Los Angeles (CA) Area Freeway Surveillance And Control Project

Fourth Annual Report, 1974

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY RONALD REAGAN, Governor

DEPARTMENT OF TRANSPORTATION
OFFICE OF DIRECTOR
1120 N STREET
SACRAMENTO, CALIFORNIA 95814

August 1, 1974

Hon. Darryl R. White
Secretary of the Senate
State Capitol
Sacramento, CA 95814

Hon. James D. Driscoll
Chief Clerk of the Assembly
State Capitol
Sacramento, CA 95814

Gentlemen:

Assembly Concurrent Resolution No. 111, Resolution Chapter No. 164, of the 1970 Regular Session requested the Department of Transportation (Caltrans) to submit annual progress reports on the Los Angeles Area Freeway Surveillance and Control Project. The resolution was authored by Assemblyman Joe A. Gonsalves.

Portions of the Surveillance and Control Project are a cooperative effort by Caltrans and the California Highway Patrol.

Enclosed are two copies of the Fourth Annual Progress Report in accordance with the resolution request.

Sincerely,

Howard C. Ullrich

HOWARD C. ULLRICH
Director of Transportation

Enclosures

RELATIVE TO THE LOS ANGELES AREA FREEWAY SURVEILLANCE AND CONTROL PROJECT

WHEREAS, The California freeway and expressway system of 12,460 miles will serve directly, or closely, all population centers estimated to reach 5,000 or more by 1980; and

WHEREAS, It is readily apparent that for the freeway system to be operating at maximum efficiency with the greatest convenience and safety to the public, the freeway system must be operated as a total integrated system of transportation; and

WHEREAS, The Los Angeles Area Freeway Surveillance and Control Project is a 42-mile experimental project located on the Santa Monica, San Diego, and Harbor Freeways to determine the feasibility of operating freeways as an integrated system of transportation by means of a real-time surveillance and control system; and

WHEREAS, The experimental project will involve techniques to provide traffic sensitive ramp control, early detection and rapid removal of disabled vehicles and other hazards from freeways, an effective warning and information system for the motorist, and services for the stranded motorist; and

WHEREAS, The project will be under construction this year, and it is expected that the testing and evaluation of data obtained from the project will be completed by 1973; and

WHEREAS, It is necessary that the Legislature be informed as to the progress and tentative results and conclusions during the experiment so that desirable legislation, if necessary, regarding the implementation of real-time surveillance and control systems for the operation of freeways may be enacted at the earliest possible time; now, therefore, be it

Resolved by the Assembly of the State of California, the Senate thereof concurring, That the members hereby request the Department of Public Works to submit progress reports on the Los Angeles Area Freeway Surveillance and Control Project to the Legislature by the 30th calendar day of each regular session of the Legislature, and the final report within 90 days after completion of the experiment; and be it further

Resolved, That the Chief Clerk of the Assembly transmit a copy of this resolution to the Director of Public Works.

Assembly Concurrent Resolution No. 111
Adopted in Assembly May 22, 1970

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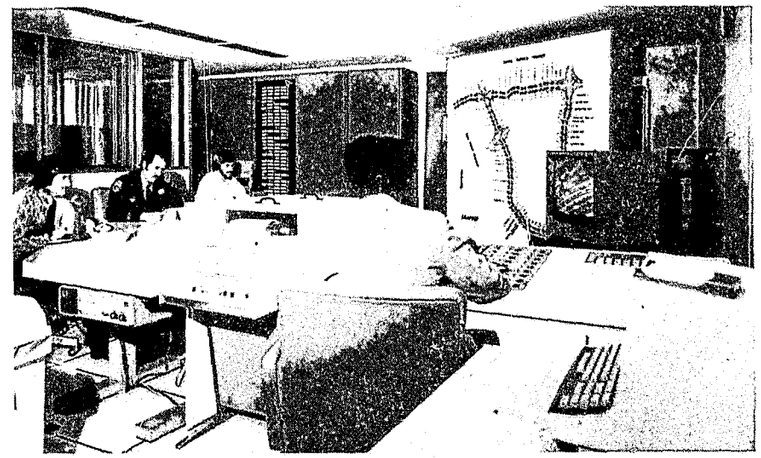


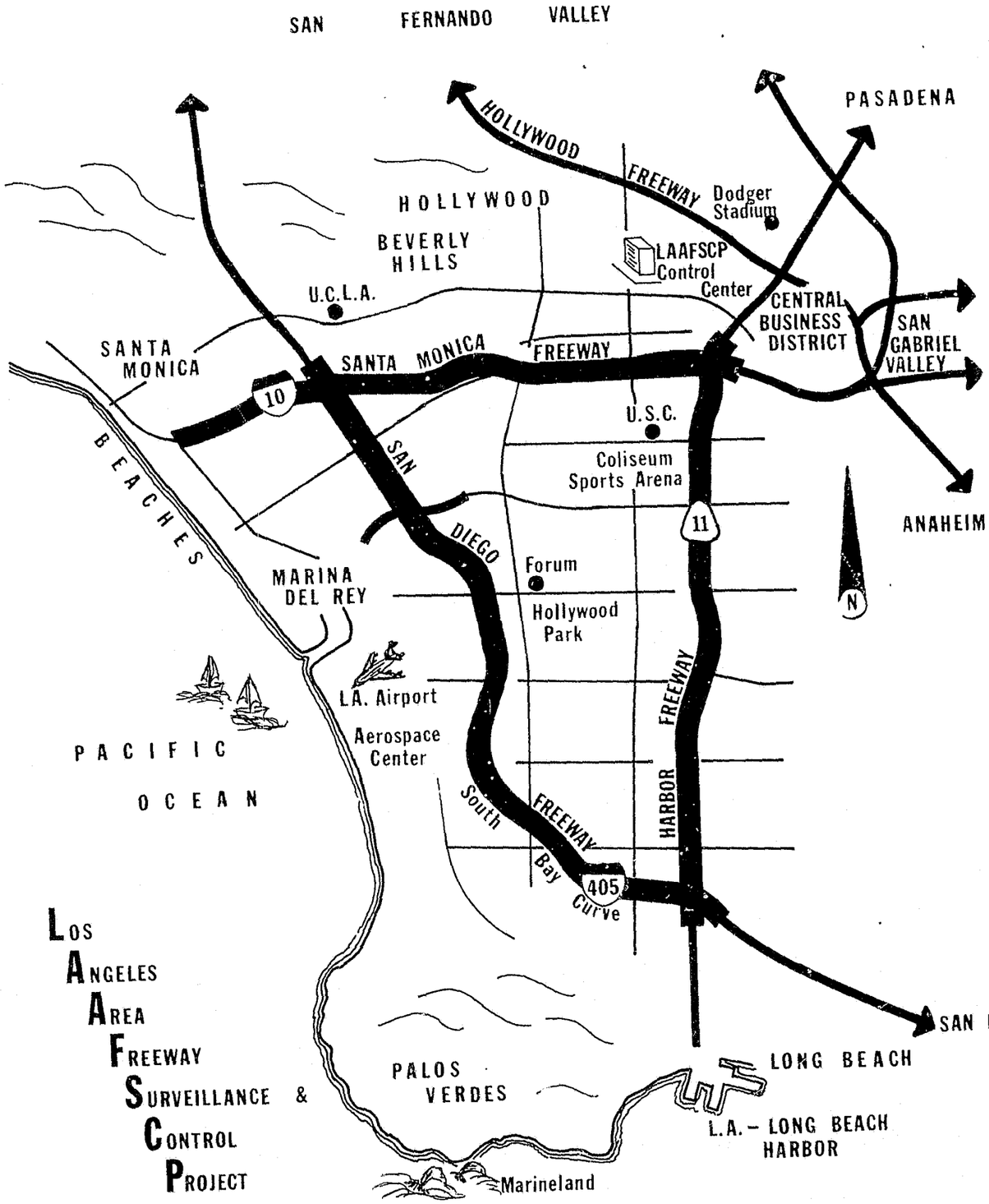
INTRODUCTION

Californians have become very dependent upon the use of freeways for the movement of people and goods. It is apparent that the public desires freeways to operate at maximum efficiency with the greatest possible convenience and safety. The Los Angeles Area Freeway Surveillance and Control Project (LAAFSCP) was devised to experiment with techniques to meet these public desires.

The techniques experimented with can be classified into four phases:

- Traffic responsive ramp control with electronic surveillance.
- Early detection and rapid removal of unusual incidents.
- Service for stranded motorists.
- An effective warning and information system for the motorist.

Experimentation in all of these phases was completed as of July 1, 1974.



SUMMARY

PROJECT RESULTS

Results of experimentation are to be detailed in final reports that will be available in the near future. These reports will show what was done, what can be done, what are the costs, and most importantly, what are the benefits.

This report discusses tentative results summarized as follows:

- Traffic responsive ramp control with electronic surveillance.

  Recurring freeway congestion can be greatly reduced with traffic responsive ramp metering. Electronic surveillance is essential to this technique.

- Early detection and rapid removal of unusual incidents.

  Electronic surveillance is being used for detection of accidents and other incidents. Coupled with rapid verification and response it offers considerable potential benefit.

- Service for stranded motorists.

Electronic detection is not necessary for providing service to motorists. If service vehicles are provided, they should be equipped with towing capability. Nonrecurrent congestion from accidents could be significantly reduced with roving service vehicles.

- An effective warning and information system for the motorist.

Information sent via commercial radio advisory is useful for providing the motorist an overview of traffic conditions. Changeable message signs are useful for "up to the minute" local information. Information systems in general require thorough surveillance and are not expected to prove cost effective.

TRAFFIC MANAGEMENT

Computer Surveillance can assist in the early detection and management of traffic incidents. The earlier an accident or other incident is removed from the roadway, the less chance there is for another accident to take place as a result of congestion created by the first one. But nothing will ever take the place of efficient management of the "incident". The law enforcement officer or highway patrolman on the scene has been and will continue to be the key to successful management of incidents.

Most incidents can be adequately managed by an Officer at the scene. However, some serious incidents do require support from other agencies and those supporting agencies should be ready to bring into play their particular expertise when requested by law enforcement.

On State highways the responsibility for traffic management is shared jointly by the California Highway Patrol (C.H.P.) and the Department of Transportation (CALTRANS). Consequently, both agencies have participated in the LAAFSCP experimentation. The techniques experimented with can act as a supplement to improve the existing traffic mangement system to a higher state of the art.

The problem of congestion is easy to define (more cars than roadway ability to serve them) but the solutions are varied and complex. The approach to solutions, however, is simple:

(1) Find out what is happening on the roadway (surveillance),
(2) Locate problems (detection), and
(3) Implement solutions (response).

The integration of solutions into a system is not a simple task but could expedite the solutions to non-recurrent (unexpected) congestion.

The final LAAFSCP report will attempt to identify solutions, and tell how these solutions can be combined into an integrated traffic management system.

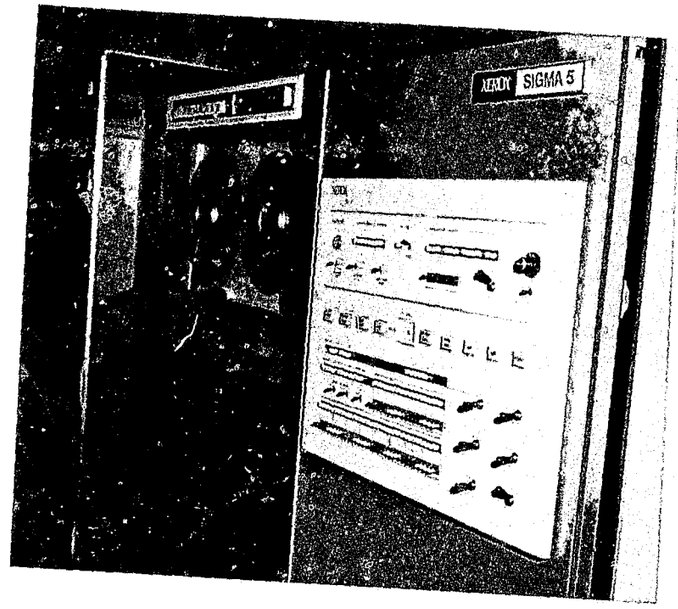
TENTATIVE RESULTS

Now that the project is nearing completion, results are becoming more clearly defined. The following discussion reports some of the more prominent findings to date for each of the four phases.

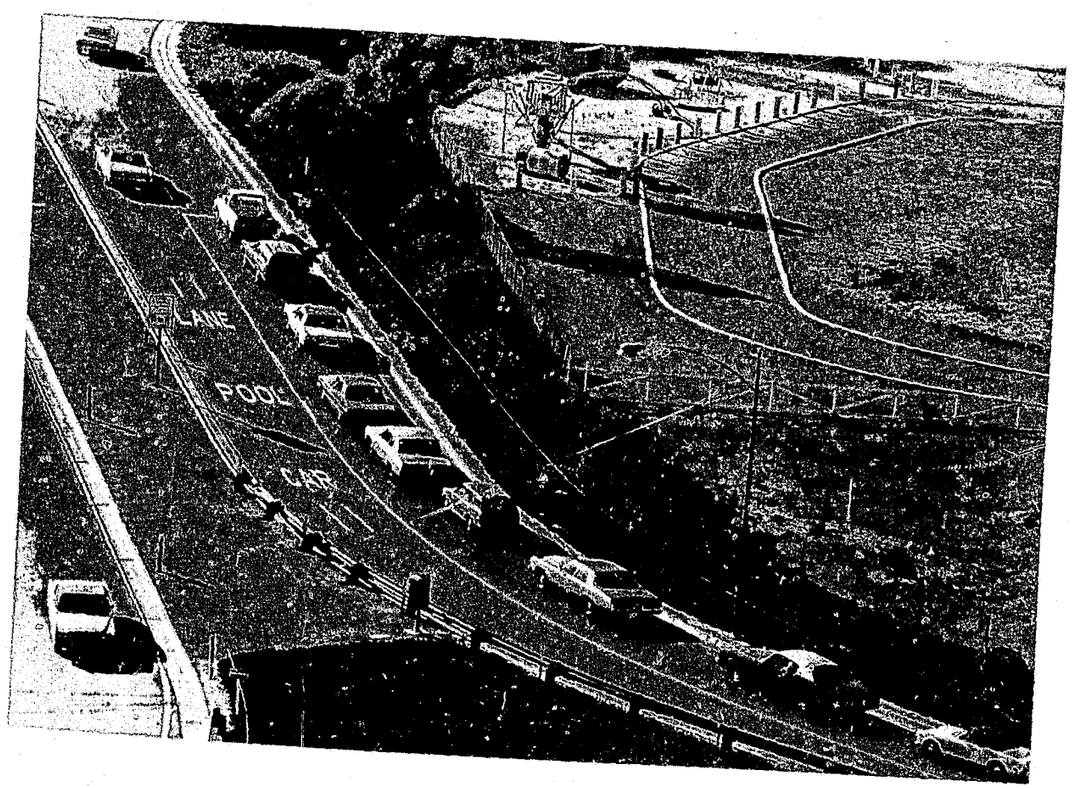
PHASE I: Traffic Responsive Ramp Control with Electronic Surveillance

Electronic surveillance is related to both recurrent and nonrecurrent congestion. Recurrent congestion results from too many cars trying to use the freeway at the same time, and occurs on a daily basis at usually predictable times and places. Nonrecurrent congestion results from an incident (accident, disabled vehicle, spilled load, etc) and occurs at random times and locations

The purpose of surveillance is to provide information about traffic flow and to pinpoint problems for traffic management. The method of gathering information uses sensors in the pavement, which feed data via leased telephone lines to a centralized Xerox Sigma V computer. The computer organizes the information and outputs it to a display map, as well as to computer tapes and printouts.



The Sigma V computer varies signal rates to provide traffic responsive metering.



Recorded data is useful to engineers for studying and solving traffic problems. The computer pinpoints immediate problems by using input data to detect sudden changes in traffic flow. These sudden changes cause an alarm to be sounded, indicating an incident has occurred.

Once an incident is detected, action by the CHP can begin to correct the problem. The problem solving or incident management often involves other project techniques such as roving tow trucks, service trucks, helicopter borne closed circuit television. These techniques are used to alleviate nonrecurrent congestion.

Recurrent congestion is alleviated by ramp control. A program is under way to furnish control for the entire urban Los Angeles area freeway system. The technique uses traffic signals at on-ramps to meter vehicles onto the freeway.

Ramp metering works by bringing into balance the freeway demand and capacity. A large delay is eliminated on the freeway for a large number of motorists while a small delay for a small number of entering motorists is caused to the on-ramp traffic.

The project has experimented with a second generation

techique referred to as traffic responsive ramp control. The computer is programmed to automatically and continuously vary metering rates to be most compatible with changing traffic volumes on the freeway. Traffic sensors located along the freeway provide the traffic volume data.

By comparing "fixed time" and traffic responsive (real time) operational modes, it was found that the waiting time at the on-ramps for real-time metering is 20% less than for fixed time metering. This delay savings amounted to more than 100 vehicle hours each day for the 13 ramps operated experimentally on the South Bay Curve portion of the San Diego Freeway (see Project Map). This time savings results from the computer selectively allowing the optimum number of cars to use the freeway flowing at speeds of 50 mph or greater. By allowing the computer to selectively permit cars to enter, the freeway throughput (vehicle miles) was increased by 3%.

The 20% delay savings resulting from the 3% increase in throughput is valued at more than $100,000 per year in motorist time savings on the 13 ramps. Based on this benefit CALTRANS proposes to expand traffic sensitive metering.

Another advantage of real time metering is the ability to allow maximum access to the freeway downstream of an accident scene. This eliminates the possibility of having a near empty freeway with people waiting on the ramps because of pre-set rates.

PHASE II: Early Detection and Rapid Removal of Unusual Incidents.

This phase involves reducing nonrecurrent congestion. Accidents are the major cause of nonrecurrent congestion. Other incidents which cause nonrecurrent congestion are disabled vehicles, spilled loads, "gawking" (or rubbernecking), etc.

The key to reducing nonrecurrent congestion is the time required to detect and remove incidents. The existing mode of operation is for the CHP Officer at the scene of an unusual incident requiring a tow truck to summon the equipment after arrival at the scene. Typically, it takes 42 minutes from the time of occurence until an accident is removed from the freeway.

It is emphasized that we are discussing only the incidents requiring the use of a tow truck. These are only a small portion of the incidents responded to by the CHP.

Figure 1 illustrates the time element involved in clearing such incidents from the freeway. On the average

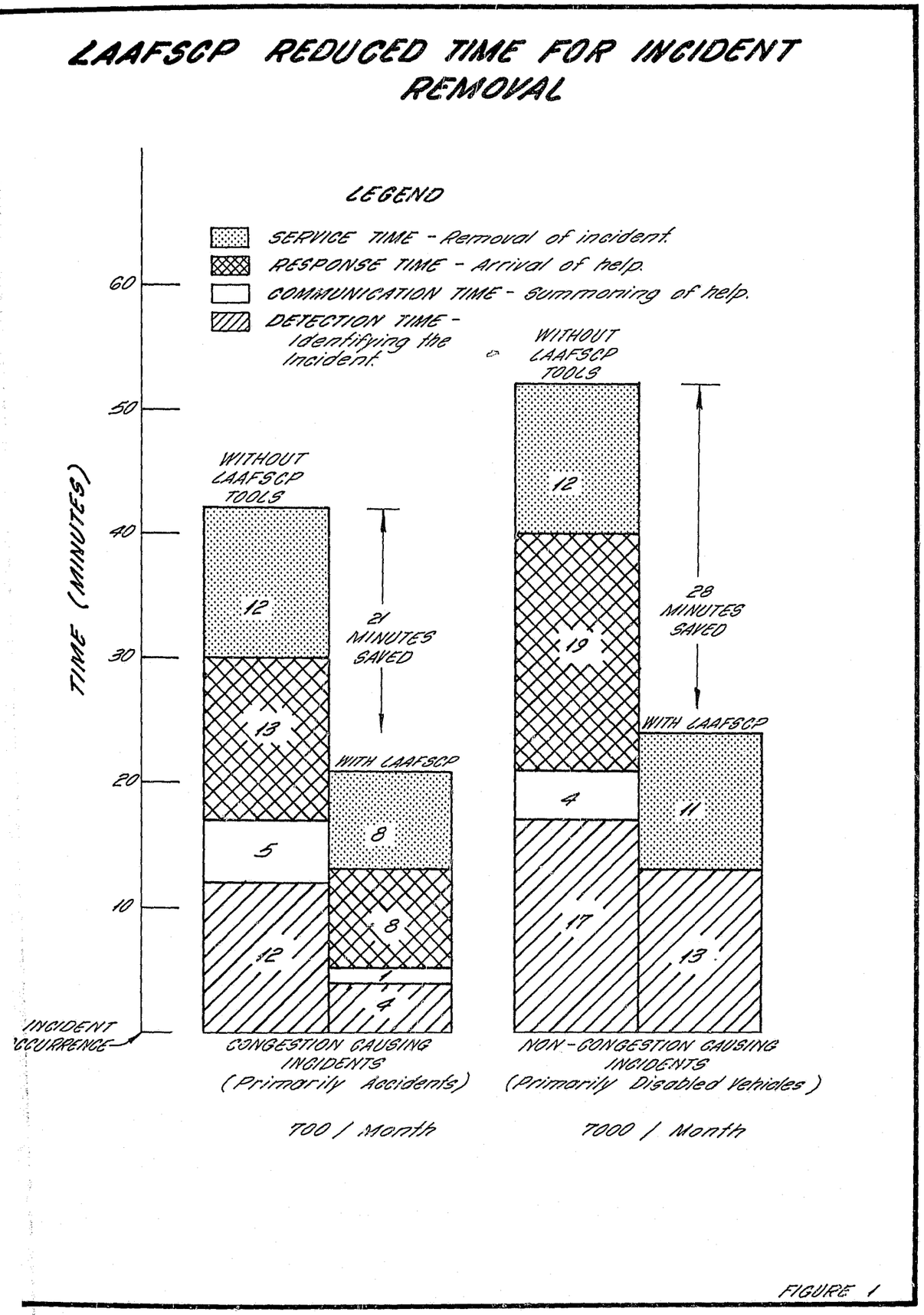


FIGURE 1

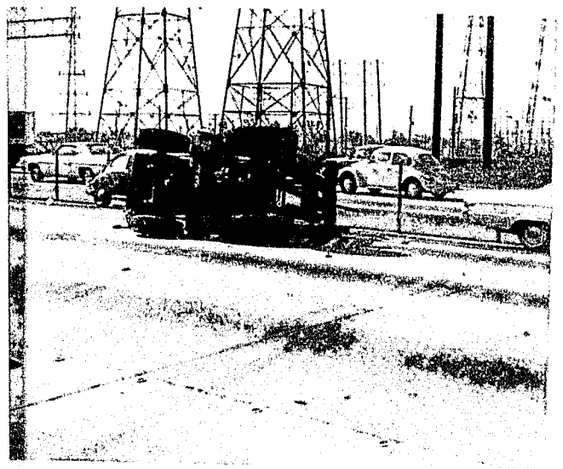
the CHP Officer arrives on the scene 12 minutes (detection time) after occurrence of an incident. Detection time of this magnitude was characterized as superb in a study by the Airborne Instruments Laboratory of New York. Detection occurs by normal patrolling or in response to emergency calls.

Five more minutes is consumed assessing the need for a tow truck, radioing to the CHP Communication Center, and the Center completing a phone call to a tow company. It then takes 13 minutes on the average for the tow truck to respond, and 12 more minutes to clear the freeway.

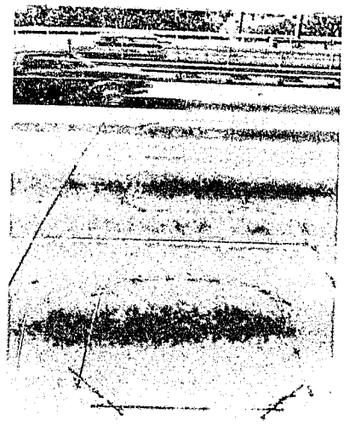
This 42 minute cycle describes only one model of process which can occur. Other situations and models have been constructed. For instance, a tow truck is not required for a large portion of the incidents. For these incidents the CHP Officer uses his push bumper or takes other expedient action to remove lane-blocking vehicles. Cycle time for these situations is significantly less than 42 minutes.

Using the LAAFSCP system for response (electronic detection and roving tow trucks) to an accident reduces the 42 minutes to 21 minutes. This time is comprised of 4 minutes for electronic detection, 1 minute communication time, 8 minutes for tow truck response, and 8 minutes for service time to remove the problem.

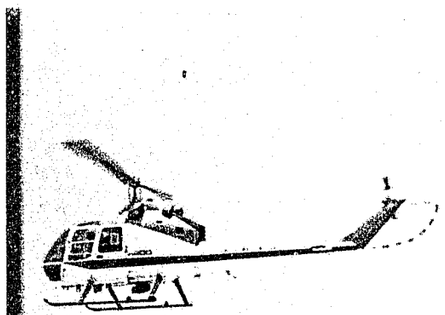
INCIDENT MANAGEMENT — SEQUENCE OF EVENTS



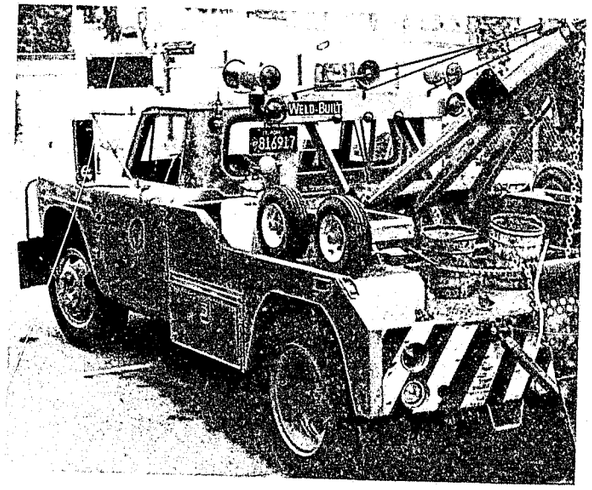
OCCURRENCE



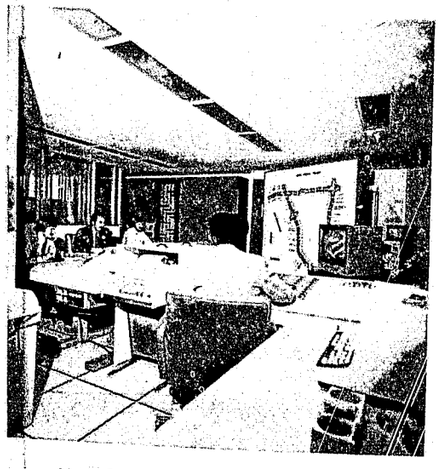
ELECTRONIC DETECTION



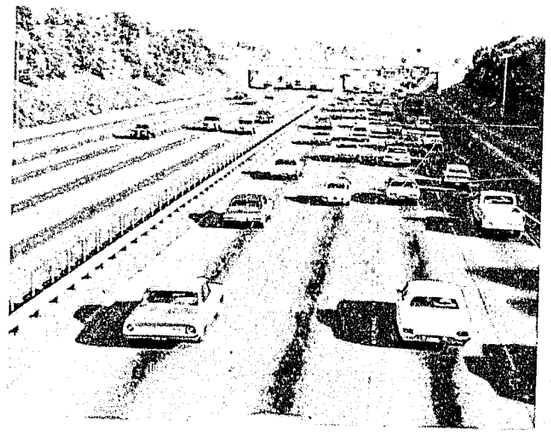
HELICOPTER



AND STATE TOW TRUCK DISPATCHED



INFORMATION CENTER



TO RESTORE TRAFFIC TO NORMAL

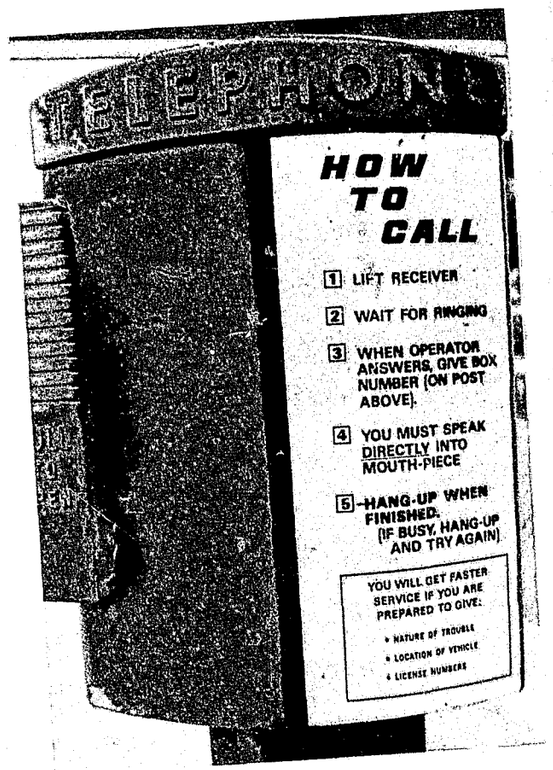
Other models can be constructed using the data from Figure 1. For instance, it might be considered desirable to dispatch CHP Officers based upon electronic detection. When CHP units are dispatched, they arrive in about eight minutes. The LAAFSCP detection time of four minutes is about the same as the time for emergency calls from the public to the CHP dispatch center. This suggests that electronic surveillance does not help the CHP get to the scene any quicker than they already do.

The major conclusion from Figure 1, is that the roving tow trucks were on the scene much more quickly than a commercial tow would have been for the same incident. The CHP Officer, who is responsible for removing the incident, did not have to request a tow truck and wait for its arrival, an average of 18 minutes (5 minutes to make the request plus 13 minutes for a commercial tow truck to respond).

As a further aid in achieving rapid removal of incidents, the CHP operated a helicopter equipped with a closed circuit television (CCTV) camera. This provided the control room staff visual contact with the incident scene. The visual contact aided the control room staff composed of a CHP traffic officer, a traffic engineer, and a highway maintenance man with aids for training and knowledge for development of long term management decisions

The best use of the helicopter is to directly advise the CHP Officer at the scene. The helicopter is most advantageous for managing major freeway incidents which affect traffic movement both on and off the freeway. Its value for detecting incidents was minor.

An operational Traffic Management System consisting of electronic incident detection, traffic responsive ramp control, and roving tow trucks can provide large benefits to the motorists. By reducing incident duration time by 50%, congestion is reduced by 75%. Other motorist benefits are reduced accidents and user costs (such as towing fees).



Services for Stranded Motorists

The accidents reduced are secondary accidents and pedestrian injuries. The 50% reduction of incident duration time allows less motorist exposure to hazardous conditions. This results in less accidents.

PHASE III: Service for the Stranded Motorist.

For every congestion-causing incident that occurs, there are ten non-congestion causing incidents. These incidents are primarily disabled vehicles that sometimes result in secondary accidents and pedestrian injuries.

The freeway exposure time for non-congestion causing incidents is 52 minutes on the average (see Figure 1). This is approximately 25% longer than for congestion-causing incidents.

A roving service patrol operation reduced this exposure time to 24 minutes. The major reason for the time savings was elimination of the response time for a commercial service vehicle to arrive. The roving patrol was able to provide the necessary service in most cases at the time of detecting the problem. Table 1 shows the type of problems encountered by the service patrol.

SUMMARY OF RESULTS-SERVICE FOR STRANDED MOTORIST PROJECT

OCTOBER, 1971 TO APRIL, 1973

DISABLEMENT TYPES ENCOUNTERED										
Out Of Gas	Flat Tire	Mechanical Failure	Overheat	Fire	Traffic Collision	Motorist Lost	Spilled Load	Electrical Failure	Causes Unknown	Total
3471	3854	4533	1068	103	1156	192	384	1060	3074	18,895
18.4%	20.4%	24.0%	5.7%	0.5%	6.1%	1.0%	2.0%	5.6%	16.3%	100.0%

RESPONSE OF THE SERVICE PATROL TO DISABLEMENTS ENCOUNTERED								
Assistance Provided						Assistance Not Provided		
Provided Gas	2408	12.7%	Transported Driver	406	2.1%	Motorist Assisted by California Highway Patrol or made Prior Contact with Private Tow	1962	10.4%
Fixed Tire	1880	10.0%	Extinguished Fire	46	0.3%			
Minor Repair	807	4.3%	Relayed Message	1292	6.8%	Motorist had Abandoned Vehicle Prior to Arrival of Service Patrol	2456	13.0%
Battery Jump	440	2.3%	Gave Directions	185	1.0%			
Provided Water	559	3.0%	Assisted Driver Helping Himself	2947	15.6%	Motorist had Repaired own Disablement Prior to Arrival of Sevice Patrol	2696	14.3%
Pushed	802	4.2%	Total	11,781	62.3%	Total	7114	37.7%

Sex of Driver	
Male	Female
78.6%	21.4%

Location of Disablements			
Lane	Right Shoulder	Center Divider	Ramp
7.3%	78.2%	8.7%	5.8%

TABLE I

The roving patrol operated independently of the electronic surveillance system. It was not dispatched to incidents and did not have towing capabilities. Detection was entirely by roving the freeway. This is because electronic detection is only activated by congestion, and only a small number of disabled motorists cause congestion. Examination of Figure 1 shows that if a roving patrol also had towing capabilities it could be nearly as effective as a system of electronic detection and roving tow trucks (PHASE II). This is because the communication time and commercial tow truck response time could nearly be eliminated.

The annual operational cost for such a system is about $10,000 per mile of freeway covered with 24-hour, 7 day a week service. Electronic detection is not essential to a service patrol but operates as an aid to increase its benefits. Benefits are derived from reduced congestion. The Accident Reduction discussed in PHASE II is still realized.

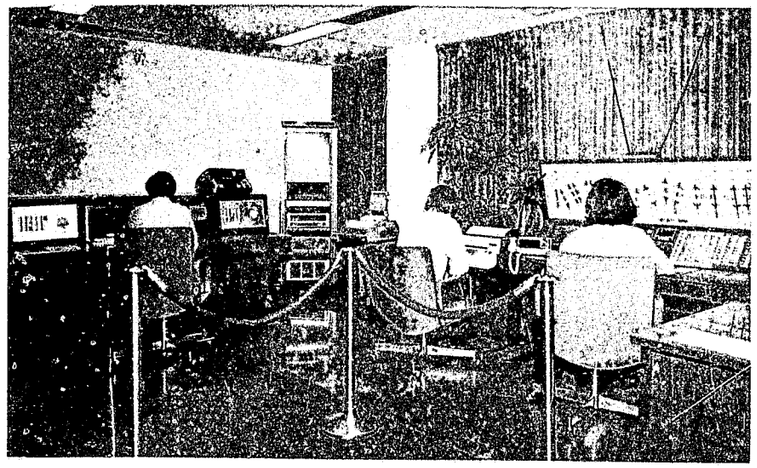
A separate part of this phase was to investigate the existing emergency call box system in Los Angeles County. The results show that only 20% of disabled

motorists use freeway call boxes. Seventy percent of the people are aware of the intended use for call boxes. The most logical explanation for the low usage rate is that many motorists prefer to take care of themselves and fear the service fees involved if they use the call box to summon help. Service fees for commercial tow trucks are generally $8.50. If a tow is required, the minimum fee is $17.50.

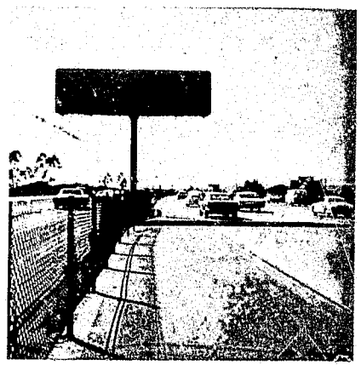
PHASE IV: An Effective Warning and Information System For the Motorist.

Two techniques are utilized to provide the motorists with useful information. The first technique is to provide commercial radio stations information to be broadcast over AM radio. This information is general, with the intent of providing the motorist an overview of traffic conditions he may encounter on his trip. The second technique utilized on the project, provides "real-time" detailed information in the vicinty of a freeway incident. This is accomplished with 35 changeable message signs along the Santa Monica Freeway. Both techniques provide information rather than instruction.

Nine radio stations received information via teletype



From this remotely located control room messages are transmitted to the changeable message signs.



The signs are capable of displaying a wide range of messages.

direct from the surveillance data center. On the average, it took 15 minutes after a problem occurred until a motorist heard about it on his car radio if the station he was listening to reported the information. No single station reported more than 50% of the known accidents on the 42-mile loop.

The radio advisories have contributed to providing the motorist an overview of traffic: however, because of broadcast scheduling committments, radio stations cannot be expected to provide the motorist with "up to the minute" traffic information. Another problem is that the overview can only be given to a limited number of motorists.

The Changeable Message Signs were officially dedicated by the Commissioner of the California Highway Patrol and the Director of the Department of Transporation, on April 20, 1973. The experimental operation will continue through June 1974. Public opinion and driver reaction surveys are being conducted by both UCLA and CALTRANS. These surveys will determine the degree of public acceptance of the system and

will also indicate a desirable mode of operation. To determine the best way to operate, we used the signs in different modes. For example, they have been blank, except during incidents, to determine if the motorist can accept a blank sign as a functioning sign. Continuous information was also displayed, such as "NORMAL" to show that the sign is indeed operating.

A recent mail survey concentrated on the period when the "NORMAL" type of messages were used. There has been over an 80% return, with many making comments. Seventy percent of the respondents indicated disfavor with slogan types of messages, such as "SEAT BELTS SAVE LIVES". Seventy percent were in favor of an expanded information usage, including messages about intersecting freeway conditions, more congestion limits and travel times. Some type of display to indicate signs are functioning when not in use, N, OK, NORMAL, etc., appears to be unnecessary.

Recent data shows that the signs are being used on the average for incidents about six times per day. Thirty-eight percent of this usage has been to warn motorists of stalled vehicles. Twenty-two percent has warned of heavy traffic on congested ramps,

congestion on other freeways, and congestion from gawking. Twelve percent of the usage has been for accidents with the remainder of the usage for possible incidents (general warning), construction, fog, travel time information, etc.

The electronic detection system alerts the sign operator to possible incidents. To sign an incident, further detailed information is required. This detailed verification information can be obtained from radio equipped CHP or CALTRANS units. When CALTRANS units were providing the verification they furnished details on 85% of the incidents which are signed.

A third technique, Roadside Radio, has not been implemented as an experimental project as originally proposed. The deferment was the result of efforts to allow commercial radio stations to provide a similar service. The original purpose for proposing roadside radio was to test and evaluate an alternate for changeable message signs. A Roadside Radio System, broadcasting only during incidents and in the vicinity of incidents, appears to be a quick economical way to communicate with motorists.

Benefits from information to motorists include convenience to the motorist, and reduction of delay and accidents. Reduction of delay and accidents does not appear to be significant. Consequently, motorist information systems are not apt to prove cost effective, since convenience benefits, while real, are not quantifiable.

FUTURE TRENDS

RAMP METERING

Because of the success experienced with traffic sensitive ramp metering, CALTRANS is developing a plan for further use. A total of 21 ramps are now under traffic sensitive operation on the 42-mile loop. Nine more ramps on the Harbor Freeway are to be converted this year. By late 1975 over 100 ramps are expected to be traffic responsive This will include nearly all of the 42-mile loop, plus portions of the San Diego Freeway southerly of the 42-mile loop.

INCIDENT DETECTION

The Federal Highway Administration (FHWA) is interested in improving electronic incident detection. Consequently, CALTRANS is under contract with the FHWA to provide traffic

flow data related to incidents to another FHWA contractor. This contractor will develop improved electronic detection techniques. LAAFSCP experience has shown the need for more refined and sensitive detection.

One limitation of electronic detection (even for improved techniques) is a lack of confirmed details about an incident. To solve this problem, CALTRANS is investigating the feasibility of 10 fixed location TV cameras along the Santa Monica Freeway.

These cameras would be operated in conjunction with the electronic incident detection. The computer would alert an operator, who would activate a camera in the vicinity to verify and further identify the problem. This mode of operation could result in detailed identification of congestion-causing incidents within two or three minutes of occurrence.

A traffic management system using this identification and verification system could prove highly effective. The TV information would allow the dispatch of commercial tow trucks and the CHP within two or three minutes. This could result in the 42 minute incident duration time being reduced to 26 minutes.

END