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16. Abstract

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FINAL REPORT

DESIGN AND EVALUATION OF ON-FREEWAY TRAFFIC CONTROL SYSTEMS AND SURVEILLANCE TECHNIQUES

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Research Report Number 173-3F

Design and Evaluation of On-Freeway
Traffic Control Systems and
Surveillance Techniques

Research Study Number 2-18-76-173

Sponsored by
The State Department of Highways and Public Transportation
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College Station, Texas

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ABSTRACT

Studies of urban traffic operations were conducted on the freeways of Texas to determine the design and effectiveness of traffic control systems and surveillance techniques. The control systems were designed to relieve peak period congestion. Surveillance techniques were studied for application in detecting disabled vehicles and their impact on the operation and safety of freeways. This study used demonstration installations and field testing under laboratory conditions to determine the implementation requirements as well as to evaluate the operational theory.

DISCLAIMER

Key Words: On-freeway control, lane use control, CCTV surveillance, use of freeway shoulders for travel, incident detection.

SUMMARY

This study is the continuation of research in the development and evaluation of traffic surveillance and control on urban freeways. Two designs of on-freeway control were considered: lane use control in an interchange and total freeway control approaching a congested section of freeway.

The total freeway control study has progressed through the preliminary designs and has been approved for demonstration and evaluation in fiscal year 1977, but the installation and the operational evaluation have been postponed until funding for this type of control can be secured.

The lane use control study was concluded. The results indicate that the control was effective in closing a lane approaching a merge area; the control was cost effective in the reduction of total delay in the intersection, and extensive traffic enforcement was essential for this type of traffic control. The demonstration project which was conducted on I.H. 10 (Katy Freeway) at I.H. 610 in Houston was discontinued after 18 months of operation as the result of enforcement problems.

Projects on the design and evaluation of traffic surveillance systems in this study were: low light level design of closed circuit television (CCTV) systems for incident identification and incident management, evaluation of detector systems for application in traffic surveillance and control, and the use of CCTV signals for the detection of traffic movement and/or traffic stoppages.

The study of the design and application of CCTV systems in urban traffic management was continued. Camera locations were examined with

respect to area coverage and resolution problems. Low light level cameras were studied for application in 24-hour surveillance and produced excellent quality pictures for traffic surveillance under average nighttime conditions.

The effectiveness of vehicle detectors as an automatic incident detection system is being evaluated on a new installation on I.H. 610 North Loop in Houston. Redundant equipment designs and computer software logic will be used to compensate for the errors in detection due to equipment limitations, vehicle placement, and vehicle detection characteristics. This effort will be continued in fiscal year 1977 because of the time required to develop a portable, on-site data recording and storage system with adquate resolution for the study.

The manufacturers of security systems which employ television and electronic sensing systems were contacted to determine their applications to traffic surveillance.

Technical assistance to the State was provided through the study for those activities that closely related to the implementation of results of the research. The operational analysis of a high accident location on U.S. 59 in Houston has continued as various phases of improved signing and markings were installed. Increasing capacity on frontage roads by computer control of diamond signals was evaluated in relation to exit ramp capacity problems. Finally, the slide presentation for Accident Investigation Sites (AIS) systems was modified for use by the State.

Implementation

The systems described in this study are capable of being operational in the near future, but the problems of organization, enforcement, and facilities must first be resolved.

Recommendations for Future Research

Those systems not completed in this study should be continued. These include low volume incident detection, conversion of shoulders for travel, and evaluation of projects for providing preferential treatment to priority vehicles.

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INTRODUCTION

Background

This report is the annual statement of progress of research conducted in the area of freeway operations. The current research project entitled "Design and Evaluation of On-Freeway Traffic Control Systems and Surveillance Techniques" has several activities carried over from the previous studies(1 & 2). The major objectives of this research, the evaluation of two on-freeway control systems, were initiated in 1973 and are concluded in the documentation of this project. The study of low volume incident detection, first proposed in 1972, has not yet been completed and will be continued in 1977(3). The series of studies on the design of closed circuit television (CCTV) systems, which have been of interest since the first CCTV systems were installed in the Baytown Tunnel and the Gulf Freeway in the mid 1960's, has been concluded in this project with a report on low light level camera equipment(4,5, & 6). Finally, a new objective was added to the research study during the current year that will be continued in 1977. The study of the conversion of shoulders to lanes of travel on freeways is of particular importance at this time as the State searches for alternatives to improve the capacity of the existing system to transport persons and goods.

The significance of the work of the Texas State Department of Highways and Public Transportation (SDHPT) in the field of freeway operations is this: the prevailing problems in urban transportation--inflationary impacts on construction, energy shortages, increasing urban travel demands--have a common, if not total solution, which is to make the maximum use of the existing facilities. This can only be accomplished with the effective management of traffic by implementation and operation of freeway surveillance and control and motorist communications systems.

Statement of the Problem

Urban freeways carry almost 40 percent of the vehicle-miles of travel in urban areas. The freeway network is only 2 percent of the total street network. Twenty to 25 percent of freeway travel occurs weekdays during the two peak periods, which constitute 10 to 15 percent of the total 24 hours. These statistics will vary from city to city but the general conclusion is that the importance of the freeway system to urban transportation is increasing. The development of bus priority systems on urban freeways to increase the people-carrying capacity of these roadways emphasizes the necessity for maintaining an acceptable level-of-service for vehicle operations. The definition of an acceptable level-of-service has not been established, because it must reflect local conditions and local transportation goals and objectives. However, traffic congestion and stop-and-go operations that prevail on most freeways during peak periods, maintenance operations, and incident occurrences are not acceptable to any motorist or transportation agency.

Many freeways are instrumented with ramp metering systems that have improved traffic operations, but some ramp systems cannot exert sufficient control to eliminate the congestion caused by increasing traffic demands. On-freeway control systems are proposed in this study to supplement ramp metering and to provide a sufficient amount of control of traffic demand.

Disabled vehicles and accidents cause as much disruption to traffic operations as any other factor[7 & 8]. Visual surveillance with closed circuit television and electronic detection with detector-computer monitoring systems were investigated in this study for application in locating and identifying capacity reducing events.

Transportation agencies must consider any system, procedure, or design modification that improves the efficiency of the existing streets and freeways, and determine the costs and benefits of the various alternatives. The realignment of freeways to use the roadway shoulder for travel in order to provide extra lanes to the total traffic, or to priority vehicles, will be used more frequently. The study of the design, operation, and safety of these freeway modifications was initiated in this project.

Goals and Objectives of the Study

The goals of the research program are to develop, test, and evaluate traffic surveillance, control and communications systems, and geometric modifications that reduce the frequency and severity of recurrent and non-recurrent congestion on urban freeways:

The objectives of this research study are:

1. To evaluate an on-freeway control system that meters traffic flow on the main lanes of the freeway when traffic densities downstream exceed critical levels.
2. To evaluate an on-freeway control system that restricts the use of one freeway lane upstream of the merge area of another freeway lane.
3. To develop systems for detection of vehicular incidents on elevated sections of freeways, causeways, and tunnels.
4. To provide technical assistance to the SDHPT for development of goals and objectives for implementation of research results.

5. To develop a design for an urban wide closed circuit television system with a cost effectiveness evaluation for use in incident identification and incident management.
6. To evaluate the operational efficiency and safety of freeway sections that have converted shoulders to travel lanes and reduced the lane widths to less than 12 feet.

RESULTS OF THE STUDY

Status of the Objectives

A review of the status of the six objectives is presented below. The results of the study related to each of the objectives are discussed in the following sections of the report.

Objective 1 - On-freeway control to meter freeway traffic flow.

This objective was deleted from the study because the installation of the control system was postponed indefinitely. Approval for the installation was withheld by the Texas State Department of Highways and Public Transportation, pending their review of project priorities and current funding allocations.

Objective 2 - On-Freeway control of one lane upstream of a merge area.

The study of the signal system to control one of the westbound lanes of I.H. 10 Freeway at the I.H. 610 Freeway in Houston has been completed and documented in Research Report 173-2. The operation of the lane control system was terminated on May 24, 1976, because of the difficulty of providing sufficient traffic enforcement to achieve an acceptable level of compliance.

Objective 3 - Development of systems for incident detection on controlled access facilities.

This study has been partially satisfied by the design of the hardware and software systems to test the accuracy of redundant vehicle detection stations to automatically record the incident of a disabled vehicle on a section of freeway. The systems will be tested by a demonstration installation on the I.H. 610 North Loop Freeway in Houston in 1977.

Additional work has been accomplished in the study of security systems employing television signals to sense the movement of objects in the field of view. The application of these systems to traffic surveillance is discussed in this report.

Objective 4 - Technical assistance to the Texas State Department of Highways and Public Transportation.

This objective has been satisfied by the conduct of three studies: the further evaluation of a high accident location on U.S. 59 Southwest Freeway in Houston; the development of a slide presentation for accident investigation site implementation; and a roadway capacity analysis for freeway bottlenecks on U.S. 59 in Houston. Results of these studies are discussed in the following sections of this report.

Objective 5 - Design of urban-wide CCTV system for traffic surveillance.

This study of the evaluation of low light level television cameras for nighttime surveillance has been completed and documented in Research Report 173-1.

Objective 6 - Conversion of shoulders to travel lanes.

The study of freeways that have added capacity by narrowing lane widths and converting the shoulder to travel lanes was to begin in 1977 but data collection activities were begun this year since the study of the on-freeway control (Objective 1) was deleted. Several sections of urban freeway in Houston are being restriped to add capacity in critical bottleneck sections. Data will be collected this year, and in 1977 and a report on the operational efficiency and safety of the redesign will be prepared.

<u>Discussion of Accomplishments</u>

Often, the time required to develop, install and evaluate demonstration systems of surveillance and control, and to construct modifications to geometric design exceeds the term of the research studies. However, the understanding and support of the SDHPT has enabled the research program in freeway operations to overcome these difficulties. The status report of the five original objectives indicates that three objectives were completed, and significant progress was made in all remaining areas of work. Brief summaries of those studies that have been documented in previous research reports and more detailed discussions of work still in progress are presented in the following sections.

On-Freeway Control - Total Roadway - The control of traffic demand on the main lanes of a freeway has been proposed as the most direct and effective method of controlling the level of service on urban freeways. The theory, method, and benefits of this form of freeway control were discussed in Research Report 202-3F entitled "Design and Evaluation of Freeway Surveillance and Traffic Control Systems."

Feasible design and operational strategies were developed and submitted to the SDHPT for consideration as a demonstration project. A request was submitted to the Subcommittee on Traffic Signals for the National Advisory Committee for the Uniform Manual on Traffic Control Devices and the Federal Highway Administration to conduct a demonstration project, and this request was approved. However, the project has not been scheduled for implementation by the SDHPT due to funding priorities. Therefore, this research objective has been deleted from the study until an operational installation is available for testing.

On-Freeway Control - One Lane - The control of traffic demand on one freeway main lane upstream of a critical merge area was studied in a major freeway interchange in Houston. The right lane of westbound I.H. 10 closed to thru traffic by overhead lane use signals and the connecting roadway from I.H. 610 (West Loop) was permitted to merge without interference (Figure 1).

The controls were applied during peak traffic periods on weekdays from November 20, 1974, to May 20, 1976. Results were published in Research Report 173-2 entitled "A Study of On-Freeway Lane Closure in the Merge Area of Two Freeways." Summarizing the findings:

1. The control system was effective in shifting capacity from one roadway to another roadway upstream of their merge point.
2. Total traffic delay in the freeway-to-freeway interchange was reduced by the application of the control system.
3. Freeway conditions downstream of the merge area were not affected by the lane use control system because of downstream bottlenecks.
4. Driver acceptance of the system was affected by the degree of congestion encountered upstream of the control and by the level of enforcement of the signals. Without enforcement, the level of acceptance declined with the passage of time.
5. With less than 80 percent compliance, it was not beneficial to continue the control.

After 18 months of operation, the traffic enforcement by the Houston Police Department was infrequent, and the driver compliance levels dropped to the 40-50 percent range. Therefore, the SDHPT decided to terminate the lane control demonstration project.

Design of CCTV System for Traffic Surveillance - The use of closed circuit television (CCTV) in freeway, bridge, and tunnel surveillance

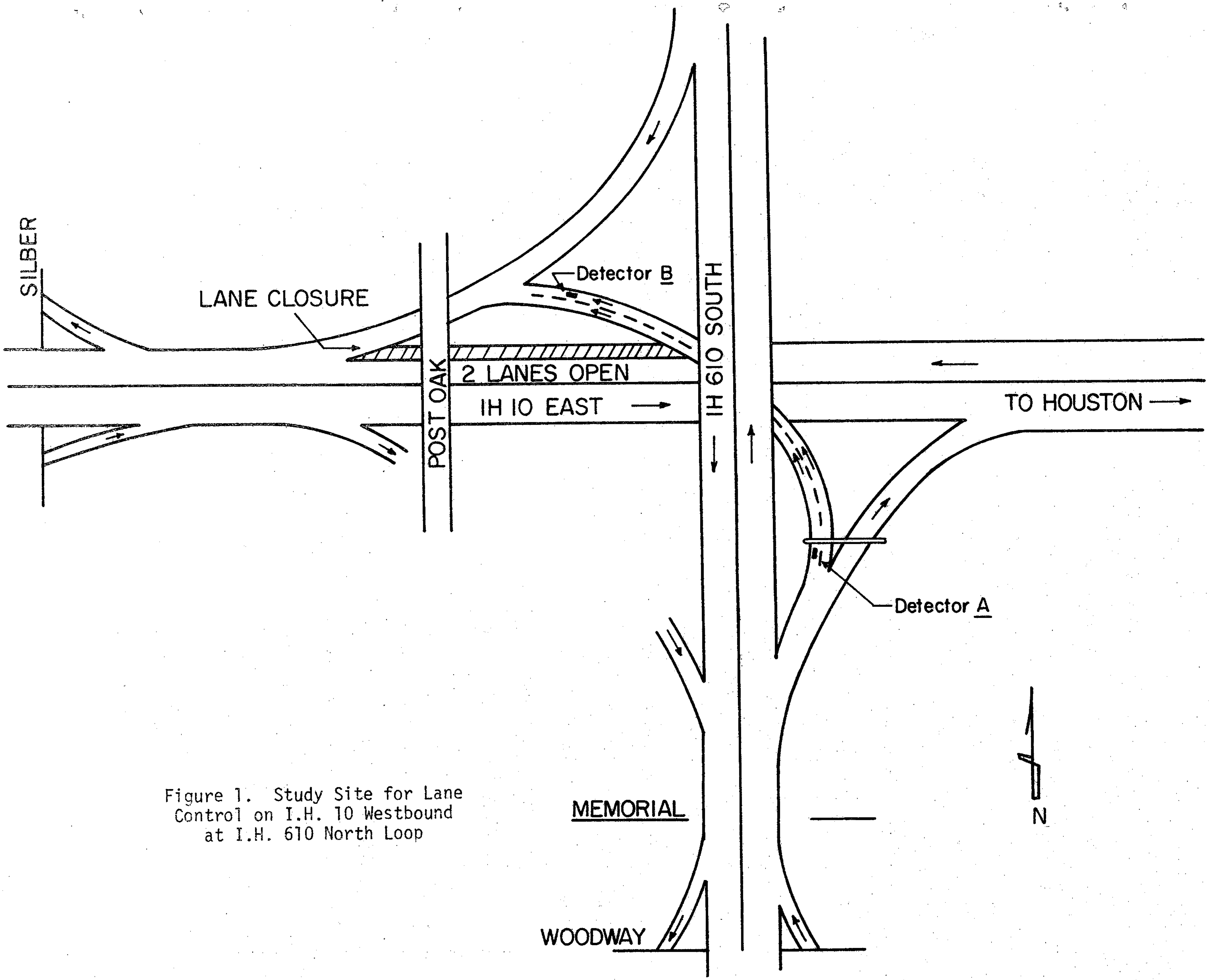

Figure 1. Study Site for Lane Control on I.H. 10 Westbound at I.H. 610 North Loop

systems has been demonstrated at various locations throughout Texas and the United States. At present most of these systems are operated only during daylight hours or in areas of relatively high illumination at night. However, a new generation of CCTV cameras has been developed which are highly sensitive to light and produce useable pictures with illumination levels typical of lighted streets and freeways. More advanced electronic and lens systems have also been developed to enhance picture quality at low light levels.

The design of a freeway surveillance system includes the selection of camera mounting height, spacing, and offset from the freeway lanes. Freeway surveillance systems have traditionally utilized luminaire pole-top-mounted cameras located above or near the freeway lanes. Certain advantages can be envisioned by mounting the cameras higher and farther away from the freeway lanes.

Thus the intent of this research was to evaluate the performance of a low-light-level television camera, and to review existing camera locations and explore alternative camera locations.

A low-light-level television camera was leased and tested under laboratory conditions at the Texas A&M University Research Annex and under field conditions on the North Central Expressway in Dallas and I.H. 35 in Austin. Video recordings were made to document these studies.

A questionnaire was distributed to a limited number of building managers in Houston to sample their attitudes regarding the possible installation of a surveillance camera on their buildings.

The following conclusions were made from this research:

1. Low-light-level television cameras produce a much better

image under low illumination levels (0.15-0.30 horizontal foot candles) than conventional vidicon tube cameras.

2. The automatic iris control feature worked well in adjusting the camera to changes in ambient lighting. Zoom lenses and focal length extenders are necessary options if maximum camera spacing and corresponding hardware savings are to be achieved.
3. Increased mounting height, usually greater than 50 feet, is beneficial in reducing the number of obstructions between the camera and the scene to be televised, but has little effect on reducing the blooming effect of vehicle headlights.
4. The use of roof-top mounted cameras could be considerably less expensive than constructing separate support structures. The questionnaire survey showed 14 of 18 respondents were willing to consider a roof-top installation. Agencies considering a surveillance system should at least investigate this possibility.
5. The use of low-light-level cameras for low volume incident detection, especially at night, is rather questionable. An incident occurring under low-volume, nighttime conditions would probably not cause much disruption in the traffic stream and therefore go undetected. Television surveillance may better serve as a confirmation of some other type of incident detection.

The results of the study are discussed in more detail in Research Report 173-1 entitled "Alternative Designs for CCTV Surveillance Systems."

Automatic Detection of Incidents - The recent history of the development of electronics and computers would convince anyone that anything in traffic surveillance is possible. But tempered with the requirements of costs to install and operate these complex systems, the outlook for automatic surveillance on streets, freeways, and highways is not optimistic even though the total benefits to the public are significant. This research has been directed toward defining the practical limits in the application of vehicle sensors, digital computers, closed circuit television, and data communications systems to one of the most difficult problems in urban transportation--the direction, location, and identification of disabled vehicles.

Although peak period operation deserves the majority of attention in freeway operations, freeways are operable 24 hours a day. When the freeway is operating below peak volume conditions, certain safety problems continue to exist. Accidents or disabled vehicles located in or adjacent to a freeway main lane provide potential for a severe collision or sudden changes in operating characteristics of approaching vehicles. Available incident detection algorithms, such as queueing and flow discontinuity models, are not able to detect these incidents under the low volume conditions which are characteristic of nighttime and weekend operation on urban freeways. The objectives of this research effort are to develop, test, and evaluate a technique for detecting these vehicular incidents which occur on urban freeways operating at low volume conditions. The type of "incidents" to be detected are individual vehicles which do not pass through a defined study section in a specified time period for whatever reason.

Redundant Detection Systems - This phase of the study is the development of a computer algorithm and detection system that would determine the occurrences of incidents at low volumes. The algorithm operates in real-time and is based on an individual vehicle input-output process. The following is a brief outline of the algorithm:

1. As vehicles enter a freeway section, the earliest and latest projected times at which they should arrive at the downstream detectors are calculated.
2. Based on these projected arrival times, vehicles are placed in one of three time accounting intervals provided in the algorithm.
3. All vehicles whose projected arrival times overlap are placed in the same accounting interval.
4. Each vehicle that exits the freeway section after the earliest projected arrival time in the first accounting interval is counted.
5. When the time-of-day is equal to the latest projected arrival time in the first accounting interval, the exit count is compared to the number of vehicles that are placed in that time band.
6. If the exit count is less than the projected number in the time band, an incident is detected, and the algorithm is restarted.
7. If the exit count is equal to the projected number in the time band, no incident is detected and the exit count is restarted.
8. If the exit count is greater than the projected number in the time band, no incident is detected (i.e., a hardware malfunction is detected), but the algorithm is restarted.

The Gulf Freeway Surveillance detection system was used in the algorithm development and testing during the installation of the I.H. 610

test site loop detectors. The detectors available for this research, both on the Gulf Freeway and I.H. 610 test site, are not capable of providing an accurate total volume count. Changes in detector sensitivity may eliminate some counting errors, but only at the risk of creating new ones. As counting errors produce false alarms in the operation of this algorithm, any detector(s) activation that could not be explained by program logic will cause the algorithm to be restarted. Although some incidents may not be detected, the number of false alarms is kept to a minimum, thus increasing the credibility of the algorithm. A high degree of credibility is considered essential to any nonredundant freeway surveillance system, particularly one without television.

The three main causes of these "false" counts as found in data collection on the Gulf Freeway were tractor-trailer trucks, motorcycles, and lane changes. Some detectors produce double actuations at the passage of a truck which can be interpretated as two cars following each other at very small headways. The examination of a large sample of freeway data resulted in the establishment of a minimum headway between two vehicles. The algorithm recognizes that headways smaller than this minimum represent the passage of only one vehicle. Motorcycles were observed to yield a much lower occupancy reading than other vehicles. Because of this characteristic, motorcycles are easily identified; however, some detectors are not sensitive enough to detect their presence. For this reason, motorcycles, if detected, are neither projected downstream nor counted as having left the study section. Lane changes at the detection station were much more difficult to identify. The occupancies recorded during a lane change may appear as two small cars traveling in adjacent lanes. Because of a great amount of programming needed to identify a lane change, the algorithm is restarted each time there is the possibility that a lane change has occurred. Refinement of the above parameters and additional efforts to characterize lane changes are recommended for future research.

The performance of the algorithm for freeway sections of various lengths will be tested. A study section was designed with detector spacings at 500, 1,000, and 1,500 feet and detectors were installed by District 12 of the SDHPT on the westbound lanes of I.H. 610 North Loop in Houston. At each detection station, three 6-foot square loop detectors were installed in each of the four lanes with 18 feet separating the leading edges of the sawcuts (Figure 2). The loop detector amplifiers were installed adjacent to each station, and a buried multiconductor cable provided AC power and data lines to all three stations. As each loop amplifier detects the presence of a vehicle, an internal relay is energized grounding an external supplied AC voltage on each data line. A special interface unit is placed on data lines so that the opening and closing of the relay can be timed and recorded by an on-site digital computer. Studies were not completed at the time of this report.

The computer used at this remote site is installed in the TTI instrumented vehicle (Figure 3). By reloading the memory of the onboard minicomputer with the low volume incident detection algorithm and by connecting the special detection interface unit to the minicomputer and detector data lines, the minicomputer is used for conducting the study tests and recording the study results on punched paper tape. The paper tape data are reduced further on larger computer systems

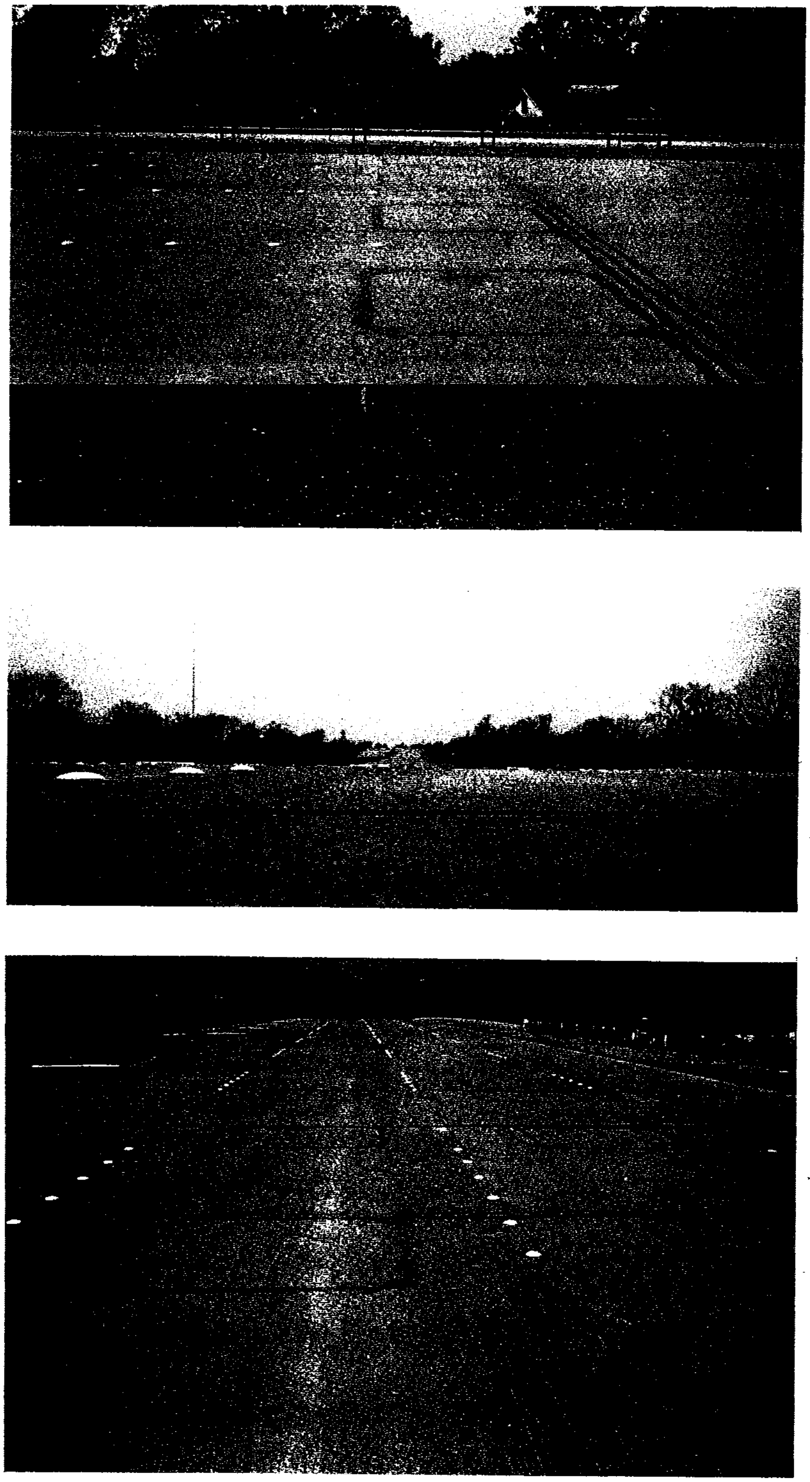

Figure 2. Detection Station
on North Loop I.H. 610 in Houston

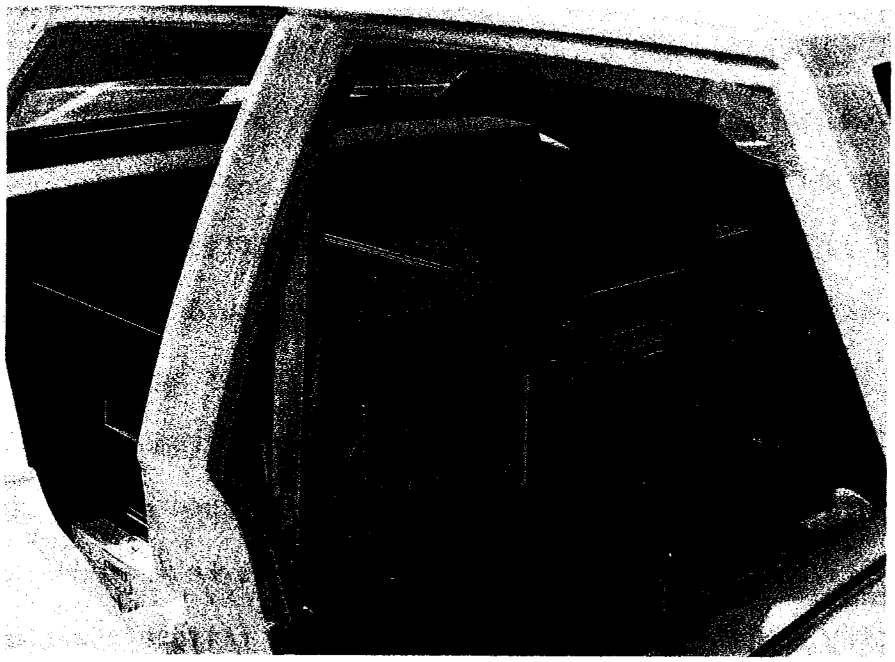

Figure 3. NOVA Model 1200 Minicomputer
in TTI Instrumented Vehicle

within the Texas A&M University system.

At the conclusion of the field studies, the accuracy of the algorithm will be determined for different volume levels of traffic flow. The evaluations will be based on the percent of incidents detected, the number of false alarms given, and the percent of time the algorithm is operational without malfunctions.

CCTV Systems - Early in the development of freeway traffic surveillance and control systems, attempts were made to secure traffic data (i.e., volume, speed, and occupancy) from monitors displaying CCTV signals from remote camera sites. The results were unsatisfactory. The systems were unreliable, and the data were not accurate enough to be used in automatic control systems or in evaluation studies. Other types of vehicle detection equipment, such as loop detectors, magnetometers, sonic detectors, etc., were and still are being used successfully. Consequently, the research and development of video detection equipment for traffic data were not pursued vigorously by the CCTV industry. Instead, requests from another marketing area of the CCTV industry and the widespread utilization of solid state electronics have provided sufficient incentives for the research and development into the video motion detection equipment.

The burglar alarm and security system industry have for a number of years utilized CCTV systems to provide complete security packaged systems to customers. The largest portion of these surveillance systems is found in banking, security sensitive industries, and correctional institutions. Surveillance personnel were faced with the dull, monotonous task of observing CCTV monitors for long periods of time during which no actions were required of the observers. This procedure of routine surveillance did not always keep personnel at peak efficiency and attentiveness. Therefore, requests were made for CCTV systems with some type of automatic scanning device that would sound an alarm whenever movement occurred in a televised scene. This type of request and an expanding market created an atmosphere for more manufacturers to enter into the CCTV motion detection business and to offer more optional equipment and competitive features. Currently, at least four companies with nation-wide marketing exposure and several smaller companies operating on a regional basis market this type of equipment. The national companies were contacted and asked to provide equipment specifications and pricing information.

The product sales literature and equipment specifications were directed at serving the security system market in three of the four units studied. The fourth unit which has a capability of storing and retaining the video image has application in many marketing fields. An analysis of the four units with respect to their use in traffic surveillance and incident detection was made with difficulty since only one model of the four is in use in the Houston area.

Specifications were studied, and questionable aspects were clarified by the engineering division of the respective companies. At present, it is not possible to take an "off the shelf" unit, attach it to a CCTV system, and receive acceptable traffic surveillance data. All units must have some type of custom electronic features added by the manufacturer or by an after-market speciality firm. The cost of the added equipment is dependent on the unit chosen and the type of application.

The two main objectives to be performed by the application of video motion equipment require contrasting operational characteristics from the equipment. On the one hand, detecting and recording individual vehicles require a different operating environment than does incident detection (stop motion). Individual vehicle detection requires that the video motion detection equipment have multiple sensing areas or windows that are adjustable in shape, sensitivity, and position within the video picture. Furthermore, the circuitry must be capable of sensing both white-going (peaks) and black-going (valleys) in the video signal. The white-going signals are objects "whiter" than the background, and black-going "valleys" are objects darker than the background. All of the present equipment has the peaking detection circuitry, but several do not have the black-going detection. The remaining requirements for single vehicle detection are presently in most equipment to some degree. All units have sensitivity selection, but all do not have shaping and positioning of windows. The sensing windows are areas that can be moved and adjusted to enable detection of single vehicles within a desired location such as a lane of a freeway (Figure 4). With the proper choice of the location of a television camera, the entire freeway traffic in both directions may be detected and recorded by individual vehicles through the use of the multi-sensing motion detection circuitry.

Stop motion detection is the ability to observe a roadway where normal moving traffic is not detected. The objective of this type of detection is to provide a memory of what the background and normal

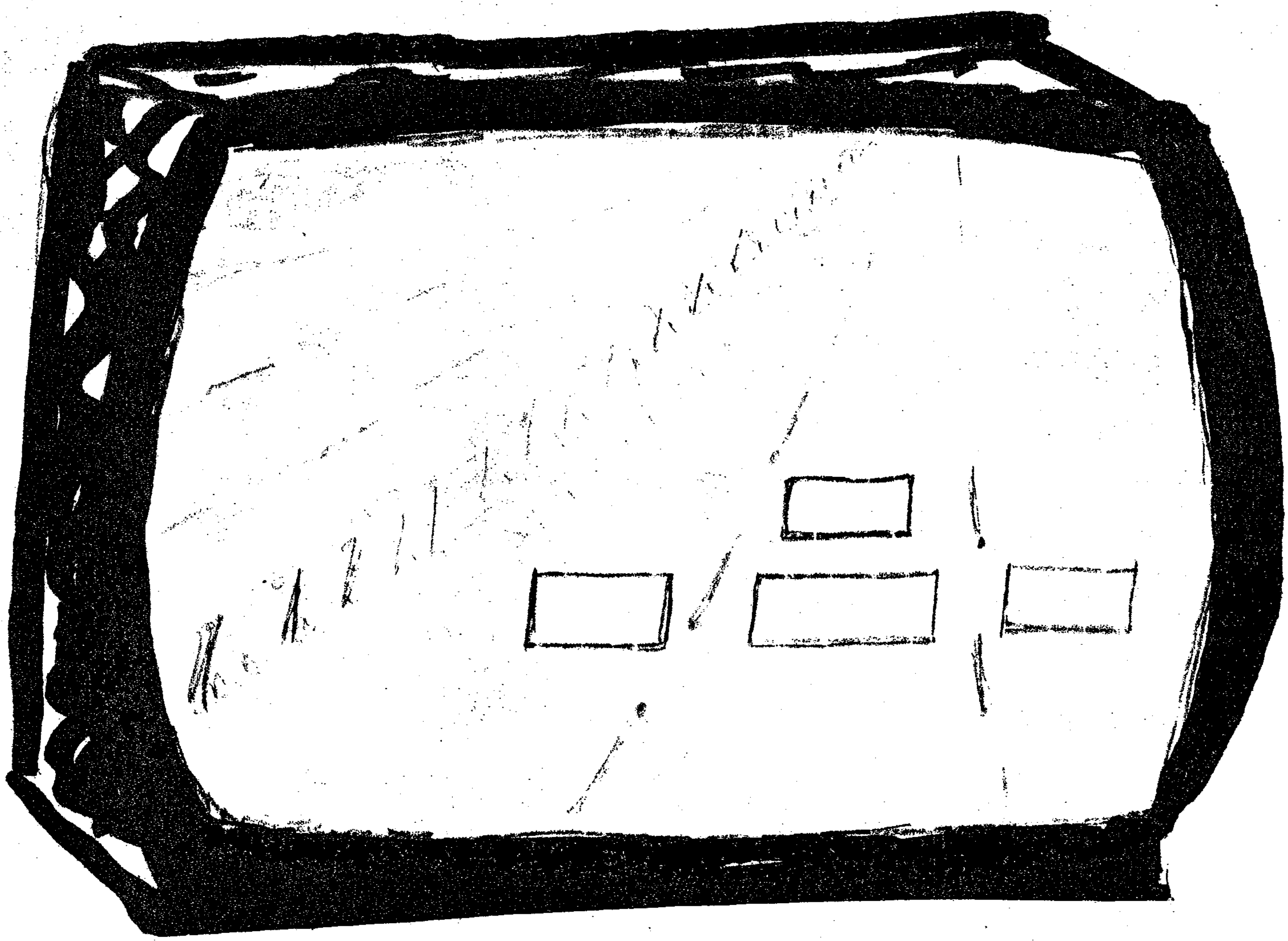

Figure 4. Proposed Volume, Occupancy, and Speed Detectors via CCTV Signal Utilizing Multiple Video Motion Detection Circuits

traffic "looks like" and detect abnormalities to this memory.

The nonmoving vehicles are not to be detected until a selected interval of time has passed to ensure that momentary stops are not detected. After detection, the stopped vehicles may, if operational procedures warrant, fade into the background and become a part of the memory. Stalled vehicles and vehicles involved in incidents within the confines of moving traffic lanes must require more rapid attention by the stopped motion equipment than vehicles parked on emergency reserved areas. These requirements placed upon the incident or stopped motion detection equipment also means that adjustable sensing areas be included along with sensitivity and positioning. The basic ingredient that makes the stop motion detection equipment different from the normal motion detection is the storage of the background CCTV image history and the adjustable updating of that history. Only one motion detection equipment manufacturer can deliver this stop motion capability, although all units may be adapted to function as stop motion detectors.

Present Equipment - The products offered by the four manufacturers were varied in design, complexity, and cost. The manufacturers and product names sampled, respectively, were: 1) JACOX, Inc. - TELESENTRY(12), 2) Princeton Electronics Projects, Inc. - PEP-700(13), 3) RCA - VIDALERT(14), and 4) Vicon Industries, Inc. - VICON(15). Jacox, RCA, and Vicon offered two or more units whereas Princeton offered only one basic unit. The study of the operational features of the specifications indicated that two projects, the VICON and VIDALERT, detected motion in essentially the same manner with only slight differences in the detection features (added more for marketing purposes than for increased video motion detection). The TELESENTRY units differed from the previous two systems in the video motion detection circuitry and the number of video signals serviced. Princeton's product, PEP-700, offered the greatest technical differences by actually storing the video signal for unlimited recall procedures. Each product is described in the following paragraphs.

The VICON and VIDALERT systems utilize similar video motion detection techniques (the rapid change in the white-going or black-going analog video signals) and are therefore discussed together. The VICON is offered in two distinct units: the more economical model utilizes 80 percent of the entire video screen in scanning for motion, and the other model can use up to two independent sensitized windows within the video screen area for motion detection. Both VICON units provide sensitivity adjustments of the detection zones. The multi-windowed model has horizontal and vertical adjustments for positioning the detection windows into any area of the video screen. Each window area covers approximately 5 percent of the total screen area regardless of the shape. The basic geometric shape of the window area will be rectangular: i.e., no horizontal or vertical adjustment will enable a trapezium or trapezoidal shape figure. The two-window VICON model is marketed to provide detection for two independent video signals but one signal may be looped through to enable both sensitized areas to be used on one video signal.

The VIDALERT is marketed in two models: providing two sensitized window areas or providing four sensitized window areas per model. Essentially, everything covered in describing the VICON units is contained in the VIDALERT units. One sensitized window is provided per video channel with horizontal and vertical adjustments and a sensitivity setting. Looped through features enable up to four windows to be placed on one video channel. An audio beeper activates upon detection along with a relay contact closure. No vital difference appears to exit between the VICON and VIDALERT units in the actual video motion detection technique.

The specifications from both manufacturers strongly suggest that to attempt video motion detection requires very clean video signals. Poor picture quality implies weak or interference-prone video signals which may cause numerous "false alarms." Also, false alarms can be caused by improper sensitivity settings, defective video system connections, and spurious moving objects of flashes of light in the camera's field of view. Sensitivities set to correct for any of the above conditions may cause "misses" to occur especially if the object in motion is 1) small, 2) too fast, or 3) too slow to effect sufficient video signal changes. Also mentioned as being provided within both units were control circuits that enabled the entire video signal to increase or decrease based on available lighting conditions within an alarm condition being detected. This provision enables the video motion detection circuitry to compensate for slow moving, cloudy shadows on sunny days and the overall light change at sunrise and sunset. Even the swaying of trees on windy days or wind blowing paper may be compensated for by sensitivity adjustments (at the expense of possible misses) or the re-positioning of the sensitized window areas to exclude the moving backgound areas.

The VICON and VIDALERT models are directed as being the least expensive of the present video motion detection equipment. The entire screen scanning VICON and the two-channel VIDALERT units retail for under $500. The multi-windowed units from both manufacturers are listed at $1,000 each.

TELESENTRY differs from the two previously discussed types of video motion detection equipment in that the total screen area is divided into 169 sampling points (or 338 points by rewiring internal jumper connection). These sample points are checked and then verified to see if a valid change in the video level has occurred. Two requirements must be satisfied before motion detection is verified: 1) two or more points on different video lines from the same video field must have received sufficient level changes (line suspicion) and 2) two or more video fields of the same scene must indicate level changes (field suspicion). Sampling occurs every 250 milliseconds. The video signal is fed directly through video amplifiers into an analog-to-digital (A/D) converter. Timing and control circuits sequence the comparisons of the stored digital point value with the present digitized point value. If the stored and present digital values differ by more than a predetermined amount (2 out of 32 possible shades of grey), an alert circuit is activated. If a significant difference is detected the next time the same video signal's sample point is examined, an alarm signal is generated. The stored memory value is updated periodically, minimizing false alarms from slow changes in picture video level resulting from overall light changes; such as sunrise, sunset, and cloud shadows. Also, a masking diode matrix panel is provided which, when programmed, disengages the comparison of the masked portions of the sample points in horizontal and vertical directions with the stored datum. Even though the entire screen area is scanned for motion, the masking provides a method of selective interrogation of the received video signal.

The significant difference between the TELESENTRY and the VICON and VIDALERT motion detection is the conversion of specific points within the analog video signal into one of 32 possible digital grey scale values. In the previous equipment operation, changes in video signal levels were interrogated for alarm conditions. Comparison of digitized data are used in the TELESENTRY unit where the present is directly compared to the past. The digitized data are stored in 5-bit words and represent 32 possible shades of grey. It would appear that based on this description of the TELESENTRY operations that a microprocessor or minicomputer is utilized. Instead, the entire unit is a hard-wired logic system. The fundamental control, comparator, and detection logic are fixed by the choice of electronic components utilized within the unit. Some adjustment can be obtained in A/D converter and video amplifier portions of the TELESENTRY unit.

Jacox, Inc., markets the TELESENTRY in four different models, each based on the number of CCTV channels serviced. Sixteen, twelve, eight, and four-channel servicing units can be obtained. Cost estimates range from over $16,000 for 16-channel operation down to $5,000 for the four-channel unit. At present, more than 20 TELESENTRY units have been installed world-wide, and more than a dozen of these installations are found in correctional institutions.

Princeton Electronic Products, Inc., primarily markets a video-graphic storage terminal. In this device, the discriminating element from the devices previously discussed is a silicon semiconductor target storage tube in which almost any type of electrical signal can be retained. There are three modes of operations that can be performed within the storage tube: 1) an electronic charge pattern corresponding to the object's electrical signal is written on the silicon-silicon oxide target, 2) a beam can scan this charge pattern which modulates the target current creating a signal that can be displayed on a video monitor (non-destructive readout), and 3) erase all or any selected portion of the stored charge pattern. The stored image can be generated from electrical signals produced by electron microscopic, infrared, ultrasonic, nuclear, thermographic scanners, or other similar types of recording instruments. The storage element is a solid-state monolithic target memory of which individual elements can be surface charged by electron beam addressing. The charged image can have up to 32 shades of grey, retaining the image fidelity up to 60 minutes without being renewed and provide a 36-power zoom capability. The erase, write, and read modes of operation can function at regular video rates.

The PEP-700 video image differentiator contains the video-graphic storage terminal as well as signal comparator circuits. The unit functions as a highly accurate comparator of a live video signal and an electronically-stored reference image. After comparison, the remaining unidirectional signal is scanned for white-going and black-going differences. The whiter than or blacker than-the-reference image signal can be displayed via a CCTV monitor or provide an output signal. It is through the use of the differentiation technique that the PEP-700 may function as a traffic surveillance tool.

The current price of the PEP-700 is approximately $10,000. Additional control equipment would have to be added to this unit for traffic surveillance so that the video signal's differences could drive detection and recording instruments.

Summary - The video motion detection equipment discussed represents a wide class of detection techniques, equipment, and costs. The less costly equipment (VICON and VIDALERT) should be able to perform the basic task of identifying individual vehicles as would be required by a traffic surveillance vehicle detection application. Based on the descriptive literature from these two manufacturers, the incoming video signals must be quite clean before reasonable detection results can be expected. Even then, if clean signals are present, the quantity of "false" and "missed" vehicle identifications is not known nor will it be until actual field testing is achieved. Also, it is unknown whether the detection technique used in these units can be adapted to provide stop motion detection.

The TELESENTRY unit, because of the quantity of systems installed, must be assumed to dependably detect motion in those application areas. Supportive equipment must be added to this unit that will enable sufficient un-masked areas to be defined and provide for adjustable A/D grey-scaled conversion levels. The TELESENTRY does provide units for multi-video channel operation and should be able to perform the required comparison logic as would be needed for stop motion detection since the reference image is firmly stored.

The Princeton Electronics product PEP-700 should provide the most complete technical equipment (as well as presenting a continual maintenance requirement) and, as such, the greatest detection capability in both moving and stop motion detection application. Control circuits would be required to delineate the difference between the moving and stop motion areas but is certainly within the realm of present day electronics. The major drawback of this unit is that only one video signal can be serviced. The major benefit to be achieved by utilizing the video motion detection equipment is the ability to quantitatively record that which is being received on a CCTV monitor and to provide an alarm if required.

Technical Assistance Studies - For several years this research program has worked with the SDHPT in various projects which were designed to transfer research results, study techniques, and new technology to the operations of the Department. The four subjects discussed in this section illustrate the range and scope of this work.

Traffic Conflict Analysis - A major diverging area on the U.S. 59 Southwest Freeway in Houston has been studied since October 1974 when the new section of U.S. 59 to I.H. 45 was opened. The area was characterized by a large number of accidents on Vehicle Impact Attenuator (VIA) Site 52, and remedial action was proposed and implemented in June 1975. More extensive modifications to signing, striping, and lighting have since been made, and the results in terms of actual VIA impacts are presented in Table 1.

Site 52 has been used as a study area for the investigation of a technique to evaluate hazardous potentials through operations and analysis. Weaving maneuvers approaching the gore area have been measured for the three conditions listed in Table 1. The results indicate that these data may be significant in relating to accidents or hazard potentials. Other similar sites must be tested to determine if the data

Table 1

Vehicle Impact Attenuator
Modification Analysis

Conditions	Time Interval	Length of Time	Number of Impacts
Before Conditions	October 17, 1974-June 4, 1975	8 Mo.	14
Phase I Modifications	June 5, 1975-February 27, 1976	9 Mo.	3
Phase II Modifications	February 28, 1976-July 12, 1976	5 Mo.	1

can be correlated.

AIS Visual Aid Development - The Accident Investigation Site (AIS) system was first tested in a pilot installation on the Gulf Freeway in Houston in 1971 and evaluated in a research report in August 1972[9]. A 16-mm motion picture film was developed from that study for the primary purpose of informing police departments of the AIS concept.

To supplement this film, an audio-visual presentation, designed to acquaint the driving public with procedures for reducing the adverse effects resulting from traffic accidents on the freeways, has been developed. The presentation includes a prepared script accompanied by a coordinated set of 35-mm slides selected to illustrate the various points.

A major emphasis of the presentation is on the concept and utilization of designated accident investigation sites, off-the-freeway locations selected to accomodate vehicles and drivers for the purpose of conducting the accident investigation. If this procedure is to be effective, freeway drivers must be familiar with these locations and the way in which they are to be used.

The presentation emphasizes the importance of smooth traffic operations on the freeway and the necessity of making the best possible use of existing freeway facilities. In addition to the utilization of the accident investigation sites, the presentation suggests other ways in which drivers of vehicles involved in accidents can be of assistance in clearing the freeway travel lanes so that normal traffic movement may resume as quickly as possible. Also, drivers are encouraged to forego summoning the investigating officer for minor freeway accidents.

The presentation is designed as a public education technique for possible use at civic gatherings and other functions where freeway drivers could be informed of these post-accident procedures.

Two copies of the Accident Investigation Sites slide presentation and accompanying script have been submitted with the final report and will be available through the Transportation Planning Division, File D-10, of the State Department of Highways and Public Transportation.

Roadway Capacity Analysis of Bottlenecks - There are three situations that relate exit ramp operations to bottlenecks:

1. The exit volume conflicts with upstream entrance volumes and through movements.
2. The exit volumes exceed the capacity of the ramp terminal.
3. The ramp geometrics restrict the existing vehicle speeds.

Case studies of the first two situations were conducted on urban freeways in Houston.

Exit Volume Conflicts with Freeway Volumes - The outside lane of the freeway must accommodate all the exit ramp traffic at the exclusion of through volumes. If exit volumes are light and a deceleration lane or high speed exit ramp design is available, the through volume is usually not greatly affected. The flow past the ramp usually can exceed a downstream bottleneck caused by geometric design or entering flows of traffic from downstream ramps.

As the demand for an exit ramp increases, the effects on the through movement are no longer one on one. That is, for each exiting vehicle, more than one through vehicle may be delayed. This is caused by the upstream maneuvering to put all ramp vehicles in the outside lane and the resulting decrease in exiting speeds. In some instances, the terminal end of the exit ramp will have inadequate capacity, and queueing on the ramp will reduce speeds and, in some instances, block the outside lane. (See next section.)

Generally speaking, exit ramps should not be allowed to contribute to congestion on freeways. Increased capacity by adding deceleration lanes or exit ramp lanes and by applying other minor modifications at the terminal end of the ramp can be achieved at a relatively low cost, and the resulting improvements in flow and cost benefits can be highly significant.

An example of the problem, solution, and resulting benefits is described below:

U.S. 59 Southwest Freeway - Southbound at Westpark - The section of U.S. 59 Southwest Freeway which passes over Westpark and a railroad crossing has all the physical features of a bottleneck; horizontal and vertical curvature, reduced lateral clearance, and discontinuous frontage roads (Figure 5). Southbound traffic approaches this section from three freeway main lanes, two I.H. 610 ramp lanes, and two high volume entrance ramps. One lane is added at the I.H. 610 interchange and dropped at the next exit ramp. Thus, it was not unexpected that the southbound U.S. 59 demand would exceed the capacity of the Westpark overpass.

However, as the lane near the freeway was developed for high density apartments, traffic demands for the Westpark exit ramp upstream of the overpass increased to a level such that the through volumes of freeway traffic passing the ramp were less than the capacity of the overpass. Thus, the bottleneck section moved upstream to the weaving section

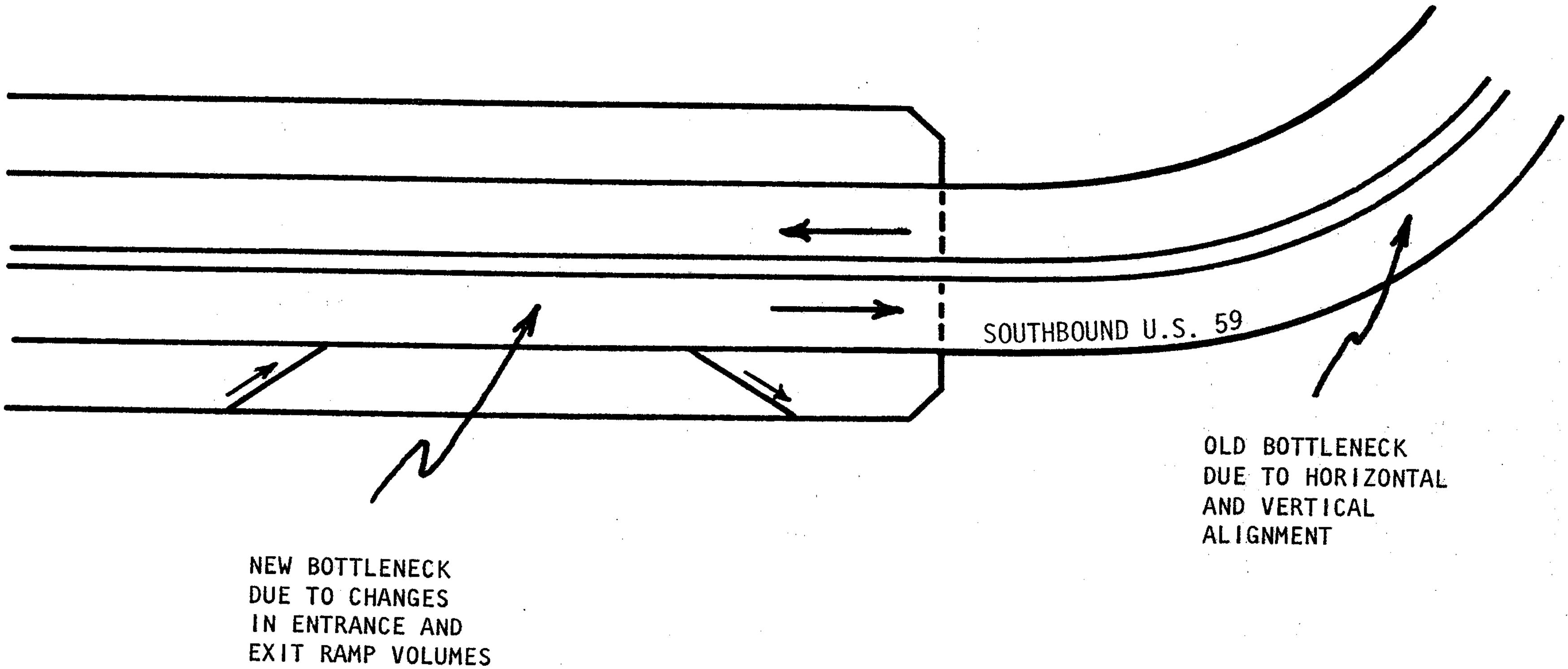

Figure 5. Expansion of Freeway by Shoulder Usage

between the Chimney Rock entrance ramp and the Westpark exit ramp.

The relief or elimination of a bottleneck is accomplished in two ways: reduce the traffic demand or increase the capacity. Ramp control was installed at the Chimney Rock entrance ramp, and peak hour entrance volumes were reduced by 150 to 200 vph; however, the freeway demands easily absorbed this change. Greater reductions in entrance volumes were not possible because of the discontinuous frontage roads.

The second solution, increasing the capacity, was implemented by the addition of a freeway lane through the bottleneck, terminating the lane at the Westpark exit ramp. This was accomplished by restriping the roadway and encroaching on the right shoulder. Thus, the cross section of 10'-36'-10' with three 12-foot lanes, a 10-foot median, and a 10-foot right shoulder was changed to 10'-42'-4' with four 10.5-foot lanes, 10-foot half median, and a 4-foot right shoulder. It should be noted that the outer separation next to the pavement was stabilized to provide more support for disabled vehicles that parked off the shoulder. The capacity of the weaving section was increased by 1,400 vph, and the bottleneck returned to the overpass.

The benefits of the added lane are obvious; the through-put of the freeway has been increased by 9 percent, or 1,350 vehicles for a two-hour period. The peak hour has been increased by 11 percent, or 780 vehicles. It is estimated that 1,000-vehicle hours of delay have been eliminated by the added lane. The quality of flow through this section has been greatly improved. It remains to be determined if the reduced congestion will result in fewer accidents or, on the other hand, if the narrower lanes will offset the safety benefits.

The cost of the realignment of lanes was less than $30,000. The project included relocation of light standards and signs, modification of guard beams and curbs, removal of curb, traffic buttons, and paint, application of asphalt overlay strip to smooth pavement-shoulder transsition, stabilization of shoulders, and the application of paint strips. Assuming an annual cost of $10,000 to install and to maintain the section, the benefit-cost ratio is extremely high.

1,000 vehicle hours/day
$5.50 per vehicle hour
200 incident-free days per year
$1,102,00 total annual benefits
$10,000 total annual costs
110:1 benefit-cost ratio

The reason that this particular project has a very high ratio is that this freeway section carries large volumes of traffic for two or more hours a day. The average savings in time to the traffic passing through this critical area is 3.75 minutes.

Application of FREQ3CP Model - The evaluation of proposed and implemented projects that offer different treatments in design and operation of priority vehicles on urban freeways began with the traffic volume data collection in June 1976 on I.H. 10 West (Katy Freeway) in Houston. Several candidate solutions will be considered based on traffic, geometric, and budgetary constraints. In particular, the simulation approach as described in the FHWA report entitled, "Simulation of Freeway Priority Strategies (FREQ3CP)" is being considered in conjunction with Benefit-Cost Analysis Procedures developed by J. L. Buffington and W. F. McFarland(10 & 11).

The Priority Entry Control Model Program (FREQ3CP) consists of the execution of a three-part process. First, the simulation submodel

(FREQ3) is used to simulate and evaluate traffic performance along a freeway under existing conditions (no control). Second, the optimization submodel (PREFO) is employed to generate, evaluate, and select an optimum priority entry control strategy. Third, the simulation submodel, FREQ3, is executed again to evaluate traffic performance along the freeway under the selected priority entry control.

The simulation submodel, FREQ3, is a deterministic and macroscopic model that predicts traffic performance as a function of freeway capacities and origin-destination patterns in specific periods of time. The optimization submodel, PREFO, has a linear program formulation that selects a priority entry control strategy (a set of allowable ramp metering rates and priority cut-off levels). The program maximizes an objective function (such as maximum passenger input or maximum passenger-miles of travel) subject to constraints (no congestion on the freeway and reasonable ramp metering limits).

To enhance the knowledge and understanding of the FREQ3CP program operations, the FHWA contracted with D-18T and D-19 of the SDHPT to host a three-day workshop in July 1976. The workshop was directed by the FREQ3CP program developer, Professor Adolf D. May from the Institute of Transportation Studies at the University of California at Berkeley. The course objectives were:

1. To understand the data and the degree of accuracy that are required to run the FREQ3CP program,
2. To input these data into the computer,
3. To run the simulation program,
4. To understand the available FREQ3CP program options and be able

to manipulate the computer input to use those options,

5. To interpret the computer output, and
6. To understand how the program can be used to examine various engineering strategies.

Several trial simulation runs were conducted by each participant during the workshop using data sets from previous California studies. As a result of the workshop, invaluable "hands-on" experience was gained by SDHPT personnel which should provide increased acceptance and utilization of the program. The FREQ3CP program and the various supportive subprograms have been installed in the Division of Automation computer program library. The program has only been approved through the validation stage and one of the major tasks that remains for full program utilization by the SDHPT is a determination of the quality and quantity of traffic data required for program execution.

The use of the FREQ3CP model requires a set of from one to six origin-destination (O-D) tables for each interval of time (an interval of time is defined as time necessary to travel the entire study system at full speed). The O-D table indicates for each interval of time (time-slice), the number of vehicles traveling from each input origin to each destination along the freeway. An option within FREQ3CP to enter more than one O-D table for each time-slice is provided. Vehicle occupancy data are entered in the priority cut-off metering level formulation and, as such, can require X% single occupant cars, Y% cars with 2 occupants, Z% cars with 3 occupants, etc. Buses are considered to contain 6 or more occupants. Any number of O-D tables from 1 to 6 are allowed to be entered with the last table reserved for bus allocation if more than 1 O-D table is used.

The time-slice concept in the simulation process of FREQ3CP requires that the time period be at least as long as the time necessary to travel the entire freeway section under study in the absence of congestion.

Fifteen minutes were shown to be useful in the approximate 10-mile system in California and 10 minutes in New York for a 6.5-mile section. The shorter time period is more sensitive to changes in demand with the longer time period insuring that more vehicles will actually travel the freeway study section.

Three methods that can be used in preparing the O-D tables are: 1) conducting O-D surveys, 2) viewing aerial photographs for vehicle storage, and 3) obtaining volume data at each entrance-exit along the study section. The results from FREQ3CP execution will only be as good as the input data. Along the study section on I.H. 10 West (Katy Freeway), volume data were obtained at each entrance and exit ramp on a 5-minute basis. Inbound data were taken from 6:30 a.m. to 9:00 a.m. and from 4:00 p.m. to 6:30 p.m. in the outbound direction. Main lane freeway counts were conducted leading into and exiting from each study section. The range of the study section extended from Washington Avenue intersection to West Belt intersection (a distance of 9 miles). Since volume data were secured in addition to actual passenger occupancy data and queue storage on the ramps, the method selected to change these data into the origin-destination tables required by FREQ3CP was from a synthetic origin-destination algorithm (SYNODM)[12]. The algorithm constructs an O-D matrix based on the total input to output of the traffic system or selected ratios of total input to output. At present, traffic data taken on the I.H. 10 West Freeway have been coded and keypunched on data cards. The SYNODM program will be executed based on these data and the resulting punched cards will be ready for FREQ3CP execution.

The other major data requirements to be coded and used by the FREQ3CP model are: 1) length and capacity of each subsection (with the subsection being defined as the distance from entrance to exit or exit to entrance), 2) selection of one out of five speed-flow curves or insertion of the user's own speed-flow curves, 3) optional weaving analysis, 4) number of main lanes in each subsection and number of lanes in each entrance/exit ramp, and 5) entrance ramp characteristics associated with priority metering operations. The capacity of each subsection will be selected based on manual counts, number of lanes, and engineering judgment. Multiple counts have been conducted at bottleneck locations within each study section. Due to the separability of the traffic simulation and the priority vehicle metering algorithms, it is possible to "create" an extra lane (capacity) in the bottleneck subsection, execute the FREQ3CP, and predict traffic conditions after added lane is in use. In this manner, other bottleneck areas may be evident. Multiple runs of FREQ3CP with small changes to demand (or capacity), added lane(s), and appropriate ramp metering (with and without priority) operations will be used in conjunction with economic factors in validating use of this program.

DOCUMENTATION OF RESULTS

Three research reports were written for the one-year period entitled "Development and Evaluation of On-Freeway Traffic Control Systems and Surveillance Techniques."

Research Report Number 173-1, "Alternative Designs for CCTV Surveillance Systems," by Donald Andersen

Research Report Number 173-2, "A Study of On-Freeway Lane Closure in the Merge area of Two Freeways," by Richard V. Fullerton and William R. McCasland.

Research Report Number 173-3F, "Final Report of Development and Evaluation of On-Freeway Traffic Control Systems and Surveillance Techniques," by William R. McCasland.

Several studies initiated under this project will be completed and documented in research reports for Study Number 2-18-77-210, entitled "Evaluation of Urban Freeway Modifications." These include:

Low Volume Incident Detection; Implementation of the FREQ3CP Model; and Evaluation of Freeway Bottlenecks.

CLOSURE

This study closes the work begun several years ago in the control of freeway demand. Other studies in ramp metering may be developed in the next few years to improve the design and operation, the cost effectiveness, and the applications to preferential operations for priority vehicles, but the basic research on ramp control is completed.

However, the research of on-freeway control systems is just beginning. Lane controls for bus and car pool operations will have to be implemented. The bottlenecks that are caused by major freeway-to-freeway interchanges must be eliminated. Lane control is a part of the solution. Area wide control systems for urban areas must have traffic control systems of sufficient power to determine the level of service for that most important arterial network--the freeway systems. Greater control than that provided by ramp control is essential for level-of-service control of freeways. On-freeway control as proposed by this study is part of the solution.

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13. JACOX, Inc.
1301 S. Patrick Drive
Satellite Beach, Florida 32937

14. Princeton Electronics Products, Inc.
P. O. Box 101
North Brunswick, New Jersey 08902

15. RCA Closed Circuit Video Equipment
New Holland Avenue
Lancaster, Pennsylvania 17604

16. Video Components, Inc.
130 Central Avenue
Farmingdale, New York 11735

APPENDIX

(No.)	(Description)	(Slide)
1.	The freeway - a vast network of highly efficient roadways that criss-cross the city and, in fact, the nation. It is the life line of every metropolitan area in the United States. Without the mobility provided by the modern freeway system, the cities of today could not survive.	AIS-1
2.	The modern freeway is a technically sophisticated traffic facility designed to meet the transportation needs in the urban area.	AIS-2
3.	Over the past 40 years, a tremendous amount of effort has gone into the design of urban freeways for safety and operational efficiency.	AIS-3
4.	And traffic engineers are working continually to devise methods for improving even further the services provided by freeways to the thousands of motorists who travel them every day.	AIS-4
5.	For a freeway to be efficient, it must be free-flowing. That means that traffic continually moves at a uniform speed. If traffic always flowed smoothly, there would be no problem.	AIS-5

(No.)	(Description)	(Slide)
6.	But there are two reasons for the smooth flow of traffic to be interrupted. The first, and perhaps the more common occurs when the demand exceeds the capacity; that is, more people try to use the freeway than can physically drive on it. You have seen the situation where people are constantly waiting on the ramps to enter the freeway, and the lanes are packed, moving slow, and in stop-and-go conditions. This is congestion.	AIS-6a AIS-6b AIS-6c
7.	Another situation producing stop-and-go conditions on freeways occurs when the capacity is reduced below the existing demand. The main thing that limits capacity beyond that which is normally available is the occurrence of a traffic accident which blocks one or more of the freeway lanes.	AIS-7
8.	I am sure that, in your freeway driving, you have been caught in traffic that is stopped because of an accident that has occurred in the lanes ahead.	AIS-8
9.	The police and traffic engineering departments are vitally concerned with freeway accident problems and are working toward minimizing the losses in lives, dollars, and time. Some freeways have special patrols to assist the drivers of disabled vehicles. In addition, every freeway driver also has a responsibility to the public to help in minimizing loss due to accidents, both in accident prevention and in reduction of time losses in the aftermath of an accident.	AIS-9a AIS-9b
10.	In this presentation, we want to point out the magnitude of the problems caused by freeway accidents and to suggest ways in which drivers of vehicles involved in an accident can assist in clearing the freeway travel lanes so that normal traffic movement may be restored as quickly as possible.	AIS-10a AIS-10b

(No.)	(Description)	(Slide)
11.	For a moment let us explore the actions of drivers immediately following a collision. Have you ever considered precisely what you would do if you were involved in an accident on a freeway?	AIS-11
12.	Let's examine the possible sequence of events that might take place following the accident...	AIS-12
13.	Assuming that you were not seriously injured, perhaps you would get out of your car, examine it and any other vehicles, and check to see if there were injuries to any of the other persons involved. You would possibly be very concerned that the vehicles not be moved.	AIS-13
14.	You would record the license numbers of the other vehicle or vehicles and set out to obtain the names and drivers license numbers of other drivers involved in the accident.	AIS-14
15.	You would be so concerned over the conditions surrounding your accident that you would perhaps give very little thought to the safety of others and the prevention of a secondary accident. The most important thing to you at that time would be the conditions surrounding your accident.	AIS-15

(No.)	(Description)	(Slide)
16.	No doubt you would immediately assume that you must notify the police and have an investigating officer come to the accident site. Most people do not realize that some of the larger city police departments do not investigate minor accidents, those which are called "fender benders." The time required to go to the site and to conduct an investigation results in prolonged congestion and delay on the freeway and is far more hazardous than is necessary.	AIS-16
17.	As a general guideline, minor accidents in which damage does not render the vehicle undriveable should not be reported to the police. The drivers involved should exchange drivers' license numbers, names, and addresses, and file their own personal report to the Texas Department of Public Safety.	AIS-17
18.	Suppose now in your case that damage is quite high and minor injuries have occurred, and you must summon the police officer to the scene of the accident.	AIS-18
19.	If you take just a moment and look back down the freeway, you will probably note a seemingly endless line of automobiles either stopped or moving very slowly, wasting time, creating hazardous driving conditions, wasting fuel, and increasing the air pollution level. What can you do about this?	AIS-19
20.	First, remove your vehicle from the through lanes, if it is driveable, and permit traffic to operate as well as possible at the moment. When the investigating officer has arrived at the scene, first he will take care of the injury situation.	AIS-20

(No.)	(Description)	(Slide)
21.	Then he will do whatever is necessary to clear the obstruction that is blocking the freeway. The total period of time that has elapsed since the accident occurred is then compounded by the time required to remove the vehicles and to conduct the accident investigation.	AIS-21a AIS-21b
22.	On the average, it takes about 25 minutes to complete this investigation - in other words, to determine the who, what, when, where, and how of the accident.	AIS-22
23.	Even though the investigation may be conducted on the shoulder, studies have confirmed that curiosity of the other motorists prolongs the slow-down of traffic when the parked vehicles, drivers, and investigating officer remain within view of the freeway.	AIS-23a AIS-23b
24.	As an aid in restoring freeway traffic movement after an accident, engineers have devised the concept of Accident Investigation Sites for relocating the investigation activities away from the freeway, preferably out of the view of motorists on the freeway.	AIS-24
25.	When driving the freeways, you should observe that these Accident Investigation Sites will be identified by special signs such as this one.	AIS-25

(No.)	(Description)	(Slide)
26.	If you are involved in an accident on the freeway, these sites will be of benefit to you. They are relatively safe and reasonably accessible. When the investigating officer arrives, he may direct you to the nearest Accident Investigation Site.	AIS-26a AIS-26b
27.	However, as a freeway driver involved in an accident, what can you do <u>immediately following the accident</u> to alleviate some of the traffic congestion?	Sequence of Slides AIS-27a AIS-27b AIS-27c AIS-27d AIS-27e AIS-27f
28.	The most important action you can take is to move your vehicle out of the traffic stream, if it is driveable.	AIS-28
29.	Drivers involved in traffic accidents often are reluctant to move their vehicles from the exact location of the accident for fear that: (1) They are violating the law or (2) They may be violating their insurance claim.	AIS-29
30.	Let's consider the first point concerning the legal implications.	AIS-30

(No.)	(Description)	(Slide)
31.	A portion of Section 39 of the Texas Motor Vehicle Laws states the following: "The driver of any vehicle involved in an accident resulting only in damage to a vehicle which is driven or attended by any person shall immediately stop such vehicle at the scene of such accident or as close thereto as possible... Every such stop shall be made without obstructing traffic more than is necessary.	AIS-31
32.	Therefore, if no injury or fatality has occurred, by law you are directed to clear the roadway after an accident.	AIS-32
33.	Regarding the second point - drivers fear that moving a vehicle that has been involved in an accident may jeopardize their insurance claim because failure to keep the accident "in tact" may make it more difficult to determine who was at fault.	AIS-33
34.	At the same time, however, the presence of the damaged vehicles in the freeway travel lanes may result in additional accidents, and in turn, more damaged vehicles and possibly more injuries.	AIS-34a AIS-34b
35.	Therefore, personal safety and restoration of traffic movement should be of utmost consideration to both the individuals involved in the accident and to the respective insurance companies.	AIS-35

(No.)	(Description)	(Slide)
36.	If at all possible, the vehicles should be moved a safe distance off the freeway. Then freeway traffic movement may resume while the accident investigation is taking place.	AIS-36
37.	You can be of further help in alleviating traffic congestion after an accident by being aware of the existance of the Accident Investigation Sites and cooperating with the officer in moving your vehicle. to one of these areas.	AIS-37
38.	We have an excellent system of freeways in this country, and there is a continually increasing demand for freeway space. Therefore, it is very important to utilize these facilities to their maximum capacity.	AIS-38
39.	Immediate removal of accident vehicles from the travel lanes and utilization of Accident Investigation Sites are means of improving freeway operations following an accident...	AIS-39
40.	And can help tremendously to expand the service of the freeway in meeting the transportation demands of the city in the years to come.	AIS-40