information. Command Post security was lacking.

Media helicopter involvement caused extreme danger to all on-site personnel. The Federal Aviation Administration, Buchanan Field, Concord, was advised of the problems being experienced and was requested to restrict all air traffic in the surrounding area. The media helicopters, in spite of FAA instructions, continuously flew above the spill scene. One helicopter circling the toxic cloud flew directly over the leaking tank truck causing downdrafts and blowing of the toxic cloud in the spill area while fire personnel were attempting to determine the exact area from which the vacuum trailer was leaking.

Training

At the time of the spill, Contra Costa Area personnel had completed the initial eight-hour hazardous materials awareness course. The second portion of the training, concentrating on on-site tactical management problems, had been planned but had not yet been presented. It was determined by the After-Incident evaluation that there was insufficient internal and external training in the management of a complex hazardous material spill incident. Since that time, the training situation has been rectified with the completion of the third portion of training for both Departmental personnel and allied agencies.

Summary

The successful management of emergency freeway incidents in California is dependent upon effective planning for use of multi-agency resources. Through legislation designating scene management responsibilities and through open communications between the CHP, Caltrans, and local fire, police, and other emergency response agencies, California has developed a high degree of cooperation in handling these incidents. The CHP and Caltrans meet regularly on an informal basis in order to resolve problems as they occur and to maintain clear lines of communication regarding multi-agency responsibilities. In addition, the statewide multi-agency training conducted by the CHP for police and fire personnel has contributed substantially to successful cooperation and coordination among responding agencies.

REAL-TIME TRAFFIC CONTROL FOR MAINTENANCE WORK ZONES

S. Z. Levine, Texas State Department of Highways and Public Transportation

Introduction

Between 1979 and 1981, the need for remedial work on Houston area freeways (particularly those over twenty years old with traffic volumes near 200,000 vehicles per day) increased markedly. Complaints from the public about traffic jams caused by such work led to one legislative suggestion that all freeway work in the Houston area be limited to night operations. This did not pass, but led to work zone operations being restricted to nighttime hours and weekends. It is during these time periods that speeds are high and the chance for errant driver behavior increases. In 1980 and 1981, 12 highway workers were killed and 34 injured while working on Houston's freeways. Most of these casualties were caused by drunk drivers and speeding motorists.

The Problem

With almost 600 miles of state-maintained roads in Harris County and work predominantly restricted to weekends, the rate of maintenance activity had fallen far behind the needed rate. This situation became increasingly critical with funding limitations and extensive red tape facing the initiation of major roadway rehabilitation efforts. In the spring of 1982, the State District Office decided a means for performing maintenance operations on even the highest-volume roadways during the previously restricted hours must be found. The objectives of this strategy were threefold:

1. Allow time for the needed remedial maintenance to be performed.
2. Insure worker safety.
3. Prevent intolerable delay to the traveling public.

Deployment of Special Traffic Handling Crew

Research studies have been conducted (2, 3, 4) on "traffic management type" capacity improvements for work zone operations. These have included the temporary use of shoulders as a travel lane, modifying intersection signal timing, encouraging traffic to divert to alternate routes, and closing entrance ramps within the work zone area. Some of these measures have been successfully implemented on major rehabilitation efforts on the Edens Expressway in Chicago and the Gulf Freeway in Houston. However, these techniques have been used only on a limited basis for short-term operations.

A specially trained crew was formed and assigned the task of handling traffic during maintenance operations on high-volume roadway pavements, thereby increasing the hours available for maintenance activity. The crew has the authority and capability of implementing proven work-zone traffic management techniques (in a manner consistent with the "Manual of Uniform Traffic Control Devices"). A major advantage of the special crew is its ability to actively manage traffic during the maintenance operation.

Prior to this, a traffic control plan was prepared based upon traffic flow-rates through a proposed work zone. The traffic data indicated the number of lanes needed to minimize motorist delay. Shoulder signing would be deployed at the outset of the operation and remain until the operation was complete.

With the special crew, the traffic control plan would be modified to react to changing traffic conditions. Excessive speeds adjacent to and in the work zone is a contributing factor to accidents. The use of the shoulder to provide additional capacity at work sites may actually contribute to speeds higher than desirable during "lulls" in traffic and thus compromise worker safety. The crew could react to this situation and "turn off" the shoulder-use signing, thus lowering speeds. This method of handling traffic has been termed "Active Traffic Management."

The District Office tried the special crew concept on an experimental basis. An urban freeway in Houston carrying 175,000 to 200,000 vehicles per day was badly in need of pavement repair and rehabilitation; but a major contract could not be let for several months. Some of the needed repairs were critical, but high traffic volumes precluded use of typical maintenance techniques. Interim repairs were needed and this site provided the first test for the special traffic handling crew.

Individuals experienced in traffic management techniques were asked to handle traffic while the interim maintenance was performed. A job of this magnitude normally would have required at least two months if work were restricted to Sunday mornings. Workload analysis showed that working Monday through Thursday during daytime off-peak hours for two consecutive weeks and one weekend would provide enough time to make the interim repairs. This schedule required three road-work crews to be available to work simultaneously. Motorist delay would be kept to an acceptable level under 20 minutes (5).

Specifically, the crew was responsible for the following:

1. Coordinating daily the scheduled hours and areas of work zone activity with the Department Public Affairs Section, who would disseminate the information to the public through press releases and radio broadcasts.

2. Coordinating with the City's Traffic and Transportation Department for aid in modifying affected intersection signal timings at city-operated signals on frontage roads.

3. Arranging for the use of Selective Traffic Enforcement Program officers for the project.

4. Actively managing traffic by using the shoulder as a travel lane; closing entrance ramps as required, and utilizing other "active" traffic management techniques.

The project was successful. On only one day did a long queue develop, and it was quickly dissipated when the special crew adjusted work-site traffic control. The "ultimate" measure of project success was achieved -- not one phone call of complaint from the public!

Managing Traffic During Special Sequences in Long-Term Construction Projects

Some construction sequences in freeway rehabilitation projects require closing of the freeway in one direction for 12 to 36 hours. By closing the freeway, sufficient work can be performed without endangering the workers. Tasks typically consist of the placement of concrete median barriers, striping placement and removal, and pavement repair.

Active traffic management permits the successful closure of lanes during the daytime weekday off-peak hours and also on weekends where volumes are high. An example of this took place on the Gulf Freeway. In order to place a concrete median barrier and restripe a section of this 75,000 ADT freeway, a freeway closure of 36 hours was needed during a weekend.

Traffic was detoured from the freeway onto the parallel three-lane frontage road. An exit lamp was temporarily modified to two lanes of capacity (which was never totally utilized). Traffic proceeded through at least two signalized intersections before being allowed to reenter the freeway. The signal timings at these intersections were modified by the City of Houston Traffic and Transportation Department and monitored by the City of Houston Police Department. The entrance ramp could not be modified to two lanes. Through the use of cones and the active presence of police officers, traffic in the middle and right lanes of the frontage road were directed to the next downstream entrance ramp.

Alternative routes also existed. An expansive public information program was executed to increase diversion. Static changeable message signs identifying these alternative routes were placed seven days in advance of the closure. On the day of the closure, the traffic control strategy was supplemented with electronic changeable message signs. In addition, a right-lane closure of the northbound Gulf Freeway was implemented at the I-610 interchange. This lane closure was three miles upstream of the start of the freeway closure setup, and was terminated 1500 feet downstream from I-610. However, the lane closure presented an impression of work zone activity in the area and did increase diversion to I-610.

Because of these measures, it was estimated that over 50 percent of the traveling public that normally would have used I-45 avoided this section on this particular day. Traffic delays never exceeded 10 minutes, which is an acceptable level.

With the contractor increasing equipment and manpower for this operation and the active traffic management strategies utilized, the work was accomplished in 12 hours, which was far less than the original 36-hour estimate. Again, no public complaints were received.

A second application of active traffic management to a construction sequence operation took place on I-10 (Katy Freeway). The ADT in this section was over 100,000. The principal difference between this operation and the one on the Gulf Freeway was the lack of a good alternative freeway route. The operation started at 10:00 p.m. on Saturday and extended to midnight on Sunday. By working during this time period, by executing an expansive public information program, and by actively managing traffic, the needed work was accomplished without incurring an intolerable delay to the motorists. A layout of the detour, which is shown in Figure 1, was circulated to the media.

Conclusions

Several conclusions can be drawn from the use of active traffic management in Houston:

1. Advance public information of impending work zone activity can minimize public complaints and erratic behavior by motorists.

2. The active presence of law enforcement officers in urban highway work zones can minimize erratic behavior by motorists.

3. Carefully planned "active traffic management techniques" can allow work zone activity to be done on high-volume urban highways during daylight hours without severely inconveniencing the traveling public and while providing protection to workers from errant motorists.

4. Cooperation with law enforcement agencies and other affected governmental agencies is a necessary part of the "active management strategies" employed.

References

1. Hauer, E., Ahlin, F. J., and Bowser, J. S. Speed Enforcement and Speed Choice. Transport Canada. ISBN 0-7727-7006-9. 1981.

2. Richards, Stephen H., and Dudek, Conrad L. Special Traffic Management Requirements for Maintenance Work Zones on Urban Freeways. Texas Transportation Institute. FHWA/TX-82/1+228-8. 1982.

3. Dudek, Conrad, and Richards, Stephen H. Traffic Capacity Through Work Zones on Urban Freeways. Texas Transportation Institute. FHWA/TX-81/28+228-6. 1981.

4. Dudek, C. L., Richards, S. H., and Faulkner, M. J. Traffic Management During Urban Freeway Maintenance Operations. Texas Transportation Institute. FHWA/TX-82/2+228-10F. 1982.

5. Huchingson, R. Dale, Whaley, John R., and Huddleston, Nada D. Delay Messages and Delay Tolerance at Houston Work Zones. Texas Transportation Institute. 1983.

6. Levine, Steven Z., and Kabat, Richard J. Planning and Operation of Urban Highway Work Zones. Presented at the Transportation Research Board Annual Meeting, January 1984.

TRAFFIC MANAGEMENT FOR SPECIAL EVENTS

T. E. Young, City of Cincinnati, Ohio

Background

This paper describes the conception, development, construction, and early operational experience with a freeway surveillance and control system on Interstate 75 and the downtown portion of Interstate 71, in Cincinnati, Ohio. (See Figure 1.)

The system was conceived early in 1967, as a part of the Cincinnati transportation, economic, and development goals to locate new sports stadiums near the central riverfront area within walking distance of the Central Business District (CBD).

The Cincinnati CBD is adjacent to the Ohio River; I-71 and I-75 use a common bridge east of the 100-year-old Suspension Bridge. The CBD also has virtually no usable street system for major traffic volumes and, while immediately adjacent to the freeway, it was served directly by only one exit and no direct entrances. In general, the transportation system in the CBD is geographically constrained and has continuing problems because of growing demand. Special events in the CBD further exacerbated difficult traffic management problems.

A freeway surveillance and control system was developed to advise motorists of the traffic and parking conditions in the stadium area on occasions of stadium events, and alternate exits to use for downtown parking when stadium parking was filled. Initially, $1,000,000 was appropriated, upon the recommendation of the City Traffic Engineer, for the surveillance and control system and other traffic control requirements.

Description of Facilities

The major CBD transportation facilities are I-75 and I-71 which are briefly described below along with some of the traffic generation characteristics of the Riverfront Stadium.

I-75

I-75, from approximately four miles north of the downtown area to its junction with I-71 on the north side of the Ohio River, is an eight-lane freeway on which the highest weekday ADT was approximately 170,000 vehicles. Peak weekend traffic volumes exceeded 200,000 per day. The Ohio River bridge is a six-lane, two-level bridge, with three lanes in each direction. At the south end of the bridge is an interchange with a lane drop reducing the I-75 and I-71 combined flow to two through lanes in each direction.

The four-lane segment through the interchange has a capacity deficiency that resulted in a daily southbound backup of traffic of from one-half to two miles in length. On a major summer holiday weekend, backups of as long as twenty miles were recorded. Travel-time studies find four-mile backups represent about one-hour passage time.

By 1980, three additional Interstate bridges were completed and along with major repairs to a surface street bridge, Interstate bypass routes are now available around the metropolitan area, which has helped to reduce the ADT to 140,000.

I-71

I-71 is also a major distributor for traffic to and from the downtown CBD and the freeway system. It is a six-lane facility, with acceleration, deceleration, and/or weaving lanes throughout its downtown alignment. Completion of I-71 through Cincinnati occurred in 1974, and the facility at its highest point carries about 90,000 vehicles per day. A significant shift in volumes occurred with the completion of I-71. Operational problems do occur in both directions of I-71 since northbound traffic from the I-75/I-71 bridge must weave across the entire facility to proceed north on I-71, with the reverse movement required in the southbound direction.

Riverfront Stadium

The Cincinnati Riverfront Stadium was completed in 1970. The stadium provides baseball seating of 52,000 and football seating of 56,000, with standing-room crowds for football of over 60,000. The stadium is a circular structure, 800 feet in diameter, which is surrounded by a trapezoidal-shaped three-level parking garage. A plaza roof forms the primary bus and taxicab loading and parking area serving as the major pedestrian access to the stadium. The parking structure has a parking capacity of 3,000 vehicles, and city-owned surface parking at the site provides an additional 2,000 spaces. Other parking facilities within the immediate area of the stadium provide an additional 1,500 to 2,000 spaces.

Surveillance and Control System

Originally only a surveillance and changeable message sign system were planned for I-75 to assist stadium traffic approaching Riverfront Stadium. The system was to advise motorists of traffic congestion and suggest alternate freeway exits, as appropriate, thereby avoiding major freeway breakdowns. Sampling detectors located at strategic points would feed data on traffic flow to a central computer and base station located in the Stadium Traffic Control Room. The computer would select from a limited number of predetermined messages available at each changeable message sign, and transmit control demands.

After careful and extensive review it was decided in 1970 that the surveillance and changeable message sign system should be expanded and redesigned as a surveillance and control system. The expanded system would thus help manage daily peak-period traffic flow. To provide visual surveillance of the roadways, closed-circuit television was also implemented in the expanded system. Transmission from the remote TV cameras is by coaxial cable. The TV system design consists of six cameras and monitors, the installation of which were completed in the fall of 1970.

Major system components are as follows:

1. The lamp-matrix-type changeable message signs (CMS) are controlled by solid-state electronic circuitry, with messages generated at the base station computer. The CMS use 15-inch-high letters on both four-line and two-line signs; only 12" letters are used on "insert type" changeable message guide signs. Low-voltage 30-volt lamps operating at 15 to 21 volts provide long lamp life. Daytime and nighttime brightness levels are automatically selected on the basis of ambient illumination. The system includes:

   a. Five four-line, 80-column, full-bank lamp-matrix-type CMS.

   b. One two-line, 180-column CMS.

   c. Thirteen one-line, 80-column changeable message inserts for mounting within fixed-message guide signs.

   d. With an 80-column line, the message on a given line is limited to approximately 13 letters, including spacing.

2. A total of 87 detectors provide traffic flow information, i.e., volumes, lane occupancy and speed data. Twelve detectors are of the magnetometer type attached to the undersides of two bridge decks. The remainder are loop detectors cut into the pavement.

3. Field stations, coaxial cable, and the base stations form the communications for the entire system, utilizing a time-sharing multiplex technique.

4. The message generation functions and control system for the sign operation are contained in a Digital Equipment Corporation PDP8F mini-computer, with necessary interfacing between both the field station and the General Automation 18/30 computer, which provides traffic control status selection on an automated basis.

5. The Manual Control panel, video sign message monitors, and teletypewriter input provide for operator control. Manual override of the automated system permits display of special messages when required on any sign or combination of signs. The Status Display Map Panel shows the current traffic status, the message shown on each sign, and detector operation throughout the system.

6. The GA 18/30 master computer for the system has 8K memory. This machine processes and evaluates information from the sampling detectors on volume, speed, and lane occupancy, and automatically controls the sign statuses/messages.

System Operations

This system is designed to provide information to the motorist already on the freeway about traffic conditions and alternate routes. Entrance ramp control or metering is not included in the current project although it will almost certainly be necessary on I-75 in the future.

The system operational mode is based on "traffic status." A traffic status represents a given combination of traffic and/or stadium parking conditions likely to occur. In the automated mode, detector information at strategic points is analyzed by the GA 18/30 computer and used to select the most appropriate status for the current condition.

The basic method of automated message selection is that of group message changes based on the current "status" or traffic condition. A total of 37 statuses are identified in the automated mode. An additional six statuses are available for manual selection, including such special messages as "Accident Ahead", "Reduce Speed", "Congestion Ahead", "Reduce Speed", "System Test, Ignore Signs", and other special-purpose messages. Future provisions will include five additional automatically selectable statuses. The system also has complete manual override provisions, and monitoring personnel in the Stadium Traffic Control Center can manually change either the entire status or any individual sign or signs within the system to meet conditions not covered by the automated selection system.

Following the opening of the Riverfront Stadium in 1970, it became evident that the stadium traffic was not in fact the major problem originally feared. The more frequent usage of the surveillance traffic control system became the daily operation on I-75. Message word selection posed some problems. For example, it was felt the word "Closed" would represent a complete physical closure with no traffic getting through, and that this word might cause loss of confidence in the system if motorists found it possible to move through the area. The word selected for general usage was "Blocked".

When the system became operational, it immediately became evident this word was also unsatisfactory, because it caused sudden and erratic maneuvers by drivers who thought they were facing an immediate emergency situation. Instead, the words "Congestion" and "Congested" were used. These words overcame many of the problems of sudden and erratic responses created by the word "Blocked". Other improved messages were also developed, with the words "Delay Ahead" as the key message, and estimated delay times, and a positive instruction such as "Use Alternate I-75".

The closed-circuit television (CCTV) system permitted effective operation of a manually changeable signing system for more than four years before the electronic surveillance system became operational. We are convinced that closed-circuit television is an invaluable, if not essential, element in optimum operation of any major surveillance and control system involving a relatively compact geographical area or areas. Capabilities and/or advantages of CCTV not now duplicated in any other way include:

1. Backup for other modes of surveillance. At the present time, CCTV technology must be considered more reliable, from maintenance and

performance standpoints, than detector output communication and analysis.

2. CCTV provides information on causes of backup, congestion, or stoppage of traffic, as well as their existence; and, unless detector spacing is extremely close, CCTV provides a more precise and rapid evaluation of the exact extent of the problem.

3. CCTV permits emergency services to be summoned almost instantly when accidents, breakdowns, or other emergencies occur within the area of coverage.

4. CCTV permits the confirmation of the sign messages that are displayed in the field. Since field message verification was not incorporated into the original electronics at the Control Center, the ability to verify these messages by CCTV is often used by operators in the Control Center.

5. CCTV does have its limitations, also, and probably would not alone provide adequate surveillance capabilities for most systems. Limitations include coverage area and nighttime resolution of cameras and monitors. Most importantly, CCTV does require trained personnel to observe the monitors, make decisions, and take corrective action. CCTV provides no capacity for automated operation.

The initial complement of personnel assigned to the Stadium Traffic Control Center consisted of two persons, a supervisor and programming specialist during the morning rush hour, one person during the afternoon rush hours, with an additional field observer for stadium events. Initial operator training includes 16 hours of instruction plus "hands on" systems use under daily operating conditions. Subsequent training is oriented to maintenance considerations and requirements, which is attended primarily by the City's electronic maintenance personnel and electrical engineering personnel. This session involves a total of 32 hours of instruction, including several field trips.

The operating procedures for the system are not difficult, and in order to distribute the work load, many additional operators have been trained. Most of the present engineering and senior subprofessional personnel in the division now serve as operators. One engineer is assigned responsibility for programming changes in the system, and for coordinating the efforts of the maintenance contractor.

System Effectiveness

The system has successfully operated in the automatic mode and it has also been found successful in various types of operations.

The changeable message sign system has operated effectively and has been accepted by the public, especially when used in conjunction with the I-75 peak-hour traffic diversions.

Typically, p.m. capacity restrictions occur on I-75 southbound at the I-71 junction and bridge over the Ohio River into Kentucky. The need for traffic diversions utilizing parallel city streets and/or other Ohio River bridges occurs frequently, but particularly on Friday afternoons and pre-holiday periods. Overall speed is estimated at 15-20 miles per hour, with alternate routes saving 19 to 48 minutes.

Stadium and Riverfront Coliseum traffic operations have been successful. Traffic crowding within the vicinity has been avoided because of the use of the CMS once the stadium parking facilities are filled. Few major traffic delays have been experienced and the parking lots normally empty within 30-35 minutes after events have concluded.

The CMS are frequently used to alert motorists and assist with maintenance operations in the sections of I-75 and I-71 which are instrumented by the surveillance and control system. Standard messages and status are on a special tape, with manual selection.

The CMS have also been very useful during special events in downtown Cincinnati. Street festivals, parades, footraces, and other special events require closure of certain major downtown streets. The CMS are used to alert freeway traffic of street closings due to the special events.

The system has also been effective in assisting with freeway incidents. For example, southbound I-75 about one mile south of the Ohio River starts a long upgrade on a very tight alignment, which is the site of frequent incidents. In response to telephone requests from Kentucky officials, manually programmed messages are frequently displayed on the CMS to help alleviate the incident problems. The CMS have also been helpful on this upgrade during severe ice and snow conditions.

System Deficiencies

The Cincinnati system was one of the earliest of its type, and electronics and communications technology have advanced dramatically in the intervening 15 years. A surveillance system installed today would avoid most or all of the problems experienced in Cincinnati.

The following summarizes some of the major deficiencies found.

- As with many systems, severe electrical storms created grounding and lighting protection problems. These have now been solved.

- The CMS did not have easy access for maintenance of electronics. Typically electronics were located in the signs over the freeway lanes and no catwalks were available. Ready accessibility to the electronics is mandatory.

- Good Control Center verification of the messages on the CMS has not always been quickly obtainable. Partial verification of CMS when within viewing range by CCTV has been used. Unfortunately, too many messages cannot be verified without use of field observers.

- Initially considerable problems were encountered with the detectors but these problems have been solved.

- As of 1985, the General Automation 18/30 Master Computer is becoming an obsolete model with some reliability problems. The PDP8F sign message generation and control mini-computer is still quite reliable.

Summary

The I-75 traffic surveillance and control system has operated successfully in the automatic mode for several years. The system demonstrates the value of the use of "real time" on-freeway congestion and incident detection and control through automatic traffic diversion to exit ramps and alternate routes by the use of changeable message signs.

The electronic technology and hardware comprising the system provides a "building block" approach for future actions without fundamental changes in the Central Control Station, or either of the computers. It will be possible to expand the system to operate additional changeable message signs further north on I-75, and also on I-71. Some entrance ramps on the Cincinnati freeway system must be controlled or metered in the future to assure good freeway system operation.

Most of the traffic congestion problems reported in our area are resulting from accidents, stalled vehicles, fire and other emergency equipment responses, and other incidents, rather than being caused by actual capacity deficiencies in the roadway system. If we are to provide safe and convenient peak-hour operation on our street and highway systems, our greatest future opportunities will be in more quickly detecting incidents of the types just mentioned, dispatching assistance to clear those problems, and communicating more effectively with motorists how to avoid them.

ORGANIZATIONAL PLANNING FOR TRAFFIC MANAGEMENT ACTIVITIES

D. H. Roper, California Department of Transportation

Every day, the flow of traffic on our freeways and streets is slowed as the result of incidents -- everything from vehicle stalls, flat tires, spilled loads, accidents, major events with large crowds, to maintenance and construction activities. And every day, the resulting congestion and additional accidents are costing the traveling public millions of dollars. During one calendar year in the Los Angeles region, there were 220 incidents that cause major blockages of freeway lanes. Delays and secondary accidents are costing Los Angeles freeway drivers a staggering $60 million each year! Clearly, it's a problem that demands attention.

Yet, in many areas, little or nothing is being done to deal with the problem. In fact, there seems to be an attitude that this is just one of those things that must be accepted and about which little can be done. Such is not the case -- plenty can be done.

Analysis of delays caused by accidents or other lane blockages in Los Angeles revealed the critical nature of the time required to remove the obstruction and restore full roadway capacity. During off-peak hours, each additional minute taken to correct the problem extends the duration of congestion by four or five minutes. In peak periods, this factor often soars to fifty to one, or more.

Clearly, any program to deal with the problem should focus on cutting this total time -- the time to detect that a problem has occurred, the time to move forces into the field to deal with the problem, the time to make decisions and implement diversion routes, the time to clear obstructions and restore capacity, the time to make necessary repairs to the roadway, and the time to dissipate congestion and return traffic flows to normal.

An effective program to manage incidents costs money: personnel costs, training costs, and equipment costs. But you can expect the resulting savings in delays and in related secondary accidents will far exceed those costs. Based on over ten years' experience in the Los Angeles District, Caltrans has seen a 5:1 or 6:1 benefit/cost ratio. Last year, Caltrans' cost for the response team program was about $85,000; of that amount, over $30,000 has been recovered from those parties who caused the accidents. During the same period, savings to the public resulting from reduced delays totalled over $550,000. The resultant benefit/cost ratio was about 10:1.

An incident management program cannot be truly successful unless there is a cooperative, coordinated attitude on the part of each of the agencies involved. The working relationship between the traffic engineering, maintenance, and enforcement organizations is particularly critical. All have a legitimate responsibility and authority at an accident scene; all have resources to help correct the situation and get traffic flowing normally again. Local agencies need to be included, too -- detoured traffic will frequently be operating on city streets. A host of other authorities also will be involved: fire departments, tow truck services, ambulance services, etc. The key is to meet together before an emergency and to plan how each agency can coordinate its necessary work with that of the other members of the team, all working toward a common goal. And keep in mind, from a traffic flow point of view, the goal is to get traffic back to normal as quickly as possible.

Invariably, with this kind of informal multidisciplinary team, the question will come up: "Who's in charge?" In Los Angeles, our answer is that no one agency is in charge; consensus decisions are made by the team. This may fly in the face of some organizational theorists, but in the real world, it works well.

The Caltrans' incident response teams in Los Angeles are comprised of about two dozen volunteers, all with a traffic engineering background and all of whom have other regularly assigned duties in the Traffic Operations functions. Teams operate similarly to a volunteer fire department -- members take equipment (vehicles, sign trucks, signs, flares) home with them, are on call 24 hours a day, and go into action whenever an incident blocks two or more freeway lanes for two or more hours. Team personnel, along with police, maintenance, and other emergency personnel meet at the incident site and actively manage the situations. Providing help for the injured, clearing the wreckage, repairing damaged facilities, detouring traffic, and keeping the public informed of the situation are all carried out in a coordinated manner.

In metropolitan areas freeways are becoming more clogged with traffic. In turn, lane-blocking incidents are increasing and delays and secondary accidents are becoming increasingly critical. The consequences of these problems can be reduced significantly using proven incident management techniques. So to do anything less is to simply surrender to the problems.

PROBLEMS AND SOLUTIONS IN ESTABLISHING FREEWAY INCIDENT MANAGEMENT

C. L. Kurtzweg, Washington State Department of Transportation

Introduction

Freeway incidents, capacity-reducing events, take many forms. The most common are accidents, disabled vehicles, and material spills that occur randomly throughout the highway network. The less common incidents are planned lane closures for construction and maintenance activity. In the Seattle area major planned incidents are more difficult to manage than emergency situations.

In an emergency environment, incidents are handled in the Seattle area by mobilizing support from response groups. The Washington State Patrol is the lead agency for incident management on freeways. Necessary support is provided by the Department of Transportation, Local Fire Departments, medical service groups, towing companies, and local police agencies. Motorist information is provided by commercial radio and TV stations, which includes five traffic reporters in aircraft during peak traffic periods.

While no formal incident management team exists, emergency response procedures work well because of the availability of highly professional, competent and well-managed emergency response agencies. Communication channels and areas of responsibility are well established. Agencies react quickly and mobilize the equipment and skills necessary to get the job done.

For major planned incidents, the lead agency is the Department of Transportation. Traffic impacts are of longer duration, spreading over days rather than hours. Normal emergency communication channels do not apply. Instead, DOT engineering staff rather than normal emergency response staff are used.

The need for different procedures for major planned incidents became very apparent during the construction closure for I-5 resurfacing during the summer of 1984.

The primary needs were:

1) Maximizing capacity of available alternative traffic routes, some of which involved city arterials.

2) Maximizing potential modal shifts to high occupancy vehicles.

3) Providing a high level of information to motorists prior to and during major closures.

To meet these needs, different communication channels and interagency agreements proved necessary. Unique driver information techniques were also necessary.

The Project Area

Interstate 5 is the major commuter facility running north-south through Seattle. This section of I-5 is the most heavily traveled corridor in the state. Average weekday traffic (AWDT) through this section is 210,000 vehicles/day, with 94,000 vehicles/day using the northbound roadway. The Washington Department of Transportation resurfaced the northbound lanes of Interstate 5 on the Ship Canal Bridge and the Lakeview/Galer Viaduct in the City of Seattle.

The city of Seattle has a predominantly north-south geography bound by Puget Sound to the west and Lake Washington to the east. I-5 is one of five routes to cross Lake Washington Ship Canal. The Ship Canal connects Lake Washington with Puget Sound and divides the central and south portions of the city from North Seattle. Alternative routes crossing the Ship Canal include State Route 99, a six-lane principal arterial, a four city arterials. I-5 includes a separate reversible roadway which is an 8-mile-long facility that runs from Seattle's Central Business District to the north. This reversible roadway operates southbound during the morning and northbound during the evening.

Project Description

Construction of this section of I-5 was completed in 1965. High traffic volumes and the seasonal use of studded tires have reduced the original concrete thickness of the bridge deck slabs to the point where steel reinforcing bars were exposed. Use of salt to remove snow and ice from the roadway has also resulted in chloride intrusion into the bridge decks.

The Ship Canal Bridge and the Viaducts between Lakeview Boulevard and Denny Way were selected for resurfacing in 1984 and the southbound lanes scheduled for the summer of 1985.

The project had three construction phases. The first (deck repair) and the final cleanup phases were completed during night and weekend hours to minimize traffic impacts.

The second phase required 24-hour lane closures of half of the structure (2 lanes). This phase consisted of final preparatory work, placing latex-modified concrete, and allowing a minimum of 96 hours curing time. During phase two, two lanes were closed, reducing capacity of the roadway from 7,600 vehicles per hour to 3,000 vehicles per hour. This required 36,400 vehicles per day to be diverted to other routes. The total duration of this phase was 48 days.

Traffic Control Plan

The goal of the traffic control planning effort was to minimize adverse traffic impacts, maintain safety, and provide a condition for efficient construction operations. The availability of the reversible lanes and a strong transit/vanpool organization in Seattle were key tools in maintaining adequate commuter mobility through this region during the project.

The reversible lanes, which are below the mainline roadway across the Ship Canal Bridge, had sufficient capacity to divert substantial northbound traffic. The capacity of the reversible lanes across the Ship Canal was maximized by construction of a crossover from the reversible roadway to the northbound mainline roadway to avoid the bottleneck area.

The operation of the reversible lanes was also modified to better serve the northbound traffic. The section operated southbound between the hours of 5:30 a.m. and 9:30 a.m., and for the remaining hours, including weekends, operated northbound.

The change in access and operating hours accommodated up to 28,000 of the total diverted vehicles.

Diversion routes both parallel to I-5 and to alternative freeway access points are within the jurisdiction of the city of Seattle. Early in the planning coordination meeting, an agreement was developed to provide City of Seattle services to include:

Police Department personnel to ensure traffic control at selected on- and off-ramps and on heavily impacted city streets.

Coordinated detouring by the Seattle Engineering Department onto city streets and retiming of traffic signals on major arterials and certain off-ramps.

Provision of Office of Citizen Participation and Seattle Engineering Department by the informational support with news releases, attendance at community meetings, and referral of appropriate issues to DOT.

High Occupancy Vehicles (HOV) were the key to moving the most people possible through the construction area. To maximize the use of transit and carpools, one downtown on-ramp to northbound I-5 was restricted to HOV use. (A second ramp is normally reserved for HOV use only.)

A formal agreement was prepared with Metro transit, the regional transit agency for King County. This agreement provided extra bus service to the most severely impacted areas of the city, promotional pieces about the extra service during the resurfacing, extensive use of Commuter Pool's contacts in the business community and media, attendance at community meetings, and many staff hours of promotional planning.

Much of the traffic management success of the resurfacing project can be attributed to these coordination efforts. Not only were all agencies aware of and contributing to the mitigating traffic measures, but the information about the resurfacing project always included references to taking the bus, joining a carpool, and using alternate routes through the project area. Presentations to community groups were conducted by DOT staff, with representatives from Metro, Commuter Pool, and the City of Seattle. The presence of these agencies presented an organized, united appearance to the community at large.

Information to motorists included general information to encourage diversion and real-time information to identify incidents.

To inform motorists of construction activities, WSDOT installed five Highway Advisory Radio stations in the Seattle area. These low-powered radio stations gave motorists pertinent information, and encouraged use of alternate routes. They advised northbound traffic to divert to SR 99 and to the reversible lanes, and to use I-405 to divert northbound traffic around Seattle. Their effectiveness was reduced, however, due to equipment problems that resulted in poor signal quality in some areas.

WSDOT has an operational Surveillance, Control, and Driver Information system, known as the FLOW system, which operates in the I-5 section resurfaced. State traffic engineers monitored traffic and coordinated operations during the project through use of the system's closed-circuit television cameras and vehicle detectors.

The Seattle area has five "sky pilots" who give daily peak-period traffic reports for local radio stations. Radio communication to these airborne reporters permitted broadcasting of accurate, up-to-date information for guiding motorists over the best available route around the construction area.

This type of information is commonly provided for construction and maintenance activities. Because of the duration of the resurfacing project and the need for greater public information, additional temporary staff was hired to develop and execute a public information program.

<u>Public Information Program</u>

The objective of the Public Information Program was to inform the public of the resurfacing work on I-5. Three groups were identified to receive resurfacing information: a) drivers of I-5, particularly commuters from the Northend and Eastside; b) neighborhoods and businesses that experienced increases or decreases in traffic; and c) businesses and events whose customers were impacted by the anticipated congestion.

Three printed items were used during the project:

1. The primary piece was a general brochure that outlined the resurfacing work, answered general questions, and included maps of the project area and reversible lanes access, and gave information on expected traffic conditions. Also included were phone numbers to call for information about the resurfacing, bus routes (Metro), and carpool/vanpooling (Commuter Pool).

2. A poster giving the Resurfacing Hot Line Information Number to call for current information was displayed at work places, in libraries, community centers, grocery stores, etc.

3. A resurfacing letterhead was produced and used in a variety of ways, including news releases.

The Information Plan consisted of three stages, each having a media mix that would get special information to target groups.

Stage One:

A news conference was held and well-attended by TV, radio, and newspapers. The news conference was scheduled to coincide with a public hearing called by the Seattle Public Health Department. The Health Department was hearing testimony from the public on the noise variance requested by the Department of Transportation for the road preparation work to be done at night. As a result of the public hearing, the Department of Transportation received a noise variance.

Other information efforts included sending letters to all community groups in the impacted area explaining the resurfacing and offering to meet with them. Interviews with newspapers, radio, and TV stations were conducted.

Stage Two:

The next stage immediately preceded the beginning of the resurfacing work. At this time, information was distributed to all groups in the form of the general brochure with information relevant to specific neighborhoods. The operation of the Resurfacing Hot Line Information Number, publicized in all printed materials, began.

A special flyer was distributed to neighborhoods impacted by the noise of the night grinding work. News releases gave all media current information, with an emphasis on communicating with the air traffic reporters. Letters and brochures were sent to groups with a need for specific information: transportation services (trucking and taxi companies, delivery services), public office holders (mayor, congressmen, state senators), emergency services (police, fire department, ambulances), and day care centers throughout the resurfacing area. Commuter Pool's Employee Transportation Coordinators distributed information to people working in downtown Seattle and large companies in South Seattle. Articles about the resurfacing were published in local newsletters, including those produced by the Boeing Company, Automobile Association, and the University of Washington.

Stage Three:

The final stage was during the actual resurfacing period. The Department's objective was to have up-to-the-minute information available to anyone interested in having it.

In addition to the Highway Advisory Radio System, a Resurfacing Hot Line provided real-time information. Over the construction period more than 4,000 calls were received. Of these calls, only 61 were complaints; the remaining calls requested information.

Response to the resurfacing project was mixed. The media generally displayed a "necessary evil" attitude.

Of all the information requested the strongest response occurred before work began, and it was from neighborhoods adjoining the areas to be resurfaced; not in regard to traffic congestion, but instead on the noise anticipated to be caused by the night work.

Evaluation

The I-5 construction incident management program was a success. Average weekday traffic through the construction dropped by over 32,000 vehicles. Of this decrease almost 13,000 vehicles diverted to the reversible lanes and a similar number diverted to a major arterial parallel to I-5. The remaining 6,000 trips changed modes, diverted to other routes or were simply not made. No facility was overloaded by this diversion and few complaints were noted concerning intolerable travel time.

Project success was attributed to management techniques that brought together engineering, enforcement, and public information skills of affected jurisdictions. Without the agreements that led to direct involvement by the City and Metro, the smooth diversion of major volumes of traffic could not have taken place. The project would not have succeeded without the extensive public information that was provided.

The public information program not only provided motorists with route diversion information, but it also gave the traffic control plan "credibility." The direct involvement of the DOT and local agencies led to the public perception that everything possible was being done to mitigate the impacts of the project.

CASE STUDIES AND WORK SESSIONS

Three case studies were presented during the afternoon session of the Specialty Conference. Each case study was studied by two groups of about 10 people each for about 30 minutes. Each group was responsible for reviewing and discussing what actions could be taken to alleviate the potential traffic flow disruption caused by the incident.

Based upon the problem statement, their assumptions (if any), their experience, and the knowledge they gained from the morning sessions, the individual groups were asked to recommend the single action plan they thought would be the most responsive and appropriate for the incident problem described. The groups were asked to identify the traffic control plan and the related field equipment and support staff needed.

Subsequent to the 30-minute study periods, representatives for each group made 10-minute presentations on their problem and recommendations. The purpose of the case studies was not to develop the optimum or best implementation plan; but instead it was to provide the group participants with some insight about the value of having had well thought-out plans ready to implement.

Each of the case examples were for incidents that occurred on major interstate freeways with disruptions affecting peak travel periods. Two of the incidents involved spilled loads. One was a hydrochloric acid spill that occurred in a high-density area on a 12-lane freeway; the other was a spilled load resulting from the collapse and breakage of a tractor semitrailer carrying over 45,000 pounds of shredded paper on a 6-lane beltway-type freeway around a major urban area. The third incident involved an oversized load which struck an overhead pedestrian bridge, the impact of which moved the bridge deck from its pier support. This traffic disruption was on a major 8-lane urban freeway.

While none of these incidents had any associated fatalities or incidents, they all produced monumental traffic disruptions and delays. They also served well as case study examples, largely because each differed greatly in terms of the incident, environment, traffic and roadway conditions, and resources available.

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