PREFACE

The California Department of Transportation has a large number of employees in maintenance and construction functions that are working on or near the highway in close proximity to passing traffic. Private contractors also have employees and workers working under the same conditions.

Under the direction of the Deputy Director for Operations, Mr. John F. Maloney, this study was made to determine if and how the safety of these employees and workers could be further improved.

PLEASE NOTE

This study of the safety of maintenance and construction personnel in work zones identifies a number of specific problem areas and makes recommendations directed toward solving those problems. As such, the study should constitute a valuable resource tool for the future.

The study is not, however, designed or intended to establish a legal standard of care. To some extent, the recommendations contained herein may conflict in whole or in part with other equally important transportation policies or goals. Limited funds may make it difficult or impossible to implement some recommended changes or to meet suggested deadlines. Solutions which appear reasonable today may be unreasonable tomorrow, given the dynamic changes occurring in the field of transportation technology. Similarly, differing local conditions may require specific solutions tailored to local needs rather than application of a uniform statewide standard.

All employees and persons interested in safety should, in reading this report, understand these considerations as a fundamental part of the study.

74-48
DND

TABLE OF CONTENTS

Summary	1.0
Organization of the Study	2.0
Statement of the Problem	3.0
Analysis	4.0
Sweeping	4.1
Pavement Markers and Striping	4.2
Litter Pickup	4.3
Patching	4.4
Snow Removal and Rock Patrol	4.5
Median Barriers and Median Screen Planting	4.6
Work Scheduling vs. Hazard	4.7
Facility Reduction and Detours	4.8
Flagging	4.9
Mobile Protection	4.10
Fixed Protection	4.11
Construction Over Traffic	4.12
Construction Adjacent to Traffic	4.13
Warning Signs and Devices; Warning Devices on Equipment	4.14
Operations, Construction and Maintenance Safety Considerations at the 'Design Phase'	4.15
Statewide and Regional Uniformity, Traffic Control Standards, and Motorist Expectancy	4.16
Speed Limits: Legislation, Policies Compliance, and Enforcement	4.17
Public Information Activities Relating to Construction and Maintenance Functions	4.18

Management Support and Safety Standards Enforcement 4.19

Safety Management Information Systems 4.20

Conclusions 5.0

Recommendations 6.0

Bibliography 7.0

Annexes

A. Steering Committee Membership

B. Task Force Membership

C. Field Questionnaire

D. Safety Management Information System - Development Sequence

E. Safety Management Information System - Contents

1.0 SUMMARY STATEMENT

The California Department of Transportation has had an active safety program for over 30 years. The goal of this program has been the continued reduction of injuries and death to our employees, many of whom spend much of their working careers within inches or feet of passing traffic. The actions of an unalert motorist could kill or cripple them in a few seconds.

Traffic flows and the number of drivers have increased markedly in the past few years. Yet motorist-related employee injuries have continued to decline. Even so, five employees have been killed during the past three years.

The traveling public often loses awareness of the dangers that the maintenance employee or construction worker faces. Motorists often drive through roadway work sites on familiar roads in comfortable, sealed, air-conditioned vehicles. If they become preoccupied or have been drinking, the chance of their making a split-second misjudgement is high -- and so is the potential for a serious accident.

This special study was initiated to identify those work functions and related tasks that are most hazardous to maintenance and construction employees and workers. Twenty

major problem areas were identified and they were grouped into the following categories for analysis: problem identification; evaluation of existing procedures; actual maintenance and construction practices (which includes the production-oriented activities on or near the roadway); traffic flows in and around maintenance and construction sites; and driver behavior and its effect on construction accidents. A subcommittee was created to handle each of these areas.

The subcommittees were composed of a cross section of individuals from both within and outside of CALTRANS. They analyzed the operations in their specific categories to determine contributory factors to motorist-related accidents. They then developed specific action-oriented recommendations and time frames in which to accomplish them.

During the study, it became apparent that the safety of employees and workers has been included in planning, conducting and evaluating maintenance and construction operations throughout the State. The Department would not have attained its present status without making such concerted efforts toward improving employee and worker safety. However, if the organization is to continue its move forward, it must continually work to increase effectiveness and safety.

Generally, the study determined that there are many safe, effective operations under way throughout the State. However, there are also areas that could contribute to increased safety if improved. Currently, safety plays a vital role in many operations. In others, it is less conspicuous.

Early in this study, it became apparent that CALTRANS does not have in-depth information readily available which properly identifies current and potential safety problems or the results of efforts to correct them. There is a critical need to develop a Safety Management Information System that will make available information related to maintenance and construction safety to all management levels. The several information retrieval systems now available within CALTRANS offer no easy way to correlate safety information. Hand-tallying of information is awkward in an organization of this size. This is a pressing, immediate need.

Another item of major importance to maintenance and construction safety is the degree of support and acceptance of responsibility given by all levels of management and supervision. Safety is something that cannot be delegated. Administrators may have safety coordinators to assist them, but in the final analysis, the line administrator must accept fully and support his unit's safety program. As safety plays such a visible and important role in managing this

Department, administrators should include specific objectives and goals related to safety in their management plans. Individuals at all levels should regard safety as an important part of their evaluation and goal-setting process. There is a need for increased commitment to safety program effectiveness throughout the Department.

It is often easy to focus on the more mechanical aspects of safety, such as equipment, signs, weather, and design. While this is necessary, it is not the most important factor. The attitude and safety consciousness of the individuals involved is probably the most critical factor affecting the success or failure of any safety program.

Throughout the study training needs were identified at all levels. It was found that providing an employee with a sound foundation on how to perform a particular job in the most effective and safe manner is critically important and should be a major responsibility of every manager and supervisor.

Another important consideration in maintenance and construction safety is the visual impact and uniformity of alerting motorists approaching the work site. There are differences in equipment, procedures and warning devices that may be inconsistent with motorists' expectations. There is a need

for increased statewide uniformity, yet any changes must leave room for some variance to meet local needs. Creativity should not be stifled by rigid inflexibility. Utilizing the expertise available throughout the Department and then combining the best ideas and procedures into a uniform statewide procedure can increase departmental effectiveness, especially in the eyes of the motorist.

Public information activities relating to maintenance and construction safety are receiving increased departmental attention. Radio, television, publications and newspapers are being increasingly utilized to increase the awareness of the motorist on the highway. This is necessary and should continue.

There are 101 separate recommendations in this report which can increase the safety of maintenance and construction employees and workers. Each recommendation not only includes an action to be taken but suggests a responsible unit to initiate it along with a suggested time frame.

The safety of our maintenance and construction employees and workers is as vital to our Department as the roads we maintain are to the State. We must regard it highly, for our safety record, just as our highways, is a reflection of our organization.

2.0 ORGANIZATION OF THE STUDY

2.1 Why the Special Study Was Conducted

In October, 1973, the California Department of Transportation initiated a special study to evaluate the safety of maintenance and construction employees in relation to passing traffic. The hazards CALTRANS' road workers face each day have resulted in death, injury, and disablement. CALTRANS' management, in its continuing effort to improve safety and working conditions, began the study to examine present practices and to develop meaningful improvements that could contribute to the increased safety of road workers while maintaining traffic flows on our highway system.

2.2 Role of the Steering Committee

A steering committee was created to act in an advisory capacity. It met for the first time on November 20, 1973. Representatives of CALTRANS; the Department of California Highway Patrol; the Department of Industrial Relations; Division of Industrial Safety; employee organizations; and Dr. Slade Hulbert, UCLA, participated in the meeting. (See Annex A) The steering committee was asked to assist in developing general directions for the full task force effort, including: (a) identification of the scope of the problem; (b) establishment of specific goals for the task force; (c) determination of who or what organization or unit should

participate in the full task force effort; (d) development of a time frame; and (e) determination of the way the project results should be presented in order to maximize their usefulness.

At this discussion-type conference, a list containing a wide range of items and areas that the task force should examine was also developed.

2.3 Creation of the Task Force

A task force was then created to conduct the study. Due to the wide range of subject matter to be covered, the task force was structured into the five following subcommittees:

I. Problem Identification Subcommittee -- This subcommittee studied available information and records to identify factors which contribute to accidents in maintenance and construction zones and involve passing traffic. Based on the information provided by this subcommittee, the other four subcommittees pursued their inquiries and developed recommendations.

II. Procedures Evaluation Subcommittee -- This subcommittee reviewed procedures, manuals and directives which relate to maintenance and construction personnel and passing traffic. They examined all procedures now in use in California and those from other jurisdictions that may be applicable or valuable to our safety program.

III. Maintenance and Construction Safety Practices Subcommittee -- This subcommittee examined actual maintenance and construction practices. It sought ways and means to improve these practices as they relate to safety and passing traffic. This subcommittee concentrated on performance of the actual task.

IV. Traffic Flow Subcommittee -- This subcommittee primarily examined traffic flows in and about maintenance and construction zones. It evaluated present practices and sought improved methods which lessened the hazards to maintenance and construction personnel from exposure to vehicles in the passing traffic stream.

V. Driver Behavior Subcommittee -- This subcommittee examined driver behavior and its effect in and about maintenance and construction sites. The goal of this subcommittee was to develop an improved means of alerting motorists to the safety concerns of maintenance and construction personnel.

There were a total of 40 active core members on the task force. Individual subcommittees were composed of 5 to 8 core members of diverse fields and disciplines from both in and out of CALTRANS. There are two types of members involved in the task force: core members, who actively participated in the full spectrum of activities of a subcommittee; and

resource members, who were contacted during the subcommittees' work to obtain some specialized component of information. Many individuals from in and out of the department were contacted for information during the course of the study. See Annex B for a roster of the members of the task force.

2.4 Work of the Subcommittees

With the information provided by the steering committee, Subcommittee I -- Problem Identification -- began its inquiry to determine just what the actual problems regarding maintenance and construction safety were. Subcommittee I then developed a list of areas and items relating to the safety of maintenance and construction personnel. This information was organized according to the responsibilities of the other subcommittees. Each of the individual subcommittee chairmen then managed their subcommittee's efforts in studying and analyzing the problem areas and developed specific recommendations for improving, correcting or reinforcing an existing operation or procedure or recommending a new one.

Subcommittee activities included research of written materials; in cooperation with the California State Employees Association, a questionnaire was sent to operating field personnel; field observations were made of actual work practices and many other contacts were made with working personnel.

2.5 Coordinated Development of the Task Force Report

The subcommittee chairmen met several times to coordinate the development of the report and provide written input from their subcommittees. Their reports were prepared in a format which outlines specific action-oriented recommendations. They were then combined, edited, and organized for sequence and continuity. The report was then prepared in this final form.

3.0 STATEMENT OF THE PROBLEM

The California Department of Transportation has had an active formalized Safety Program for over 30 years. The result of this effort has been a continued reduction in disabling injuries to CALTRANS employees. However, during the last three years (1971 through 1973) five CALTRANS maintenance employees were killed as a result of accidents involving the traveling public. In addition, 125 employees received injuries during that same period, and more than 10 contractors' employees were killed in similar accidents in road construction zones.

As a means of reducing the number of such incidents, the Department instituted a study in 1973 geared toward improving the safety of road maintenance and construction personnel. This was done through the identification of major problem areas based on an evaluation of existing accident records and subjective input from field personnel and managers. In cooperation with the Mechanical and Construction Trades Council of the California State Employees Association, a questionnaire was sent to a cross section of maintenance personnel throughout the state. The results of this questionnaire contributed to the identification of safety related problems as seen from the eyes of the employees. (See Annex C)

Twenty major problem areas were detailed for analysis and are briefly described below:

PROBLEM AREA DESCRIPTION

3.1 Sweeping

From 1971 through 1973, Department employees were involved in over 14 serious sweeping accidents. Subjective field input indicated that there have also been a considerably larger number of "near misses" which did not result in injury or property damage to either employees or the motoring public.

The most common sweeping incident involved the rear-ending of our slow-moving sweepers. It was concluded that safety improvements could be made through in-depth review and analysis of sweeper scheduling, levels of service and lighting and signing practices.

3.2 Delineation - Striping and Pavement Marking Activities

Accident records and subjective employee input demonstrated that this activity is extremely hazardous. During the past several years, incidents in this activity resulted in two fatalities and several major disabling injuries.

Improvements in work scheduling, standards for lane and facility closures and signing were identified as means of increasing safety in this type of operation.

3.3 Litter Pickup

Department employees were involved in over 20 incidents in the past three years. Most of these incidents occurred on or near the shoulder where a motorist struck either a parked or slow-moving vehicle or the employee. Some of these incidents resulted in major injury to both the employee and the motoring public.

The frequency of litter pickup activities has been greatly decreased. However, some specific problems still exist, such as work procedures, signing standards and shadow protection.

3.4 Patching

During the past three years, 12 employees have been injured in accidents involving the motoring public while performing patching operations. Patching activities constitute a major exposure hazard. Lane closure standards, shadow vehicles and equipment, and coordination of work activities with traffic enforcement agencies have been identified as areas requiring attention.

3.5 Snow Removal and Rock Patrol

There are approximately 80-100 incidents each year in which the motoring public is involved in an accident with snow removal equipment. Such incidents rarely result in injury to our employees, but the potential for injury, particularly to the public, is great.

Specific items contributing to this problem include equipment deficiencies, vehicle lighting, levels of maintenance and motorist education.

3.6 Median Barriers and Median Screen Planting

Although our employees have experienced few incidents (i.e., actual accidents) while performing work activities in road medians, their exposure is high and the potential for serious injury is great. Subjective input from field maintenance employees indicates that work activities in the median (primarily median repair) are viewed as one of the four most hazardous road maintenance activities.

The primary steps in minimizing this problem involve decreasing the magnitude and length of employee exposure.

3.7 Work Scheduling Versus Exposure Potential and Hazard

A critical factor in minimizing the exposure of our employees to traffic is how we schedule our traffic-disrupting work activities. This was not defined as a specific problem area, but was identified as a possible means of reducing employee exposure and risk by planning around safety considerations.

3.8 Facility Reduction and Detours

Lane closure activities and detour areas provide an inherent potential for conflict between the worker and the motoring

public. Many employees have expressed apprehension about the adequacy of safety considerations in both lane closure and detour operations.

Principal problem areas include non-standard practices in the signing and use of closures, inadequate traffic-management considerations at the planning phase, excessive quality standards for some detours and the application of minimum lane closure standards that do not fit the work site.

3.9 Flagging

During the past three years, 14 Department employees were involved in accidents with motorists while performing flagging duties. Most did not result in serious injury, but the exposure and potential for serious injury is extreme. Employee input regarding "near misses" confirms this supposition. Many employees viewed flagging as one of the most hazardous road work activities.

Principal problem areas in flagging include the adequacy of training and the need to improve the motorists' awareness of potential hazards.

3.10 Mobile Protection

The use of mobile protection (e.g., shadow vehicles, etc.) was not identified as a problem area per se, but was

suggested as a possible means of providing increased safety to employees in all exposed road work activities.

3.11 Fixed Protection

The use of fixed protection (e.g., barriers, cones, etc.) was identified as a means of improving safety through the establishment of more definitive standards for their mandatory use.

3.12 Construction Over Traffic

Workmen's hazards in relation to traffic during construction over traffic are generally limited to vehicles hitting falsework members located on the shoulder and over-height loads hitting falsework girders. While there have been no worker injuries as a result of these situations, there have been enough non-injury incidents to indicate a potential hazard.

Some specific problem areas include inadequate consideration for workers at the design phase and the allowance of over-height loads in restricted-clearance situations.

3.13 Construction Adjacent to Traffic

Construction activities such as median barrier installation, median and shoulder widening, and reconstruction present high potential for accidents involving road workers and the motoring public.

Primary problem areas are incomplete worker safety consideration at the design phase and inadequate safety enforcement by the contractor.

3.14 Warning Signs and Devices; Warning Devices on Equipment

A motorist's response to highway warning signs and devices is extremely critical when he is approaching a construction or maintenance zone.

Both employees and motorists have expressed concern about the adequacy of current devices and practices.

Primary problem areas include the use of warning signs where not needed and the need to develop more signs and devices which are appropriate to specific situations and which stimulate motorist response.

3.15 Operations, Construction and Maintenance Safety Considerations at the Design Phase

Construction and maintenance safety problems can be inadvertently created as the result of inadequate consideration in the design phase.

3.16 Lack of Statewide and Regional Uniformity, Traffic Control Standards, Enforcement (Motorist Expectancy)

Uniform standards for traffic warning devices for construction and maintenance operation are necessary to fulfill motorists'

needs, attract their attention, deliver the message and insure proper response.

Motorists follow their experiences and have certain expectancies which help them drive safely and efficiently. When these expectancies are not obtained, however, the reverse often occurs, leading to driver confusion and error, especially in unusual situations.

3.17 Speed Limit Policies, Legislation Restrictions and Compliance

Drivers are generally not responsive to reduced speed postings in highway construction and maintenance zones. In many cases, reduced traveling speeds are necessary to provide adequate safety for both the worker and the motorist.

Primary problem areas are the lack of voluntary driver compliance and the need to develop a more effective means of traffic control enforcement techniques.

3.18 Public Information Activities Relating to Construction and Maintenance Functions

Employee and limited motorist input has revealed that motorists often do not react to an impending roadwork zone. They do not understand "why we need to disrupt traffic flow".

Motorist attitude and reaction are obviously important factors in minimizing hazards to our employees. Both employees' and motorists' safety can be enhanced through increased communication and awareness efforts.

3.19 Management Support and Safety Standards Enforcement

Management's support and enforcement of safety policies and standards is necessary to a viable safety program. Management has generally supported safety efforts, however, safety effectiveness can be further improved through increased support at both the field and headquarters levels.

3.20 Safety Management Information System

An important element of any viable safety program is an information system which provides a management with timely and accurate awareness of safety problems and progresses toward achieving safety improvement efforts and goals.

The existing information system does not provide sufficient or timely information on accidents and accident patterns.

4.0 ANALYSIS

4.0.1 Method Used -

For purpose of simplification, the areas to be studied were grouped into five separate categories and assigned to a special subcommittee. Those subcommittees were:

I. Problem Identification

II. Procedures Evaluation

III. Maintenance and Construction Safety Practices

IV. Traffic Flow

V. Driver Behavior

The subcommittees then examined existing procedures, activities and conditions; made visits to observe field work; and, based on the information obtained, developed specific recommendations for improving or changing procedures or actions where necessary.

The following subsections each discuss an item of concentration of the special study.

4.1 SWEEPING

Department of Transportation employees have been involved in at least fourteen serious accidents involving sweepers during the past three years. A major safety concern is the driver who runs into the rear of the slow moving sweeper which generally results in major injuries.

Discussions with the equipment operators in various districts indicate the majority feel their sweeper operations are relatively safe except on high-traffic volume urban freeways.

a. Work Scheduling - Most districts do their sweeping on a normal work week (Monday - Friday) and during normal work hours (7:30 a.m. - 4:00 p.m.). Some metropolitan areas do some off-hour sweeping in extremely critical areas. In one district, median sweeping is done on Sunday morning with little or no disruption of traffic. In another district, night sweeping operations were tried to see if there would be a reduction of incidents. In actual practice, however, the severity of incidents increased due to higher speeds.

Also, one metropolitan district currently sweeps on a five day schedule that runs from Saturday through Wednesday. Public complaints due to sweepers working Monday through Friday during the day caused a previous change to night work. Severity of accidents and possible legal action during the trial night work, however, forced the present schedule.

b. Signing - With few exceptions, there is little or no advance warning to the public that a sweeper is working on the highway ahead. None of the districts contacted use standard roadside signs for advance warning as they believe that roadside signing would not be effective in operations that are continually moving. Some districts have signs on shadow trucks that indicate a sweeper is working ahead; however, some districts do not use shadow trucks.

c. Lighting - Warning lights and the color of sweepers are not uniform within a district or statewide. Warning lights on sweepers vary from two flashing amber lights in different locations to illuminated directional control-type signs. Some sweepers are also equipped with warning flags. The rear of some sweepers has been painted yellow with black chevron stripes. Other sweepers are completely orange. Some areas have installed as many as six blinking amber lights plus rotating amber lights on a sweeper.

d. Levels of Service - A headquarters teletype dated June 14, 1973 to all districts states that sweeping frequency should be reduced by 50% wherever it can be tolerated. Many districts have conformed to this procedure. A new policy for level of services in the state is currently being prepared.

It is incumbent that each Maintenance superintendent and/or foreman inspect and sweep only areas that are not self-cleaning

in order to keep employee exposure at an absolute minimum and yet consistant with maintaining the roadside in an acceptable condition.

e. Communications - When sweepers are operating on the highway, they do not have an adequate means of communicating with shadow vehicles and/or their base station in case of a breakdown or accident. This can result in the employee having to walk to a telephone to obtain assistance. Having radios in sweepers would reduce this hazard.

RECOMMENDATIONS

4.1.1 Sweeping - Hours of Work - The Maintenance Branch in each district should determine the safest hours and days to conduct sweeping operations using input from the District Traffic Branch. This determination and schedule adjustments should be made as soon as possible and no later than November 1, 1974.

4.1.2 Sweeping - Advance Signing - A trial program using a sign such as "Sweepers Working Ahead" should be implemented on a trial basis in a metropolitan district. Headquarters Maintenance Branch should design the program and insure that it is operating in the field by November 1, 1974.

4.1.3 Sweeping - Signs on Sweepers - Visibility of the sweeper should be improved by placing additional signing or other delineational devices on the sweeper. Headquarters Maintenance Branch should establish the overall Departmental policy and directive for this by October 1, 1974. The appropriate districts should implement this program by January 1, 1975.

4.1.4 Sweeping - Short Sight Distances - Shadow trucks with maximum visibility signs should be used in all sweeping operations on ramps and in all areas where sight distance is short. Headquarters Maintenance Branch shall establish the overall Departmental policy and directive for use of shadow trucks by November 1, 1974 and all districts should fully implement the program by January 1, 1975.

4.1.5 Sweeping - Signs and Warning Flags - All sweepers and shadow trucks should be equipped with illuminated directional control signs and warning flags. This program should be implemented by Headquarters Equipment Branch by January 1, 1975. The program should provide for installation at the time of purchase or when such vehicles are in the shop for other work.

4.1.6 Sweeping - Chevron Stripes on Vehicles - The entire rear portion of all sweepers and shadow trucks should

be painted with yellow and black striping. Headquarters Equipment Branch should implement this program by October 1, 1974 for application to all new sweepers and trucks as they are purchased.

4.1.7 Sweeping - Levels of Service - The levels of service criteria for sweeping as established by Headquarters Maintenance Branch should be reviewed to reduce the amount of non-required sweeping and resultant exposure of employees. This review should be in addition to the one made recently in connection with the energy crisis. Headquarters Maintenance Branch should revise this requirement by October 1, 1974.

4.1.8 Sweeping - Standardized Equipment - The placement of equipment and warning devices on sweepers and shadow trucks should be standardized statewide. Headquarters Equipment Branch should develop standards based on a composite of the best existing installations throughout the state. Standardized placement should be implemented statewide starting January 1, 1975, beginning with new equipment and existing equipment going into shops for major overhaul. The entire program should be completed by January 1, 1977.

4.1.9 Sweeping - Energy Attenuators on Vehicles - A trial program using attenuators or water bumpers on the rear

of sweepers and shadow trucks should be implemented. The program should be implemented by Headquarters Equipment Branch by July 1, 1975 and evaluated one and two years later.

4.1.10 Sweepers - Radio Equipped - Radios should be installed on all sweepers and shadow trucks. Headquarters Maintenance Branch should determine the areas in most critical need for radios and cooperate with Headquarters Equipment Branch to start an installation program by July 1, 1975. Installation should be completed by July 1, 1978.

4.2 RAISED PAVEMENT MARKERS AND STRIPING

4.2.1 Raised Pavement Markers - The number of accidents and concern expressed by employees regarding the installation of raised pavement markers indicates a need for careful evaluation of operations in order to reduce exposure.

a. Headquarters Direction - On June 14, 1973, a Headquarters teletype stated that replacement and washing of non-reflective pavement markers shall be discontinued on all highways. This leaves only reflective markers to be maintained. This procedure is now generally being followed throughout the state.

b. Work Scheduling - Generally, maintenance of reflective markers is scheduled by the local foreman using district equipment. Most of this work takes place during the normal work day (approx. 7:30 a.m. to 4:00 p.m.) without the need for unusual scheduling. In critical metropolitan areas, however, work is scheduled at other hours and/or on weekends. A directive from the Maintenance Manual states that this work should be done in conjunction with other maintenance operations wherever possible.

c. Use of Warning Devices - The use of warning devices or signs in connection with raised pavement marker maintenance is not consistent throughout the state. As this is generally a moving operation, no advance warning signs are usually used,

particularly in rural areas. In some locations, lanes are closed for this operation.

There is a noticeable lack of statewide information regarding lights, flags, and color combinations on vehicles used in this type of operation.

d. Level of Service - The present "level of service" requirement states that "reflective markers shall be placed when two successive markers are missing. Missing pavement markers should be replaced continuously in conjunction with other maintenance operations to minimize traffic disruptions."

e. Special Equipment - A single machine which will spot blast, mix and dispense epoxy, and provide protection to the operator is under development by the Equipment Branch. This will reduce exposure to the blastman and epoxyman and will eliminate the go-cart operations.

RECOMMENDATIONS

4.2.1.1 Raised Markers - Installation - Whenever possible, the initial installation of raised markers should be done by the contractor or CALTRANS prior to opening the highway to traffic. Both Headquarters Construction and Maintenance Branches should reinforce this procedure in Headquarters level directives by January 1, 1975.

4.2.1.2 Raised Markers - Combined Schedule - Scheduling replacement of raised markers in conjunction with other maintenance junctions should be emphasized on a continuing basis by all levels of maintenance supervision involved in work planning.

4.2.1.3 Raised Markers - Installation - Scheduling - Wherever heavy traffic flows have a strong bearing on when marker replacement function are performed, each District Maintenance Branch shall evaluate and establish the safest time of day and/or of week to carry out this function with the assistance of the District Traffic Branch. This process, if not in existence now, should be used as soon as possible.

4.2.1.4 Raised Markers - Uniformity of Signs and Devices on Equipment - Uniformity in the placement of lighting, flags, illuminated directional control signs and chevron striping on the rear of vehicles should be initiated by Headquarters Equipment Branch by January 1, 1975 and should be accomplished by January 1, 1977 for all vehicles used in marker replacement.

4.2.1.5 Raised Marker Installation - Pilot Vehicles - On two-way roads, a pilot vehicle with illuminated directional signs should be used. Headquarters Maintenance Branch should develop this overall policy based on the input and recommendations of all Districts by January 1, 1975.

4.2.1.6 Marker Replacement - Level of Service - Levels of service for marker replacement should be evaluated by Headquarters Maintenance Branch to establish a level that reduces the need for replacement and still meets traffic safety criteria. This should be completed by January 1, 1975.

4.2.1.7 Development of Marker Installation Equipment - Headquarters Equipment Branch should accelerate the development of specialized equipment for the installation of raised pavement markers in a rapid manner to increase employee safety. This equipment should be operational no later than July 1, 1976.

4.2.2 Traffic Striping - Traffic striping is hazardous due to the relative differences in the speed of the machines and the normal flow of traffic. Striping alone, however, does not warrant major closure of a highway.

a. Work Scheduling - With the exception of metropolitan areas, most Districts work a normal work day and week. Extremely critical areas are scheduled for striping on weekends or during the periods when there are low traffic volumes. Most districts expressed concern that night striping on roadways with uninterrupted traffic flows is not feasible. They feel that the lights used to get enough sight distance for the operation are confusing and hazardous to oncoming and passing traffic. However, night striping on new construction is a prevalent practice.

Night striping has been performed in District 08 on a high volume urban freeway. Special lights were mounted on the striper to provide adequate vision for the operator. Although there were no incidents relating to striping at night on a limited basis, the striping crew believes that day scheduling is inherently safer and more productive and recommended night striping when no other time is possible.

b. Signing - One-half of the districts do not use roadside signing with their striping operations. One district closes

two freeway lanes for striping. Four districts use signs at two and four-mile intervals along the highway and move the signs ahead as the work progresses. Other districts do their striping without any lane closure or signing. A sign "Striping Next ____ Miles Ahead" has been used for approximately 10 years in District 01. Based on this experience, the operators feel that the sign is effective in warning the traveling public and contributes significantly to the safety of the operation.

c. Lighting - There is no statewide uniformity regarding the placement of warning lights on striping equipment. The new hot-stripe machine has illuminated direction control signs and most of the supply trucks are similarily equipped. The cone retrieval trucks' warning devices vary from lighted arrows to simple rotating amber lights. In some cases the supply truck is used both as a pilot and back-up truck. The lighted arrows are not visible from the front when used for a pilot vehicle on two-lane highways. On one cone retrieval truck the rotating amber light was not visible from the rear because of added equipment that blocked the view of the light. In another situation, it was observed that the overhead "pass" sign on a CALTRANS striping vehicle indicated to pass to the right when, in fact, it was obvious that there was no shoulder or roadway on which to traverse while overtaking the vehicle.

d. Levels of Service - The Departmental Maintenance Manual provides direction that the stripes should be replaced after

a loss of 50% of their effectiveness. Under present work loads, this level is difficult to attain.

e. Hot-Paint Striper - The hot-paint stripers that have been designed and fabricated by the Equipment Branch provide for a safer painting operation. The design speed of the striper is 25 m.p.h. However, the maximum speed at present is approximately 15 m.p.h. with an average speed of 7 to 10 m.p.h. When compared to the old stripers that averaged approximately 5 m.p.h., the exposure time is reduced considerably. With the hot-paint striper, the traffic cone placement and retrieval operations are eliminated. These were considered two of the most hazardous parts of traffic-line striping.

RECOMMENDATIONS

4.2.2.1 Statewide Striping Criteria - Statewide striping criteria should be established to provide a general framework so each district can develop its own procedures. Specific considerations for hour of day and day of week should be included. Headquarters Maintenance Branch should develop this by January 1, 1975 with each district implementing the program by July 1, 1975.

4.2.2.2 Statewide Signing and Warning Device Criteria - A statewide signing and warning device criteria to be

used with striping operations should be developed to provide statewide uniformity. However, this should contain sufficient flexibility so that each district can adjust to meet individual needs and traffic conditions. Headquarters Maintenance Branch should cooperate with Headquarters Traffic Branch to develop this by April 1, 1975.

4.2.2.3 Uniform Placement of Lighting and Equipment on Vehicles Used in Striping - Headquarters Equipment Branch should develop uniform statewide specifications for placement of lighting and warning devices used on all striping equipment and vehicles. These specifications should be developed prior to July 1, 1975 and all equipment should be so equipped by July 1, 1977.

4.2.2.4 Hot-Stripe Equipment - The new hot-stripe application process permits equipment to move at higher speeds and dries fast enough to eliminate the need for placement and pickup of cones. The Equipment Branch should procure this equipment as rapidly as possible.

4.3 LITTER PICKUP

During the past three years, 12 employees performing litter pickup functions have been injured in accidents involving the motoring public. Most of the accidents have occurred on or near the shoulder where the motorist struck either a parked vehicle or the employee.

As a result of limitations on funding and manpower levels, litter pickup activity is now at a minimum. Thus, during this special study, few litter pickup activities were observed. However, much litter pickup activity is performed without the benefit of signing or a shadow vehicle. Also, employees were observed working with their backs to traffic. Thus, they would have little or no warning if a vehicle were to leave a traffic lane and head directly toward them.

If litter pickup activities are being performed in a protected area or in an area not immediately adjacent to the shoulder, signs and shadow vehicles are not necessary. However, working with one's back to traffic is hazardous at any time.

RECOMMENDATIONS

4.3.1 Litter Pickup - Parking Vehicles - Firm policies requiring that litter pickup vehicles be parked well away from traffic should be adopted. Headquarters Maintenance Branch should establish these guidelines by October 1, 1974.

4.3.2 Litter Pickup - Advance Warning Signs - Departmentwide policies concerning the use of advance warning signs and shadow vehicles in litter pickup operations are needed. Headquarters Maintenance Branch should develop this by October 1, 1974.

4.3.3 Litter Pickup - Safe Working Techniques - Guidelines should be issued for personnel working on foot anywhere near the traffic lane (litter, maintenance and landscape personnel). Employees should be given clear directions to always work facing traffic so that they can more readily observe vehicles leaving the roadway. Headquarters Maintenance Branch should develop this procedure by October 1, 1974.

4.4 PATCHING

Patching activities are inherently hazardous and present the potential for major exposure to accidents involving maintenance employees and the motoring public. During the past three years, 12 employees have been injured while performing patching operations.

Eight patching type operations in four districts were reviewed. Patching operations were generally well-planned and executed and appeared to be appropriately and necessarily timed to preserve the facility in a safe and usable state. All operations reviewed were being conducted during daylight hours which appears to be appropriate as it offered maximum visibility of both the operation and employee to passing traffic. In one operation involving high-density commuter traffic on a freeway, the start of the operation was delayed until the traffic count indicated it was safe and least disruptive to begin the operation. Present patching procedures, including scheduling, type of equipment to be used, etc. appear to be satisfactory. However, there is a need for some improvement in associated activities that could reduce exposure, increase visibility and assist in traffic flow.

Cone Spacing - Cone spacing in the work area does not always adhere to Construction Safety Orders. The minimum spacings as described in the "Manual of Warning Signs, Lights and

Devices" are not clear and could be confusing and misinterpreted. The Construction Safety Orders require a minimum cone spacing of 25 feet in the immediate work zone.

Coordination with CHP - Coordination with CHP and other law enforcement agencies to assist in critical traffic flow control, lane closure set-ups, etc., varies considerably from territory to territory. The use of CHP or local law enforcement officers to assist in traffic control can reduce job hazards, particularly in high-density traffic in metropolitan areas. Assistance from these agencies can be particularly helpful at the "set-up and removal" phase of the project by guiding and slowing traffic as it approaches the work zone. CHP does not have sufficient manpower to assist in all such operations. However, at very hazardous locations or in heavy traffic flow it may be appropriate to request CHP assistance.

The Joint Operational Policy Statement provides adequate direction from the Departmental Headquarters Level which operational level commanders and administrators can implement without additional written direction.

Shadow Vehicles - There is a need to provide a mobile form of protection in all patching-related activities where workers are exposed to the traffic flow. Shadow vehicles are used in most operations. But because shadow vehicles may be in an improper location or too far behind the exposed employee, they

do not always provide maximum protection. An additional exposure problem involves employee carelessness. At times, employees will position themselves in such a manner that available shadow vehicles do not provide sufficient protection from passing traffic. Often, employees will take risks by unnecessarily standing on the traffic side of their work or shadow vehicles.

Equipment - The visibility of roadwork equipment seems to vary somewhat. Not all vehicles are marked with the alternating "black and yellow" or "black and white" striping typically used to improve the visibility of the vehicle. Visibility of the equipment can be improved by alternating color combinations as described above.

RECOMMENDATIONS

4.4.1 Patching - Cone Placement - Standards for cone placement which are at minimum safety levels should be clearly understandable and included in the Maintenance Manual. Requirements should be reviewed at least every two years and contain the current opinion of field personnel. Headquarters Maintenance Branch should coordinate this review with positive input from the Traffic Branch. These requirements should be initially reviewed by October 1, 1974 with updated procedures disseminated to the field by January 1, 1975.

4.4.2 Patching - Improved Cone Placement - The Manual of Warning Signs, Lights and Devices should be updated to improve description of cone placement procedures. Headquarters Traffic Branch should complete this revision by April 1, 1975. Maintenance Branch input should be an integral part.

4.4.3 Patching - Coordination With CHP - Procedures should be reinforced to provide for notification and coordination with CHP and other law enforcement agencies on maintenance projects. This may range from a planned conference prior to a major maintenance project with high traffic density to sufficient notification of the beat officer prior to going on shift. CHP should also provide positive feedback as to their intended degree of participation in the larger projects. There is no need for an additional policy or directive in this area as the Joint Operational Policy Statement between the departments is adequate for operational level commanders and administrators to implement or improve. This action should be undertaken as soon as possible.

4.4.4 Patching - Shadow Vehicles - Clear directions as to when shadow vehicles "or other similar protection" in all lane closures and in all work activity near the traveled way should be established. In most instances,

an increased use of shadow vehicles should not require purchase of additional equipment but simply better utilization. The overall statewide directions should be developed by Headquarters Maintenance Branch by April 1, 1975.

4.4.5 Patching - Shadow Vehicles Use Training - A short training program should be developed and conducted for supervisors in the proper placement of shadow vehicles to improve safety and increase statewide uniformity. This can improve consistency of appearance to the motoring public. Headquarters Maintenance Branch should coordinate the development of this training program which should in turn be conducted by district personnel. This training program should be completed by July 1, 1975.

4.4.6 Patching - Safer Work Practices - Personnel actually performing patching functions should work facing oncoming traffic at all times if possible. This may require modification of existing practices such as material delivery, unloading, etc. Headquarters Maintenance Branch should coordinate the development of improved work practices in this area. Development of work practices should be started by October 1, 1974 and the new improved practices operational by January 1, 1975.

4.4.7 Patching - Chevron Stripes on Equipment - Distinctive black and yellow diagonal striping should be installed on the rear of all roadwork equipment including pickup trucks engaged in patching operations. Headquarters Equipment Branch should start this project by January 1, 1975 and complete it by January 1, 1977.

4.5 SNOW REMOVAL AND ROCK PATROL

Snow removal operations on California highways can be divided into two types. Freeway or multi-lane operations and rural two-lane procedures.

Multi-lane operations normally have a lesser accident potential for the traveling public and the plow operator due to wider traffic ways and one-direction traffic flow. When accidents do occur on multi-lane roadways, they are usually of the reae-end type and are caused by vehicles traveling at excessive speed or following too closely. Because of signing and higher levels of traffic enforcement in chain control areas on multi-lane freeways, there is a tendency for the public to reduce speed and be more alert to traffic conditions. The alignment of and non-separation of traffic on rural two-lane roadways creates a higher accident potential. Plows must work over or in close proximity to the center line. They are often slow-moving motor graders or trucks equipped with a push plow. Vehicles on low traffic volume highways may travel too fast for conditions or without chains. Vehicles parked or abandoned on shoulders may be hidden by snow. When collisions with large snow plows do occur, however, there is less chance for injury to an employee due to the size and weight of his vehicle.

Snow removal procedures presently being practiced by CALTRANS appear to be adequate. Present operations developed from

actual experience over a period of many years. Efforts are continually under way to further improve snow removal operations wherever possible.

The equipment that CALTRANS employees operate under snow conditions were developed specifically for snow removal and are generally effective. However, there are a few areas of concern:

a. Sloping and curved windshields on some snow plows allow snow to collect and wipers cannot carry it off under severe storm conditons, thus reducing visibility. When windshield wipers are mounted at the bottom of these windshields, they clog up with snow and are difficult to operate.

b. The color of hoods on snow removal equipment is an important factor. Black hoods reduce glare and improve visibility.

c. Gasoline driven snow removal vehicles of larger sizes (4 tons or over) without vertical exhaust stacks and mufflers create problems. Maintenance costs are high as mufflers mounted under these vehicles become encrusted and packed with snow and ice which can crush them. This can easily happen if the plow runs off of the roadway while plowing. It has been estimated that mufflers are replaced twice each season on these types of snow removal vehicles. Exhaust pipes can also become plugged with snow. This can present an unseen hazard to the operator as carbon monoxide fumes may seep into the cab.

d. Communication is an important factor to a snow removal equipment operator. Without a two-way radio, it is difficult for an operator to summon assistance if he becomes disabled in a remote area. Conversely, it is difficult to contact him if there is a need for emergency reassignment.

e. Several comments have been received regarding the need for a more distinctive color warning light on snow removal equipment. Due to the large number of vehicles that use amber lights traveling on California highways, their impact has been diluted. Snow plow operators feel that blue would be a better color. It is realized, however, that this would come into conflict with current legislative changes being made to restrict their use to law enforcement vehicles.

f. Snow plow vehicles in the four to ten ton classification with high silhouettes provide better visibility than ones with more silhouette and size. This provides increased protection to the employee.

g. By utilizing the current bare pavement policy in snow plowing, there is increased exposure to traffic in that plows are continually on the roadway. It may be practical to not remove snow down to the bare pavement on some rural two-lane roadways. This would tend to reduce speeds; however, it may also increase the accident potential when rutting and break-up of snow and ice occur.

h. Sanding operations in snow areas result in a high level of exposure for maintenance personnel and inflate maintenance costs. These would be reduced if sanding were restricted to curves, intersections and icy stretches.

i. There is a need for the traveling public to obtain additional information regarding driving under extreme weather conditions. There is no such information in the Department of Motor Vehicles' Driver Handbook or questions relating to this on drivers' license examinations. There has been television and radio news coverage of highway conditions by the California Highway Patrol and CALTRANS. Radio and T.V. broadcasts regarding driving under adverse conditions can be increased with specific comments about snow plow operations on the road. Another group that should be contacted are driver education classes in high schools. They should receive tips on snow driving with specific references to snow plow and sanding operations and chain control requirements.

RECOMMENDATIONS

4.5.1 Snow Removal - Equipment Design - Equipment designed or used for snow removal operations should have the following characteristics wherever possible: new vehicles should be purchased with vertical windshields and top-mounted windshield wipers, hood tops should be painted black, vertical stack mufflers should be installed on all gasoline-powered snow removal equipment;

and only large-size vehicles with high silhouettes should be purchased for snow plow operations. Headquarters Equipment Branch should implement these changes starting October 1, 1974 and modify present equipment on a continuing basis.

4.5.2 Snow Removal - Radios on Equipment - Two-way radios should be installed on all snow removal equipment which operates in remote areas to provide for rapid emergency communication. This should be done by reassignment of existing radio equipment if possible and prior to the purchase of additional equipment. The Headquarters Maintenance Branch communications unit shall initiate steps to reassign radio equipment by November 1, 1974 and, if necessary, budget for additional equipment for the 1975-1976 fiscal year.

4.5.3 Snow Removal - Uniform Warning Devices - To increase the effectiveness of present amber warning lights, Headquarters Equipment Branch should develop specifications for locating such devices on all equipment. Headquarters Equipment Branch should closely coordinate this activity with CHP Enforcement Services Division Engineering Section. Specifications should be developed by January 1, 1975 and all changes made by January 1, 1976.

4.5.4 Snow Removal - Bare Pavement Policy - Where possible, on rural secondary highways the policy of snow plowing to bare pavement should be adjusted to allow for some snow on the pavement. Headquarters Maintenance Branch should develop statewide uniform standards on bare pavement by November 1, 1974.

4.4.5 Sanding - Reduction of Levels - Whenever possible, sanding operations on highways should be reduced to curves, intersections and icy stretches to reduce exposure of maintenance personnel. Headquarters Maintenance Branch should develop a statewide policy for reduced levels of sanding by November 1, 1974.

4.4.6 Inclement Weather - Public Information - Increased information should be provided to the public regarding driving under extreme weather conditions. Headquarters Office of Environmental and Community Affairs should increase coordination and cooperation with CHP Office of Public Safety Information to disseminate this information. This should be started immediately.

4.5.7 Driver's Handbook - Winter Driving Information - Positive action should be taken to have winter driving information included in the Department of Motor Vehicles Driver Handbook and possibly a question on the written driver's license examination. Headquarters Office of Environmental and Community Affairs should initiate this action by October 1, 1974.

4.5.8 <u>Snow Removal - Driver Education Classes</u> - Arrangements should be made for winter driving tips around snow plow and sanding operations to be included in driver education classes. Headquarters Office of Environmental and Community Affairs should coordinate this with CHP Office of Public Safety Information to arrange for CHP officers making presentations in the schools to include this information. This should be done by January 1, 1975.

4.6 MEDIAN BARRIERS AND MEDIAN SCREEN PLANTING

One of the most hazardous locations for an employee to work is the median area of a heavily traveled freeway. Because of the limited right of way on metropolitan freeways, workmen are in close proximity to fast-moving traffic when performing median maintenance or repair functions. The amount of damage done to median barriers attests to the considerable number of vehicles that enter median strips and strike existing barriers. Employees are also susceptible to being struck by these vehicles.

Three basic types of median barriers (concrete, cable, and metal beam) are in use. Screen planting is also used in some medians. Workmen's median duties can be divided into construction and maintenance operations.

Median cable and metal beam barriers account for over 90% of the repair work being done in metropolitan districts. Cable barrier accounts for approximately 53% of these barriers. The '72-'73 fiscal year Quality Standard printout, however, indicates that 88% of damaged median barrier is of the cable type and its repair requires 75% of expended man-hours.

Maintenance management standards provide a crew of three men and one truck for cable and fabric repair. Four men and two trucks are allowed for median beam barrier rail, channel,

post and light screen repair. The Maintenance Manual of Instructions specifies that when maintenance activity does not encroach upon or impair the normal traffic lanes, no advance signing should be used. Also, work immediately adjacent to the traffic lanes should be protected by a truck equipped with flashing amber lights and parked off the traffic lanes. In actual practice, however, the "Roadwork Ahead" sign is usually placed ahead of the operation and cones are used along the shoulder. Also, trucks are being used as shadow vehicles for workmen.

a. Concrete Barriers - Concrete median barriers are now being installed on many freeways where conditions warrant them. They are very effective in safely redirecting vehicles, yet they experience a minimum of residual damage. This sharply reduces the amount of maintenance needed to keep them in effective condition and the amount of time employees spend in exposed positions. However, there are hundreds of miles of divided highways and freeways with other types of median barriers or screen plantings which require a higher degree of maintenance.

Concrete barriers are currently recommended to be installed in medians up to 32 feet wide. Currently, most installations are being slip formed. This method reduces exposure time. However, the entry and departure of concrete trucks from the work area presents traffic problems. Work on limited median

widths usually requires a lane closure. Elimination of expansion joints at 20' intervals would reduce workmen's traffic exposure. Curing application and glare screen installation are operations with exposure potential.

b. Cable Barriers - Median barriers consisting of cable and chain-link mesh combinations require high levels of maintenance as the mesh is easily damaged. Expanded metal glare screen mesh is used instead of chain-link mesh for replacement. However, sections of glare screen appear to be relatively short and spaced out so that no effective glare barrier is provided. This may not necessitate immediate replacement.

Cable barrier is flexible and deflects up to 12 feet. It is currently recommended for use in median widths of 32' to 50'. It is also used in conjunction with median screen planting.

During construction of cable barriers, workmen's exposure to traffic begins with the layout of the post locations. Exposure is usually experienced during the unloading of posts, the pouring of footings from the rear of a mix truck and during the erection and secural of cable and mesh.

c. Metal Beam Barriers - Current maintenance practices call for the repair of metal beam barrier when it is damaged yet still structurely sufficient to perform its basic function.

One method of reducing employee exposure in the median divider would be to not repair metal beam barriers until they are structurely deficient or distracting to passing motorists.

d. Median Screen Planting - Median screen planting is primarily done in medians wider than 30 feet. It appears that maintenance operations in wide medians are no more of a risk than work performed adjacent to shoulders. However, maintaining plants in narrow medians does expose employees to passing traffic. Therefore, it may be appropriate to discontinue the use of decorative planting in these areas. Also, sprinkler control valves should be placed at locations which are not exposed to passing traffic so that they can be turned on in relative safety.

RECOMMENDATIONS

4.6.1 Median Barriers - Concrete - Concrete median barriers should be placed in narrow medians wherever possible because of the low maintenance and reduced employee exposure. Headquarters Traffic Branch should accelerate the program for replacement of beam and cable barriers with concrete barriers. This program should be implemented by January 1, 1975.

4.6.2 Median Barriers - Reduced Use of Glare Screen - Expanded metal glare screen should be used only in those locations where glare reduction is essential. Headquarters Traffic Branch should develop a uniform statewide policy for use of these materials by October 1, 1974.

4.6.3 Median Barriers - Metal Beam Repairs - Repairs should be made to metal beam barriers until they are structurely deficient or are distracting to passing drivers. Headquarters Maintenance Branch should develop this as a statewide policy by October 1, 1974.

4.6.4 Median Screen Planting - Reduce - Screen plantings in medians less than 30 feet wide should be discontinued. Landscape Architecture Branch should implement this policy with the assistance of the Headquarters Maintenance Branch by October 1, 1974.

4.6.5 Medians - Safer Sprinkler Controls - Headquarters Landscape Architecture and Maintenance Branches should coordinate the safe location of sprinkler control valves for median and shoulder planting. Placement of these control valves should consider the exposure of employees to passing traffic. This should be included in all designs developed after September 1, 1974.

4.7 WORK SCHEDULING VERSUS HAZARD

In construction project contracts special provisions usually specify periods during which the contractor is restricted from disrupting traffic flow. This is usually during commute periods. Contract provisions may also require full widths of roadway to remain open on Saturdays and Sundays. However, this is usually because contractors must pay premium rates for weekend and night work.

Section 2.30-Traffic of the CALTRANS Construction Manual relates to traffic considerations in contract administration. It embodies practices and improvements developed through experience. It also makes specific reference to night work. The direction and guidance it provides allows for adequate pre-planning of traffic handling as it relates to construction. It recommends that representatives of various groups and agencies be included in the planning phase. While it makes reference to the District Traffic Branches performing a review of traffic concerns it appears that this role could be strengthened.

Night operations add an entirely new dimension to work being performed on or near a highway. It is easier to control the reduced traffic that is on a highway at night. Such traffic on a multi-lane freeway can be funneled more easily into a reduced number of lanes. This is of considerable assistance

in marker and stripe placement or removal. Girder or falsework erection or removal can be carried out in an unimpeded and safer manner. Reduced traffic flow provides for routing of traffic to adjacent roadways or detouring over ramps that would be impractical during daylight hours.

Many contractors are not properly equipped to operate during darkness. The use of special contract provisions in "Traffic Control System and Construction Area Lighting" provides guidance for contractors who do engage in night operations.

In some cases, the selection of work hours seems to be subjective. There is no firm data on which to base a decision as to whether night work with low traffic volumes is safer than day work with high volumes. Strong consideration must be given to the increased number of drivers under the influence of alcohol that are on the highway at night. The highest incidence of drunk driver involvement is on Thursday, Friday and Saturdays between the hours of 5 p.m. and 4 a.m. Severity of accidents at night is also higher. Conversely, during the heavy traffic of daylight, the severity of accidents is reduced.

Maintenance men contacted during the field survey generally were not favorable to night work. One employee stated that he was more comfortable in relatively high traffic volumes as vehicles tend to follow each other better.

In discussions with management in various Districts, it is apparent that working during daylight hours is the best procedure. This provides better working conditions for the employee and less confusion to the motoring public. Any deviations from working during daylight hours should be made after a careful study by the Traffic Department or Highway Operations to determine the safest time for the operation.

Another suggestion recommends that tasks be scheduled in combination with other work to reduce exposure time. This would also reduce total set-up and take-down time and exposure. This may require delay or acceleration of some operations in order to provide for grouping of tasks.

RECOMMENDATIONS

4.7.1 Work Scheduling - Nights - A departmentwide policy sould be written which establishes general criteria for scheduling nighttime maintenance activities. Headquarters Maintenance Branch, with the assistance of Headquarters Traffic Branch, should develop this criteria by April 1, 1975. Within this framework, each district should develop night-versus-day scheduling guidelines. This should be done by July 1, 1975.

4.7.2 Work Scheduling - Coordination - Individual tasks or operations should be scheduled at the same time as

other maintenance tasks to minimize employee exposure time and reduce the number of individual set-ups. Headquarters Maintenance Branch should develop a general criteria for this multiple-task approach with each district developing their own specific procedures for coordination and scheduling. Headquarters criteria should be established by January 1, 1975 and District guidelines by April 1, 1975.

4.8 FACILITY REDUCTION AND DETOURS

The objective in any facility reduction or detour is to safely restrict or divert traffic without causing unreasonable delay while accomplishing the necessary work. This must be done within reasonable cost and also provide a high degree of safety to the employees.

There is a variety of lane closure and detour procedures in existence throughout the state. Specific procedures are spelled out in a wide range of directives, manuals and guides, emanating from both headquarters and the districts.

In preparing for facility reductions or detours, it is of critical importance to identify potential or actual traffic problems. The closure or reduction must then be carefully planned along with the actual work to be conducted. To properly plan this type of activity, there should be input from operational level managers representing Traffic, Construction and Maintenance interests along with Safety representatives and the CHP or other law enforcement officers, especially if the closure or reduction is within a city and not on a freeway.

Once the pre-planning is completed, there should be close coordination and cooperation throughout the operation. At the termination of the project there should be a post-operational critique to evaluate action taken for use on future projects.

Different approaches, however, must be taken for metropolitan and rural areas. And night versus day operation presents an entirely different set of circumstances. Partial or complete restriction of traffic flows adds another element for consideration.

The following subsections include specific details and recommendations on how to improve lane closure and detour procedures:

4.8.1 Facility Closure - Freeway lane closures are of major concern at anytime of the day or night. Hazards are very high for crews working on these roadways. Complete closure of a facility maximizes worker safety and offers the opportunity for improved work production.

Presently, however, the goal of both maintenance and construction practices is to provide the maximum level of service and convenience to the traveling public during the performance of necessary work. Facilities are not completely closed except as a last resort. This is especially true of many construction operations because closures would halt traffic for an extensive period of time.

Continuous closure of all or major portions of a roadway during off-peak periods, particularly for maintenance operations

in large metropolitan areas, is a potential alternative that has not been fully explored in California. There have been some planned closures in other states. For example, the State of Illinois has a procedure where two lanes of six or eight-lane major freeways are taken out of service on a regular basis for periods of three to four months during the summer. They do this to rehabilitate the roadway. Because of the harsh weather, their roadways need extensive repair on a 10-year cycle. At the same time, they do whatever other maintenance work is necessary. Due to special procedures, such as having two-way traffic in the other direction of the freeway and extensive publicity, they have been satisfied that the adverse effects on traffic are acceptable.

With the present level of development of freeway and highway systems in the larger metropolitan areas of our state, there are many corridors that could provide adequate traffic service during nighttime off-peak hours if a freeway were closed. And, in many cases, there is more than one freeway in a corridor.

For example, in the San Francisco Bay Area it would be possible to close several freeways during the nighttime hours. State Route 101 between San Jose and San Francisco could be closed at any number of locations and traffic routed over parallel freeways and/or on essentially non-residential major surface streets. Traffic handling costs would be higher than a

partial closure, however. Careful pre-planning of alternate routes and work schedules would be needed. Also, the success of informing the traveling public as to the necessity and presence of the closure and recommended alternate routes would play a key part in public acceptance. If a continuous closure is utilized, work activity should also be readily apparent during the entire closure. Work crews should be scheduled 16 to 24 hours a day to take full advantage of the closure. Local governments, nearby businesses and residents must also be convinced of the need for this type of closure.

Complete closure of a facility would provide the following advantages:

a. Increased worker safety.
b. Higher efficiency in work performance.
c. Safer movement of vehicles entering or leaving the site.
d. Shorter overall period of traffic impairment.
e. Considerable reduction of travel to and from the work site.
f. Less time expended in equipment set-up and take-down.
g. Improved project management technique would result because of the absolute necessity for effective pre-planning.

Disadvantages of complete facility closures:

a. More pre-planning would be necessary.
b. Maximum effort and coordination would be needed between various units performing work within the closure.
c. Public resentment of detours and/or delays.

d. Moving state highway traffic onto surface streets would require prior acceptance and cooperation of local authorities, businesses and residents.

e. Alternate routes may not have sufficient durability to stand up under increased traffic flows.

With the almost total lack of information regarding complete facility closure and coordinated activities for maintenance and construction, CALTRANS has an opportunity to develop and implement a nationwide pilot program.

To make this effective, it is important that a coordination system be an integral part. Basically, the system would require the cooperation of any and all units that have maintenance responsibilities on a given stretch of roadway. This can range from patching operations to light bulb replacement. Privately-owned companies may also have related activities that could be planned along with CALTRANS activities, such as replacement of overhead wires and water mains. Unit managers and supervisors should be jointly responsible for these activities so that all activities could take place in a well-coordinated simultaneous manner and minimize the period of time the roadway is closed.

RECOMMENDATIONS

4.8.1.1 Pilot Complete Facility Closure - A trial program should be established in a major metropolitan

district to fully utilize the complete facility-closure concept. As this is basically a traffic-flow problem, Headquarters Traffic Branch, with the full support of the Maintenance and Construction Branches, should be assigned responsibility to plan, implement and evaluate the program. Planning should start immediately with the pilot program to be operational by January 1, 1975. A first-year evaluation should be completed by January 1, 1976.

4.8.2 Lane Closure - Individuals working on the highways adjacent to moving traffic expressed opinions that the most hazardous roadwork activity was the set-up and removal of a lane closure. The second-most hazardous activity was working within a lane closure. These two problem areas warrant close examination.

Information on all aspects of lane closures was obtained through interviews, reviews of written procedures and discussions with experienced personnel.

a. Devices and Layout - Accident analysis did not indicate specific inadequacies with equipment now being used in the layout of the closures. Therefore, we must focus on anything that causes confusion to a motorist and operations that increase worker exposure to traffic. Section 4.11 discusses fixed protection in more detail.

b. Training and Procedures - It has been observed that adopted practices are not followed. This may occur because the knowledge is not available, training is inadequate or supervisors are not fully accepting responsibility for the safety of individuals working for them.

Training plays a key role in improving safety of the worker. Managers and supervisors at all levels share a major part of the responsibility of seeing that this training is adequate.

The San Francisco-Oakland Bay Bridge has an admirable worker safety record under some of the most difficult traffic conditions experienced in the state. While they have the advantage of having a limited facility on which to concentrate, it is readily apparent that considerable effort has gone into pre-planning, training, and critiquing their operations for further improvement.

All accidents and injuries should be examined to establish who is responsible for or contributed to the incident, and the following questions should be asked: Were the procedures the best and safest way to do the job? Was the worker properly trained? Were supervisors fully accepting their responsibility?

c. Coordination With CHP and Law Enforcement Agencies - The degree of coordination and cooperation between CALTRANS and CHP or local law enforcement agencies in establishing lane

closures is of major importance. The most hazardous element of a lane closure is the actual set-up. CHP or local police within city limits could be of considerable assistance in set-ups, especially under difficult traffic conditions. However, agencies are not always informed of lane closures in advance.

Generally, resident engineers and maintenance superintendents notify the CHP when they begin major projects. However, on many occasions routine maintenance jobs are started and the CHP is not aware of them until the beat officer observes the operation in progress and traffic is already tied up.

This communicatinn problem can easily be corrected without additional directives or headquarter's level procedures. Managers and supervisors scheduling the work can fulfill their responsibilities by making sure that CHP or local law enforcement agencies are notified by several means, including:

(1) A telephone call to the appropriate CHP area office or police department.

(2) A personal visit.

(3) Sending an advance copy of foremen's work schedules with problem areas highlighted.

With this information, each CHP or local police commander could then brief each shift concerning projects on their beats or arrange for traffic control assistance if necessary. Beat

officers patroling near projects would assist in traffic control or may be of assistance as point controls during the critical period of closure set-up. They would be more effective than a non-uniformed flagman. Conspicuous presence of a patrol car would also assist in reducing speeding and other violations.

If officers are on the scene when projects are being set-up, they can ascertain if resulting traffic congestion is likely to cause accidents. "Round-Robin" escorts could be commenced early so traffic flow could be controlled past the project. The key here would be to take positive steps to prevent accidents instead of waiting to see what occurs.

d. Reducing Frequency of Lane Closures - As has previously been stated, better pre-planning of work hours, detours, closures and other traffic control activities could improve safety. Lengthening the work period with fewer set-ups and possibly improved productivity could also be of assistance. Consideration should be given to longer lane closures during daylight hours if traffic flow capacity is increased or traffic demand is reduced.

One of the ways to increase traffic capacity is to utilize the shoulders as a traffic lane. This has been done but probably could be utilized more frequently. Consideration should also be given to closing on and off ramps

to reduce traffic flow. This procedure would also reduce confusion caused by delineation where ramps within a lane closure are kept open. All of this takes considerable pre-planning.

e. Freeways Without Shoulders - In some areas, traffic flow has been increased by converting shoulder areas into traffic lanes. This has been done at the expense of having a location where vehicles can stop. This affects maintenance vehicles, CHP and other enforcement vehicles and disabled motorists.

When traffic flow analyses are made of existing facilities, consideration should be carefully given to the trade-off of not having these safe locations available. Careful consideration should be given to re-establishing full shoulders on existing facilities. Where traffic does not permit, the establishment of part-time shoulders which serve as traffic lanes during heavy traffic periods and are clearly designated as shoulders in off-peak hours should be considered.

RECOMMENDATIONS

4.8.2.1 Lane Closure Training - To ensure that well-accepted, safe working practices in lane closure activities are being properly handled, increased emphasis should be placed on training responsibilities and safety. Each first-line supervisor should be oriented to his basic training responsibilities on a one-to-one

basis or by the coach-pupil method. All activities should be monitored on a continuing basis by the responsible supervisor. He should work to reinforce safe working practices among his employees and provide constructive guidance where improvement is needed.

4.8.2.2 Evaluation of Accidents in Lane Closures - All accidents and injuries within lane closures should be evaluated on a continuing basis to determine how this function can be performed with increased safety. This should be an ongoing responsibility of the first-line supervisor with input from individuals performing the various work tasks.

4.8.2.3 Coordination of Lane Closures With CHP/Police - Each maintenance superintendent and foreman should take positive steps to ensure that the CHP or local police are fully informed of planned maintenance activities that will effect traffic flow on non-freeway state highways within city limits. On high volume metropolitan freeways the presence of a CHP officer at the lane closure set-up should be requested. If this procedure is not currently in practice, it should be initiated as soon as possible.

4.8.2.4 Multiple Activities in Single Closure - Improved advance planning that will allow for conducting as many activities as possible during a single lane closure and thus reduce the number of closures should be initiated. Maintenance branches in each district should begin this procedure as soon as possible if it is not presently being done.

4.8.2.5 Use of Shoulders For Traffic Lanes - Standards should be clearly established for freeways which provide for an appropriate balance between traffic flow increases by utilizing shoulder space for added lanes and providing a safe location for parking of maintenance, law enforcement and disabled vehicles. Part-time shoulder lanes, as being experimented within San Diego, may provide a reasonable alternative. Headquarters Traffic Branch should coordinate the development of uniform statewide shoulder-use standards including part-time lanes. This should be developed and implemented prior to July 1, 1975.

4.9 FLAGGING

The flagman's is an extremely exposed position with a high accident potential. His job is considered to be one of the most hazardous activities on the roadway.

One way to reduce the potential hazard would be to minimize the use of flagmen. Flagmen are basically used at those locations where it is necessary to change traffic controls at frequent intervals, such as stopping traffic for truck or equipment movement and alternate directional use of a single traffic lane.

A critical examination should be made of each roadwork job to determine if flagging is necessary and if so, what is the minimum level that can be used commensurate with other job and safety needs. It appears that flagmen are used at times as substitutes for other means of warning. For example, if a flagman is being used only to slow traffic, perhaps fixed protection could be used instead. The flagman would only move onto the roadway when posted traffic directions had to be altered.

Another apparent need is improvement of the motorists' awareness that a flagman is ahead. Additional advance signing and increased use of cones can materially assist in alerting motorists.

Equipment used by flagmen is usually limited to a red/orange shirt or vest, hard hat, and a hand held stop/slow paddle. This small paddle is not as visible as the longer pole paddle signs that are available for use in California and which are mandatory in other states. It is also more difficult to misuse the larger pole paddle by using it to wave traffic or by holding it in such a manner that it is not clearly visible.

The most important factor in flagging procedures is proper training. This training should be expanded to include not only verbal instructions, but instruction by a coach-pupil method and a concise, brief, illustrated handbook or guide which is easily understood. Several states, including Minnesota and Washington, have developed a well-written pocket-sized flagman's manual. It appears to be more appropriate than the material included in the CALTRANS' Manual of Warning Signs, Lights and Devices. Another alternative would be to develop a single plastic card with critical flagging operations printed on both sides. This could easily be carried in a shirt pocket.

Any person, including CALTRANS or private contractors' employees, who would be expected to perform flagman's duties should be required to be trained prior to actual flagging on the roadway. This training should be a short concise "explain, demonstrate, and perform" type of session based on uniform criteria for use throughout the state. Instructions should include basic

hand signals, use of pole signs, driver reaction time, stopping distances, use of cones, and temporary use of flares.

Even this basic training in flagging operations and certification of individuals can not only contribute to increased worker safety, but also be of assistance in the event of subsequent civil litigation.

RECOMMENDATIONS

4.9.1 Flagmen - Evaluation of Use - Headquarters Traffic Branch should evaluate each type of operation in which flagmen are used by CALTRANS and contractors with the goal of reducing the use of flagmen by alternate effective means of control. Specific recommendations should be developed by April 1, 1975.

4.9.2 Flagmen - Uniformity of Equipment - For statewide uniformity, Headquarters Traffic Branch should clearly specify the type and color of clothing, vests, shirts, and hard hats to be worn by personnel conducting flagging operations. Specifications should also be developed that require the use of pole-type signs for flagmen. The hand-held paddle sign should be used only where the pole sign cannot be used. These specifications should be developed by January 1, 1975.

4.9.3. Flagmen - Training - A flagman training and certification program should be developed by Headquarters Traffic Branch in cooperation with Headquarters Maintenance and Construction Branches for CALTRANS and contractors' personnel. A concise handbook, instruction card or guide should be included. This program should be developed by January 1, 1975 and all CALTRANS personnel who may perform flagging operations trained by July 1, 1975.

4.10 MOBILE PROTECTION

Mobile protection is that form of warning device that moves along the highway to provide protection to mobile operations. Mobile protection provides advance warning to the public that slow-moving vehicles or equipment are ahead so drivers can change lanes, slow down or stop.

While there is a potential for serious injury to employees operating equipment on the highway at reduced speeds, their equipment is usually large. Accidents that do occur are usually more detrimental to the occupants of vehicles striking the equipment.

The use of a shadow truck provides one more vehicle in the traffic stream. It results in substituting one vehicle for another in a collision. This is a trade-off that must be considered in deciding whether or not to deploy a shadow vehicle.

However, there is full justification for use of a shadow vehicle in those locations where there is restricted sight distance, such as ramps and curves. The shadow vehicle could trail the operation stopping at visible locations with signs warning of the slow-moving vehicle ahead.

One recommendation suggests the use of the slow-moving vehicle emblem as authorized under section 24615 O.C. on all slow-moving

vehicles operating on the highway. While it is not mandatory on vehicles used by highway authorities, it is permissible when vehicles are operating under 25 m.p.h. The emblem should be removed or covered if the vehicle or equipment is traveling over 25 m.p.h. No additional legislation would be required to permit the use of the emblem. The use of the slow-moving vehicle emblem may not be well understood by the traveling public and additional public awareness may need to be created. The use of the emblem would be consistant with other slow-moving vehicles now using it.

The use of lighted arrow signs have been successful and their use should be mandatory on all slow-moving vehicles working on the highway.

RECOMMENDATIONS

4.10.1 Shadow Trucks - Criteria For Use - The use of shadow trucks should be limited to those situations where sight distance is restricted, equipment is being protected or if workmen are in exposed positions. Headquarters Maintenance Branch should establish a uniform criteria by January 1, 1975 for the use of shadow trucks with sufficient flexibility included to provide for the unusual situations encountered statewide.

4.10.2 <u>Slow Moving Vehicles - Uniformity of Equipment</u> - Where slow-moving equipment and/or shadow vehicles are used, they should be equipped with uniform lighting; color or chevron striping; lighted directional arrow signs; and slow-moving vehicle emblems. Headquarters Equipment Branch should design uniform specifications for vehicles that may be used with both self-contained mobile protection vehicles and shadow trucks. Uniform specifications should be developed by January 1, 1975 and operational by January 1, 1977.

4.11 FIXED PROTECTION

Fixed protection is that utilized at a specific location at a fixed work site. Setting up fixed protection and working within its area is considered to be one of the most hazardous exposures of employees. The broader aspects of lane closures are covered in section 4.8.

Generally, districts follow the criteria established in the CALTRANS Manual of Warning Signs, Lights and Devices for Use in Performance of Work Upon Highways, (1973 edition). Special procedures and adaptations of these procedures have been tried in various locations throughout the state. Some of them have not been evaluated as to their effectiveness.

Some problem areas relating to fixed protection are as follows:

a. Procedures - Setting up and taking down fixed protection in a safe, rapid manner cannot be over emphasized. Procedures should be a composite of the best utilized statewide. Training in how to set up and take down the protection as safely and rapidly as possible should be provided to all personnel and supervisors. Rules which emphasize the employees always face oncoming traffic cannot be over emphasized. By having even the slightest indication that a vehicle is entering his work zone, an employee may have the critical instant needed to escape.

b. Cones - The quality and style of cones varies considerably throughout the state. Many are of low visibility and are easily displaced by high speed traffic, especially trucks and buses. Considerable high-exposure time is spent replacing them after they have been knocked down or have fallen over. Rubber collars that add weight to cones have been used with good success. For night work, reflecterized collars have been used as well as lighted cones. There are advantages and disadvantages to both.

In the case of cones, barrier placement and tapers, it has been suggested that delineation patterns in ramp areas be improved and standardized statewide. Procedures for closing ramps as set forth in the Manual of Warning Signs, Lights and Devices do not appear to be followed statewide. Either the manual contents have not been utilitzed or better placement patterns have been developed. If so, they should be evaluated for possible use throughout the state.

The use of flashing warning signs has been highly recommended for use in connection with fixed protection set-ups.

c. Shadow Vehicles - Shadow vehicles, in addition to being used for mobile protection, are also used in fixed locations to protect workers on the roadway. Due to improper placement, shadow vehicles have not always been used to their full advantage. This can be corrected by development of uniform

shadow vehicle placement procedures and by training supervisors and employees in their use. The use of present equipment can be maximized with little additional expenditure.

d. Signs - Generally, utilization and placement of warning signs conforms with the standards described in the Manual of Warning Signs, Lights and Devices. One exception, however, is the use of "End Roadwork" signs. They are not used for many projects where it would be appropriate to inform the motorist that he is leaving a work zone. Their regular use would be a way of providing increased signing credibility.

The present orange and black signs, although meeting recently established color standards, are not considered as effective as the yellow and black warning and advisory signs formerly used in conjunction with maintenance and construction activities. Many comments have been made that they are less noticeable and more difficult to read, especially during hours of darkness.

A need also exists to provide more definitive signs which would provide more emphasis for command messages. This includes "Merge Left" or "Merge Right" type of signs. The Manual of Warning Signs, Lights and Devices does not indicate the most appropriate placement of the "Road Construction Ahead" (C-18) or "Roadwork Ahead" (C-23) signs. These signs should be placed nearest to the lane of traffic requiring a lane change.

The potential of lighted or electronic changeable message signs has not been fully developed. In District 07, the Emergency Incident Response Team sign vehicles with their library of changeable messages is an initial entry into this type of function which has considerable potential. Having a changeable message displayed in lights may be more effective and also provide for flexibility. This new type of equipment should be thoroughly explored with manufacturers. California is in a position to exercise leadership in their development.

e. Equipment - The visibility of roadwork equipment and vehicles varies somewhat throughout the state. The basic vehicle color is orange with the exception of Toll Bridge Authority whose vehicles are yellow. Not all vehicles have black-and-yellow or black-and-white chevron striping on the rear. Uniformity should be increased in this area.

RECOMMENDATIONS

4.11.1 Fixed Protection - Uniform Set-Up and Take-Down - Statewide uniformity should be established in procedures for setting up and taking down fixed protection in a safe, rapid manner. A composite of the best ideas of all the districts and the Toll Bridge Authority should be incorporated into this procedure. Headquarters Maintenance Branch and Headquarters Construction Branch should jointly develop this new procedure with the cooperation of Headquarters Traffic Branch.

Action should be started by January 1, 1975 and concluded by July 1, 1975.

4.11.2 Increasing Safety By Job Restructuring - Each job or function performed on the roadway should be restructured in such a manner as to eliminate or minimize the amount of time an employee or worker would have his back toward oncoming traffic. Wherever possible the employees' job should be performed so he can see oncoming traffic in his field of vision. Headquarters Maintenance Branch should coordinate this restructuring for maintenance functions and Headquarters Construction Branch should coordinate the restructuring for construction jobs. Action should be started on this restructuring by October 1, 1974 and concluded by July 1, 1975.

4.11.3 Uniform Specifications and Use of Cones - Uniformity of traffic cones specifications and placement should be established throughout the state. Headquarters Traffic Branch should develop uniform procedures for their placement. Action should be undertaken by October 1, 1974 and completed by October 1, 1975.

4.11.4 Increased Use of Flashing Warning Signs - Flashing warning signs should be used wherever possible in construction and maintenance zones throughout the state.

Headquarters Traffic Branch should establish uniform criteria for their use and placement. Action to develop this criteria should be started on by January 1, 1975 and completed by June 30, 1975.

4.11.5 Uniform Guide for Use of Shadow Vehicles - A uniform guide for the use of shadow vehicles as fixed protection should be established based on the best procedures being used throughout the state. This should be supplemented by training of first-line supervisors in proper placement and use of shadow vehicles as fixed protection. Headquarters Traffic Branch with the cooperation of Maintenance and Construction Branches should develop this uniform procedure and training program. Action should start on this by January 1, 1975 and be concluded by December 31, 1975.

4.11.6 Use of "End Roadwork" Signs - Reemphasis should be made of existing procedures relating to the placement of "End Roadwork" signs. Headquarters Traffic Branch with the cooperation of Maintenance and Construction Branches should develop this reemphasis program. This reemphasis on use of these signs should be completed by January 1, 1975.

4.11.7 Improvement of Sign Colors - The present black and orange color combination on construction and maintenance signs

should be evaluated to determine the best color combination that will increase the safety of workers and the motoring public. If an improved color combination is developed, efforts should be taken to amend Federal requirements so the improved combination can be used in the future. Headquarters Traffic Branch should have an alternate color combination plan prepared by January 1, 1976.

4.11.8 Sign Placement - The Manual of Warning Signs, Lights and Devices should be clarified to indicate the most appropriate placement of "Road Construction Ahead" (C-18) or "Roadwork Ahead" (C-23) signs. Headquarters Traffic Branch should develop this clarification by July 1, 1975.

4.11.9 Changeable Message Signs - An in-depth evaluation should be made of the potential of mechanical lighted or electronic changeable message signs. Headquarters Traffic Branch, with the cooperation of Maintenance and Construction Branches, should start this evaluation by January 1, 1975 and complete it by January 1, 1976. Headquarters Traffic Branch should also coordinate the implementation of new sign standards in the field by July 1, 1976.

4.11.10 Vehicle and Equipment Color - Color combinations of equipment and vehicles should be standardized statewide. This includes uniform chevron striping on vehicles. Headquarters Equipment Branch should develop uniform specifications by January 1, 1975. They should be implemented by July 1, 1975.

4.12 CONSTRUCTION OVER TRAFFIC

Traffic related accidents during construction over traffic have been limited to vehicles hitting falsework located on the shoulder and over-height loads hitting falsework girders. While there have been no workmen injured as a result of these accidents, there have been enough incidents to indicate a potential hazard.

The probability of injuries to workmen from a vehicle hitting the vertical members of falsework has been virtually eliminated during the past five years by establishing strict standards for the design and construction of these falsework members to better resist vehicle impact. Fortunately, those cases which resulted in major damage have occurred during non-working hours, either early in the morning or on weekends. In these cases, however, probably only the absence of workmen prevented their injury. Section 7-204.7 of the Highway Design Manual needs additonal emphasis on providing for as much clearance as possible to increase worker safety. Most construction-over-traffic accidents involve illegal oversized loads.

Statistics on accidents involving work over a State highway indicates that the greatest hazard is to the vehicles and occupants traveling under the work rather than to the workmen. However, the potential for serious injury to workmen is always present when construction over a highway results in a height restriction for vehicles passing underneath.

RECOMMENDATIONS

4.12.1 Falsework Clearance Specifications - Section 7-204.7 of the Highway Design Manual should be revised to include specific comments on construction safety relating to falsework clearances over roadways. Headquarters Project Development Branch should implement these changes by January 1, 1975.

4.12.2. Construction Structures and Worker Safety - Volume III, Chapter 10 of the Bridge Planning and Design Manual should be revised to specifically refer to worker safety during construction as a consideration in structure type selection. Headquarters Office of Structures should implement these changes prior to January 1, 1975.

4.13 CONSTRUCTION ADJACENT TO TRAFFIC

Construction performed adjacent to traffic can be broken down into three general operations:

a. Median and shoulder widening or reconstruction.

b. Median Barrier Construction.

c. Miscellaneous shoulder and median work - signs, signals, lights, drainage, etc.

The main problem in all three cases is the close proximity of men and equipment to moving traffic. Quite often there is little or no buffer zone between the work area and the traffic lanes. This condition provides no leeway or recovery area for driver error and can distract workmen.

One of the most common accidents within a construction zone occurs when a vehicle partially encroaches or actually enters the work area. This may result from driver inattention, confusion, or error. The potential for this type of accident is most prevalent when no buffer or neutral zone is provided to allow for recovery of control between the traffic lane and the work area.

Another type of common accident in this area occurs when construction equipment or vehicles enter or leave the work area. Entering a work area from a traffic lane involves the task of slowing down enough to safely leave the traffic lane

and yet not cause traffic to backup behind. There is also the problem of having a trailing car follow the work vehicle into the work area. Leaving a work area is probably a more hazardous maneuver, particularly when one must leave a median area by merging into a fast lane of traffic. Trucks and other construction equipment have a major problem making these maneuvers because of their size, slow acceleration and poor maneuverability. Many times truck drivers are unfamiliar with the project and the best method or route for entering or leaving the project. This is a serious problem in relation to passing traffic.

Men working adjacent to traffic lanes with no buffer zone are susceptible to several type of accidents. They have been struck by mirrors and other objects extending from vehicles. They have been struck by vehicles that wandered only inches into the work area. They have been struck when they inadvertently leaned or stepped into the adjacent traffic lane. They have also been struck while attempting to cross traffic lanes to either enter or leave a work area.

Accidents have also occurred when a workman performs traffic direction functions, sometimes without a flag or paddle. Motorists have become confused and struck the rear of vehicles, workers or flagmen. There is a need for well-planned, clear, concise directions to drivers by anyone performing traffic direction functions.

All of these types of accidents are compounded at night. Workmen often cannot see the size of the vehicle and misjudge its width. Drivers, on the other hand, cannot properly see individual workmen even though the work area may be adequately delineated.

The causes of this type of accident can be attributed to all people and conditions involved. They are caused by errors in judgement by workmen and drivers, the contractor in selecting equipment and work procedures, and the state in its design of the work or by not exercising more control of work methods or sequence. Usually, the cause is not directly attributed to any single factor but to several that combine to create an unsafe condition.

State designers must give more thought as to how the work will be safely done. Too often this has been considered the contractor's and/or resident engineer's problem. Work provisions should specify procedures and operational sequences if regular methods may be unsafe. More consideration to traffic management should be given when designing individual projects.

RECOMMENDATIONS

4.13.1 Safety Training For Employees and Workers - Workmen should be properly instructed and frequently reminded of the hazards and procedures of their work. This

is a basic responsibility of the first-line supervisor who should have the full, meaningful support of upper levels of management. Increased compliance with Construction Safety Orders 1509 and 1510 can also be of assistance. However, a "work safe" attitude is probably the most critical factor. Headquarters Construction Branch should ensure that proper training and follow-up is being provided throughout the state.

4.13.2 Planned Work Sequences For Increased Safety - Contractors should be required to plan their operations and work sequences in a manner that provides increased consideration for the safety of the workmen in addition to concerns for production. Construction Safety Order 1509 provides support in this area. Headquarters Construction Branch should develop guidelines for this requirement by January 1, 1975.

4.13.3 Use of Safety and Traffic Experts During Construction - The contract special provisions should require that the contractor include safety and/or traffic experts in developing and executing construction plans if the Project Development Branch considers conditions complex enough to warrant an expert's attention. These requirements should be developed by the Headquarters Project Development Branch and implemented by January 1, 1975.

4.13.4 Traffic Direction Training - Anyone performing traffic direction functions on a construction job - even on an infrequent basis - should have basic instruction in traffic direction and flagging. See Recommendation 4.9.3 - Flagman Training.

4.13.5 Safety Considerations in Design Stage - Safety during construction, including adequate buffer zones, should be an integral part of the design phase. Headquarters Project Development Branch, with the help of the Headquarters Safety Coordinator, should create specific safety requirements and practices to be followed during construction. This program change should be operational by January 1, 1975.

4.14 WARNING SIGNS AND DEVICES; WARNING DEVICES ON EQUIPMENT

Driver response to traffic control devices (TCDs) becomes extremely critical in the proximity of maintenance and construction zones. This is especially true on urban freeways. Drivers tend to respond to devices only when they feel there is a reason to respond.

a. Drivers' Attitude - Drivers moving along in an urban freeway traffic stream apparently adopt an expectation pattern which results in much closer intervals between vehicles than on rural highways or city streets. The nature of modern freeway design, with its limited access, traffic separation and high geometric standards fosters a "trusting attitude" in the driver. Maintenance and construction work being performed on and alongside freeways can upset the freeway "mental set" or attitude of the driver. The driver is apparently less prepared to anticipate and cope with anything unusual. Consequently, a hazardous condition to both the motorist and nearby construction or maintenance personnel is created.

b. Alerting Drivers - Engineers have endeavored to preserve safe conditions in these areas through the use of warning devices, such as, special delineation, channelization, illumination and signs. In extreme cases, it may be necessary to interrupt the steady traffic stream with attention-getting lights, flares and law enforcement officers.

There is a need to develop distinctive and appropriate strategies to cope with various types of activities realizing that drivers will only respond when they see an actual need to respond. Areas of concern are:

(1) During long-term activities, drivers who pass through an area frequently become indifferent to ordinary traffic control devices that they have seen often. They no longer relate to them as being associated with any immediate hazard.

(2) During short-term operations, a disproportionate amount of time is used to place, move and remove traffic control devices.

(3) In some operations, the use of traffic control devices involves frequent posting, removal, or covering and uncovering.

(4) Many activities involve moving vehicles and equipment from place to place, such as mowing; sweeping; lamp replacement; object retrieval; flushing; spraying; striping; and weeding.

(5) At many times no work activity is obvious. This includes employees' lunch periods.

(6) Setting up and taking down traffic control devices creates an unusually hazardous exposure of personnel.

(7) In some cases there is no "safe" time to do the work. A closure is the only alternative.

Changeable message signs in construction zones could be of considerable value. The ability to have a sign that can be changed to meet current needs could be of assistance. This is a relatively new area that deserves full exploration.

It appears that there is a need for established procedures concerning the use of signs, flashers and flags on moving and fixed protection equipment. Equipment and vehicles that are now available can be easily misused which lessens long-range credibility. For instance, rotating beacons on maintenance vehicles that are visible from 360 degrees have a long-range effect on motorists on the other side of the freeway in that they become less alert to warning lamps. Covers or partial covers should be available for these warning lights to limit their visibility in areas where they are not needed. When vehicles are at locations where they do not present a hazard to passing traffic, warning lights are not necessary. There should be uniform guidelines for the use of signs, flashers, and flags which will contribute to their credibility.

c. Drinking Drivers - Alcohol and fatigue greatly impairs a drivers' ability to detect unusual or hazardous conditions. Current research shows that these drivers literally "follow their noses". Therefore, TCDs must be placed directly in, or as close as possible, to their path. Drunk and fatigued drivers are particularly susceptible to optical illusions or confusing displays.

d. Driver Response - It is generally true that motorists respond to the total driving environment (primarily visual), and that TCDs constitute only a part of that total. TCDs, by themselves, will have little influence unless they are used to create a barrier or narrow a lane. Even then, they must be "seen" by the motorist. Hulbert and Beers, in a study of driver response to "wrong way" signs, found that 5% of healthy, alert, young drivers utterly and completely failed to see two sets of large red signs when they unexpectedly came upon them. Therefore, it is of critical importance that the total scene agree with the TCD treatment and/or the TCDs be strong enough to overcome or override the "natural scene".

e. Legal Requirements - Traffic control devices which are errected for "legal" reasons must be appropriate to actual field conditions to maintain their credibility. At some locations, it is readily apparent that the devices are not needed, yet the only reason they are used is for "legal" purposes. Advance warning signs must be followed quickly by an appropriate scene so that they do not lose their impact or importance. The legality of not using such devices on construction zones that do not warrant them should be thoroughly reviewed to determine what is really essential and what is nice to have. For example, the State of Delaware only uses traffic control devices where a definite need for them is established. Limiting traffic control devices to those locations where there is an actual need will increase their credibility to the driver.

f. On The Job Traffic Safety Coordinator - On large construction and maintenance operations it would be appropriate to assign an individual to a clearly defined job of "Traffic Safety Coordinator". It would be his responsibility to see that motorists are aware of each major construction and maintenance project. Having an individual filling the spot who is familiar with traffic control from engineering, maintenance, human factors and legal standpoints would be an advantage. He could also perform coordinating functions for traffic handling and safety with the CHP and other appropriate law enforcement agencies. He should be familiar with the requirements of the California Occupational Safety and Health Act. He should be easily recognizable on the job site by a distinctive badge, hat or other apparel. This individual would perform his duties under the direction of a maintenance foreman or the resident engineer of the project. Having an individual specifically assigned these responsibilities should result in an increased attention to safety factors.

g. Contract Requirements - Traffic control and employee safety requirements are often not emphasized clearly in a contract. If they are not obvious, they do not attract the attention they deserve from a contractor or his representatives. Stating contract items regarding traffic control and safety along with penalties for non-compliance clearly and concisely could be of considerable assistance to resident engineers and

other CALTRANS personnel in making work sites safer. Having a bonus system to reward the contractor for proven employee safety records could also be an incentive.

RECOMMENDATIONS

4.14.1 Assignment of Traffic Safety Coordinators on Construction Projects - A clearly-defined assignment of Traffic Safety Coordinator for construction and maintenance operations should be created. This should be a full-time assignment on major projects and a clearly established part-time function on minor projects and it should be as important as other components of a project. Headquarters Traffic Branch, with the cooperation of the Headquarters Safety Coordinator, should develop the criteria for this position by April 1, 1975. It should be implemented on all major projects as of July 1, 1975.

4.14.2 Uniformity of Signs and Devices on Equipment - Uniformity of design, placement and use of warning signs and devices on equipment should be increased. This is similiar to recommendations in other parts of this report. Headquarters Traffic Branch should develop uniform guidelines for equipment and its use. It should cooperate with the Headquarters Equipment Branch to develop the design and placement specifications.

The development phase should be completed by January 1, 1975 and uniform use should be fully operational by January 1, 1976.

4.14.3 Increasing Drivers' Alertness - Distinctive and appropriate means to change drivers' attitudes and increase their alertness to maintenance activities and construction zones should be produced. Headquarters Traffic Branch should develop this approach with the support of the Maintenance and Construction Branches. This project should be started by October 1, 1974 and completed by April 1, 1975. A test phase should be conducted for two years and the results evaluated.

4.14.4 Changeable Message Signs - A trial changeable message sign program should be developed and evaluated for possible use in statewide construction projects. Headquarters Traffic Branch should conduct this program with the support of the Construction Branch during a major construction project in 1975. It should be evaluated at the conclusion of the project.

4.14.5 Contracts to Include Items for Traffic and Safety - Headquarters Construction Branch should implement separate contractual items for traffic and employee safety as part of all future contracts starting on January 1, 1975.

4.14.6 Reevaluation of Traffic Control Devices - Headquarters Traffic Branch, with the assistance of Headquarters Construction and Legal Branches, should reevaluate all traffic control devices being used in construction and maintenance projects. Their goal should be to determine which devices are necessary as opposed to those which are nice to have or for legal purposes. This evaluation should be started by October 1, 1974 and completed by April 1, 1975.

4.15 OPERATIONS, CONSTRUCTION AND MAINTENANCE SAFETY CONSIDERATIONS AT "DESIGN PHASE"

Concern has been expressed that there is insufficient consideration given to maintenance and construction worker safety in the design of a highway or structure. Some construction workers and maintenance employees believe that their safety has been neglected or has a relatively low priority at the design stage as compared to the public's safety and convenience.

It is apparent that the reduction or elimination of hazards to which the traveling public is exposed to is being dealt with at the design stage. Some working level employees feel that their exposure could also be reduced if this goal received proper emphasis at every stage of a project.

An evaluation of existing policies and procedures in relation to employee safety and the design phase reveals there is a lack of specific directives and/or instructions on the subject. Those in existence are as follows:

a. Circular Letter 70-93 - This requires formal safety reviews during the design and construction stages. Public safety and reduction of hazards to the traveling public are emphasized. Only two districts have issued supplemental instructions to this directive. (District 04 Circular Letter 71-15 and District 07 Design Procedures Manual Section IV - 21.0) While the concern for public safety in this Circular

should not be given any less attention, there is a need for increased emphasis on road worker safety.

b. Headquarters Construction Branch Chief's Memo of August 28, 1972 - To all Branch Chiefs and District Directors. A portion of this memorandum states, "regarding safety for workmen we should take a closer look at our designs to be sure we aren't designing into our projects items that could be a safety hazard when being constructed."

It appears that much can be done during the design phase to improve the safety of construction and maintenance personnel who build and maintain highways and related facilities. Items that need attention include:

1. Insufficient separation of workmen from passing traffic.
2. The construction of detours under traffic conditions.
3. Lack of parking room for Maintenance vehicles.
4. Access of sprinkler control valves.

RECOMMENDATIONS

4.15.1 Policy Regarding Worker Safety During Design - The department should take a stronger position in regard to construction and maintenance employee safety during the design stage of a project. Headquarters Project Development Branch should initiate a policy change in circular letter and/or directives by October 1, 1974.

4.15.2 Safety Review During Design - Requirements should be established for a detailed review of planned construction during the design stage in order to evaluate safety aspects in relation to construction and maintenance employees. This should be done by a committee composed of a design project engineer; a maintenance superintendent; a representative from the Construction Branch (preferably with current resident engineer experience), and a District Safety Coordinator. Headquarters Project Development Branch should implement this program by January 1, 1975.

4.15.3 Increased Emphasis on Safety in Design Publications - All manuals, handbooks and other applicable publications should be reviewed and amended to stress the importance of construction and maintenance safety considerations during the design of highways, landscape areas, and utility locations. This should be implemented by the Project Development Branch by January 1, 1975 and should be completed by January 1, 1976.

4.16 STATEWIDE AND REGIONAL UNIFORMITY, TRAFFIC CONTROL STANDARDS, ENFORCEMENT "MOTORIST EXPECTANCY"

Traffic warning and control devices in construction and maintenance zones should be uniform in order to fulfill the needs of passing motorists, attract their attention, and encourage a proper response.

As they become more experienced, drivers develop certain expectancies and conditioned reflexes which help them drive safely and efficiently. When these expectancies do not occur and a driver is faced with a new set of circumstances, confusion and error frequently result.

The use of non-uniform traffic control devices in construction and maintenance operations can violate the drivers' expectancy and adversely alter his behavior or response. This can seriously affect the safety of highway construction and maintenance workers. However, occasional oversized or unusual signs or devices of standard design may be appropriate to gain attention.

a. Detour Signs - Vehicle Code Section 21362 states that detour signs are required at the nearest point of detour or from any bridge which is closed to traffic while under construction or repair. This type of signing is appropriate

at locations where the traveling public must take an alternate route. However, these same signs are also required on detours where high-standard roadways are used and there is no possibility of drivers having to retrace their route to reach a detour or destination. In these cases, this required signing is unrealistic and contributes to driver disrespect of other necessary and meaningful signs. There is a need for flexibility in this section to allow that signs not be required on high-standard detours that are equal to or better than the original roadway.

b. Sign Removal or Coverage - Signs are often erected days or weeks ahead of a work date and are often left uncovered when there isn't any activity. This has a detrimental effect on the integrity of the signs. By covering and uncovering or removing these signs, their credibility can be increased in the eyes of the driver.

c. Lane Closure Warning Signs and Devices - There is a lack of statewide uniformity in the use of lane closure warning signs. Two of the eleven districts have adopted Special Provision 7.26 of the Traffic Control System for Planned Freeway Lane Closures. The provision is supplemented by a detailed plan for the "Traffic Control System for Lane Closures" which specifies the use of Type B advance warning (sequential) arrow signs. Techniques used by maintenance operations are not the same as those used by construction. As the average motorist does not recognize the difference between construction

and maintenance operations, there is a need for increased consistency in this type of signing.

RECOMMENDATIONS

4.16.1 Legislation Changes Regarding Detour Signs - Section 21362 of the Vehicle Code should be amended to eliminate the requirement that detour signs be placed at those locations where the detour is of comparable standard with the original route and there is no need to notify the motorist in advance. Thus detour signs would be posted only where absolutely necessary. The Headquarters Traffic Branch should initiate action to amend the Vehicle Code during the 1975 session of the legislature.

4.16.2 Improved Standards for Display of Signs - Uniform standards for uncovering and removing construction and maintenance zone signs that are commensurate with the actual need for the signs should be established and followed. Headquarters Traffic Branch should develop this departmentwide criteria with the assistance of the Headquarters Construction and Maintenance Branches by January 1, 1975. This should be fully operational by April 1, 1975.

4.16.3 <u>Increased Uniformity of Lane Closure Signs and Devices</u> - The use of lane closure warning signs and devices for both construction and maintenance operations should be uniform statewide. Headquarters Traffic Branch, with the assistance of the Construction and Maintenance Branches, should develop statewide uniform application standards for their use by January 1, 1975 and should be implemented statewide by April 1, 1975.

4.17 SPEED LIMITS: LEGISLATION, POLICIES, COMPLIANCE AND ENFORCEMENT

On major highways and freeways, drivers are not responsible to reduced speed postings in construction and maintenance sites when there is not a visual impact that conveys the need to reduce speed. This creates a hazardous situation for employees and workmen on the highway due to the reduced time available for reaction or evasive action where speeds are too high for conditions.

Speed reductions in construction and maintenance zones should be instituted only as a last resort to provide safety to motorists and workers. The posted construction zone hazards may be quite obvious to the motorist and yet compliance is not assured as drivers are generally not receptive to reduced speed postings, especially on freeways.

Posting techniques to obtain maximum "voluntary" driver compliance should be a high priority objective. Without a high percentage of driver compliance, the job of enforcement is made virtually impossible. Radar speed checks should be used before and after posted reduction signs to check their effectiveness and determine to what degree drivers are complying with them.

"Reduced Speed" zones should be posted in a flexible manner based on the immediate hazards, hour of the day, worker location in respect to passing traffic, holidays, weekends, etc. The speed limit should be set at the maximum safe speed possible and should be uniformly enforced on a statewide basis.

To increase safety during high hazard hours, traffic has been escorted by CHP units through critical areas at reduced speeds. This has been an effective means to prevent accidents. CHP units equipped with roof-mounted electronic changeable message signs would be useful for this type of escort. Some signs are used on the rear of CHP vehicles in some CHP areas in the state for providing escorts under hazardous traffic conditions.

A black-and-white CHP unit parked near or within the construction zone or maintenance area would be of positive assistance in reducing speed. While there is a limitation on the number of officers and units that CHP can supply, there are times when this type of deployment can be of considerable assistance and prevent accidents. Districts and maintenance territories have established working relationships with CHP area commanders to obtain assistance for these operations.

It is difficult at times for a traffic officer to effectively observe, overtake, follow and clock a violator within a

relatively short construction zone or maintenance area. The officer observing a violator must at times travel at high speeds to overtake the violator and he is then also subject to accident involvement. This is especially true in areas where there may be reduced highway standards as in detours. If the officer had electronic or mechanical speed measuring equipment (radar or vascare) to use in speed enforcement he could do a more effective job without decreasing his own safety or that of the motorist and people working within the construction or maintenance zone.

In California, local law enforcement agencies have used radar effectively for several years on surface streets and other secondary roads. The California Highway Patrol has not used radar because of a lack of specific approval for its use by the California Legislature. Bills have been introduced several times and have not passed. Having radar or other electro-mechanical means available for speed enforcement throughout the state would be of considerable value to the CHP. An appropriate starting point for its use, if unavailable statewide, may be the authorization for its use within construction zones. In conjunction with this, construction and maintenance zones could be appropriately posted with "Speed Limit Enforced by Radar" signs. This would have a considerable deterent in maintaining realistic reduced speeds through these zones.

RECOMMENDATIONS

4.17.1 Support of Legislation For CHP to Use Radar - CALTRANS and the CHP should take positive action to secure passage of legislation to permit CHP use of electronic or related mechanical devices to measure speed. It may be appropriate to initially secure legislation to permit the use of radar to enforce realistic speed limits in such critical locations where construction or maintenance activities are under way. This should be implemented by the CALTRANS Assistant Director for Legislative Affairs with the support of the Headquarters Traffic Branch and in cooperation with the CHP Office of Special Representative. Legislation should be introduced at the 1975 session of the legislature.

4.17.2 Increased Flexibility of Speed Limit Signs - Speed limits through construction zones and maintenance work areas should be established with sufficient flexibility to provide for timely realistic changes by the day of week and hour if necessary. While the establishment of speed limits based on this criteria is under way at the present time, there is a need for increased flexibility. Headquarters Traffic Branch should develop guidelines for this increased flexibility by July 1, 1975. District Traffic Branches, with the assistance of District Construction and

Maintenance Branches should implement this policy as soon as the speed limit data is available.

4.17.3 Increased Coordination With CHP - District traffic branches, resident engineers and maintenance superintendents should increase their present levels of coordination with appropriate CHP area commanders and traffic control and enforcement functions for construction zones and maintenance work areas. This coordination should include arrangements for visible preventive patrol, enforcement, fixed-post activities, and traffic escorts (Round-Robin) where critical conditions exist. This should be implemented immediately. Headquarters Office of System Operations should provide for reemphasis to appropriate field functional administrators by November 1, 1974.

4.17.4 Construction Zone Signing for Radar Enforcement - If legislation is secured for the use of electronic-mechanical means of measuring speed, all construction zones and critical maintenance work areas should be posted with "Speed Limit Enforced by Radar" signs. Headquarters Traffic Branch, in coordination with Construction and Maintenance Branches, should initiate signing standards so as to be prepared for posting as soon as the legislation is authorized.

4.18 PUBLIC INFORMATION ACTIVITIES RELATING TO CONSTRUCTION AND MAINTENANCE FUNCTIONS

The objective of a public information program regarding construction and maintenance activities is to create and maintain an awareness in the mind of the motorist regarding the unusual hazards and conditions that prevail in roadwork zones. This area has considerable potential for utilizing new and innovative means to attain this goal.

The California Drivers' Handbook (revised 1974) published by the Department of Motor Vehicles covers a wide variety of situations that the California driver may encounter. However, it does not specifically cover construction and maintenance operations. To make drivers and potential drivers more aware of highway construction and maintenance functions, information should be added to the handbook along with a related question on drivers' examinations. This material should include but not be limited to: The mental attitude related to construction and maintenance activities; explanation of the orange-and-black warning signs; procedures to follow when encountering a flagman, and safe driving near lane and road closures. This could be one of the best means to reach the new driver.

Until now, CALTRANS has not utilized the full potential of the public information media to increase the motoring public's

awareness of highway maintenance and construction activity. The following are some activities currently under way to remedy this situation:

a. Headquarters Graphic Services Unit has developed five 30-second television spot announcements geared to the safety of maintenance personnel. "Be Aware Out There" is the attention-getting slogan for this series. This pilot program could be the forerunner of a very beneficial activity. They were distributed to district Public Information Offices on July 3, 1974 for subsequent distribution to all state T.V. stations.

b. Public service radio announcements based on the above T.V. spots have been produced by Graphic Services. They should augment the impact of the T.V. spots.

c. Headquarters Public Information Office has developed an illustrated "Be Aware Out There" brochure informing motorists how to drive safely through highway construction and maintenance zones. Accurate depiction of signs and signals that motorists will encounter plays a key part. With the aid of the California Department of Education, CHP and the Office of Traffic Safety, it will be distributed to:

(1) Driver education classes.

(2) Auto Club offices.

(3) Highway Users Federation.

(4) Construction companies and organizations.

(5) Other interested organizations and individuals such as the National Safety Council, Public Organizations, Civic groups, etc.

(6) Utility companies.

(7) NHTSA of the United States Department of Transportation.

(8) Information KIOSKS at State Highway Rest Areas.

d. Headquarters and District Public Information Offices now provide public service news releases relating to construction and maintenance projects. These are sent to local radio and television stations, and newspapers. The level of these messages could be increased by adding safety tips for driving through these zones.

e. These information releases are provided for all construction activities which affect traffic flows and last more than 24 hours. This is an important means of disseminating this information.

f. Several news releases on the importance of maintenance and construction man safety have been issued, and additional releases and magazine stories are planned. The CALTRANS Public Information Program can play a key role in helping to make construction and maintenance work safer. Activities such as this reflect management's attitude toward employee safety and also have a direct bearing on employee morale.

RECOMMENDATIONS

4.18.1 Construction and Maintenance Information in DMV Driver's Handbook - Arrangements should be made with the Department of Motor Vehicles to have specific information regarding driving through maintenance and construction zones included in the next revision of the California Driver's Handbook. Headquarters Traffic Branch should prepare the material and necessary correspondence for the Director's signature and cooperate with DMV in implementing this recommendation. This material should be developed and presented to DMV by October 1, 1974.

4.18.2 Public Information Activities Relating to Construction and Maintenance - The Headquarters Public Information Office should continue its program to inform the public of the importance of driving safely through maintenance and construction zones. All ways of disseminating public information should be utilized. The Headquarters Office of Environmental and Community Affairs should cooperate with the Headquarters Office of System Operation and the Headquarters Safety Coordinator and provide them with copies of all maintenance/construction related information activities.

4.18.3 <u>District Public Information Activities</u> - Each District Public Information Office should endeavor to increase the level of public information relating to construction and maintenance safety and support the Headquarters program. District Public Information Offices should inform the Headquarters Public Information Office and their District Director and Maintenance and Construction Branches of their activities.

4.19 MANAGEMENT SUPPORT AND SAFETY STANDARDS ENFORCEMENT

A critical factor in making a safety program effective is gaining the support of all levels of management and supervision. Each worker's attitude toward safety is, in most cases, a direct reflection of that of his supervisors and managers. If the organization's or the manager's main concern is for production and not safety, the employee's will usually be also.

Employee morale, along with adequate supervision, proper safety policies and work procedures and safety standards enforcement also have a direct bearing on safety. Units with poor morale frequently have poor accident records. Individual employees with poor morale may be accident prone.

Safety is something that cannot be delegated by a manager or supervisor and forgotten about. Managers and supervisors at all levels must be fully involved in the safety of their operations.

As part of the field inquiry, several first and second level supervisors and four District Safety Coordinators were contacted. In substance, their observations and comments were as follows:

a. Most supervisors are accepting a degree of responsibility for the safety of their crew. They discuss work assignments with their crews in detail and emphasize how to avoid hazards. Foremen usually remind their crews of safety procedures pertaining to each particular job assignment. They generally conduct tailgate safety meetings every 10 days, as required, and also meet with their superintendents and assistant foremen once a month. The supervisor's job of showing his employees how to perform their job in the safest manner could be improved by an actual show-and-tell type operation.

b. Employee safety considerations are included as part of the annual appraisal and development process (Form 637). However, safety is considered in the general context of work habits, such as use of tools, etc. As a result, safety emphasis tends to become diluted, if it is specifically considered at all.

Consideration of the supervisor's responsibility and performance in developing employee safety is not specifically addressed in any formal appraisal process. The annual appraisal and development process could conceivably be used for that purpose.

In summary, evaluation of both employee and supervisor performance, as it relates to safety, can and should be strengthened.

c. District Safety Coordinators say that the Safety Program has the support of local management. Funding constraints, however, at times cause some of the lower priority safety items to receive deferred attention. The recent passage of the California and Occupational Safety and Health Act (AB 150) has stimulated increased interest in employee safety and management generally seems more inclined to devote effort and funds for safety purposes.

d. It was expressed that management needs a more positive and easier way to evaluate which cost centers and which persons in these cost centers are having the accidents and poor safety records. In small and medium size districts with few accidents (50-100/year), this information can be easily tabulated manually. However, in large districts and on a statewide basis an automated system would be more appropriate. (See 4.20 Safety Management Information Systems)

e. District Safety personnel said they would welcome more frequent contacts and visits from Headquarters Safety personnel in order to strengthen the understanding of district and statewide problems.

f. Comments from some district personnel indicated that they would like to reestablish Quarterly Safety Conferences. This would give all districts and headquarters a chance to discuss problems and possible improvements in safety procedures and devices.

g. The District Coordinators mentioned that they would like the Headquarters Safety Section to pool all available safety information and act as a central information source. This would apply primarily to new developments; new standards; new techniques; successful activities in other districts; citation information; problem areas; etc.

h. Some Safety personnel feel that it is desirable to have some persons on the Headquarters Safety staff who possess detailed knowledge of field safety. This would assure that from a statewide perspective, Safety personnel are experienced in CALTRANS' particular safety practices and understand local problems.

i. In order for any change in safety procedures to be truly effective, both employees and management must clearly understand the reasons and rationale for the procedure. Increased two-way communications are needed to help in this application process.

j. There is a need for increased consistency by managers in accepting their safety responsibility, identifying

accident-prone employees and handling unsafe activities. Under AB 150 (CAL/OSHA) it is clearly the responsibility of the "person in responsible charge" for enforcing employee safety and insuring that the work environment is safe. The person in responsible charge is usually the first-line supervisor.

Actions to correct this weakness can range from suggestions and training on how to do the job properly to disciplinary action.

In general, some comments indicate that generally not enough is being done to locate the individual with chronic safety problems and that this type of individual is getting off too easy.

RECOMMENDATIONS

4.19.1 Increased Safety Instruction to Employees - First-line supervisors should become more involved in providing safety instructions to their employees. This should be done by coach-pupil or show-and-tell sessions in which job duties are explained, demonstrated and performed. The Departmental Safety Coordinator should develop a Departmental policy statement regarding this emphasis by October 1, 1974. Each level of management and supervision within the department has a responsibility to see that this is an ongoing

portion of their supervisory and managerial responsibilities.

4.19.2 Positive Corrective Actions Related to Safety - Departmentwide action should be taken to prevent reoccurrences of accidents contributed to by employees or supervisors. This should include a full range of actions, from training, counseling, direction, and guidance to punitive action. The Departmental Safety Coordinator should develop such a policy for the department with the cooperation of the Maintenance, Construction, Personnel, and Training Branches and representatives of employee groups. This policy should be developed by January 1, 1975.

4.19.3 Safety Management Information System - A safety related management information system to identify safety trends, needs and problems and evaluate results is critically needed within the department. See 4.20 for specific analysis of this item and recommendations.

4.19.4 Increased Support to District Safety Programs - The Headquarters Safety Unit should strengthen its role by providing field contact and support to district safety programs and increasing its ability to provide and share safety information with the districts. The Headquarters Safety Coordinator should determine

district safety needs by means of conferences and interviews with district line managers and safety personnel. This determination should be initiated prior to September 1, 1974, and be ready for implementation beginning January 1, 1975.

4.19.5 Evaluation of District Safety Programs - An appraisal of the strengths, weaknesses, successes and failures of each district safety program should be conducted annually by each District Director and submitted to the Deputy Director for Operations for review by the Operations Accident Prevention Committee. This annual appraisal should, as a minimum, address success in attaining injury and accident prevention goals, actions to achieve hazard control, attitudes of supervisors in achieving safe production and effectiveness of safety personnel in providing safety consultation to line managers. The Office of the Deputy Director for Operations should initiate this program by January 1, 1975.

4.19.6 Safety Program Management Manual - A department safety program management manual should be developed which provides clear, complete and coordinated information. It should be composed of portions of the multitude of manuals, directives, and guides now in use. This would provide a central resource for

this information. It should be developed by the Departmental Safety Coordinator prior to July 1, 1975.

4.20 SAFETY MANAGEMENT INFORMATION SYSTEM

An important element of any viable safety program is an information system which provides management at all levels with timely and accurate awareness of safety problems and progress toward achieving safety improvement efforts and goals. After the task force started its analysis of accidents and incidents relating to maintenance, construction and passing traffic, it became evident that the present safety information system is not providing adequate, timely information to administrators and managers at all levels throughout the department. A complete revamping of the existing safety information system must be instituted to satisfy the department's safety information needs.

The department's existing safety information system was developed over the years in an evolutionary manner and has not been modified for the past six or seven years. During the past several years, safety information needs have changed and production management systems have been developed in other areas which could be related to work activities and safety (eg. Maintenance Management System). The recent enactment of CAL/OSHA also requires a more complete and sophisticated safety program and information system.

It is difficult to extract special data from the existing system to recap prior accidents. This lack of data

availability and non-usability of much of the existing data can be related to the following findings:

a. The existing system does not allow for forecasting or predicting potential accident situations.

b. The existing system was developed to compile the accident data in a summarized form.

c. There is no possible correlation with accident data from the public sector. Example: traffic flow versus accidents; traffic speed reduction versus accidents; facility type versus accidents.

d. Large amounts of clerical time are expended on input documents to insure accuracy.

e. Data has been insufficient to use in Maintenance/Construction work zone programs, i.e., data not specifically related to work activities.

f. Existing summary data being gathered and run through the computer is not usable; it must be reviewed against the original input document to obtain precise accident-cause information.

g. Input, using the existing system, is in some cases inaccurate.

h. The existing system does not provide timely information (i.e., there is always a 60 day delay).

i. Progress toward safety goals is difficult to measure.

To effectively manage the department's safety program, it is of critical importance to have a comprehensive safety management

information system that will provide usable data at all levels within the department. The maintenance territory superintendent should be able to retrieve information relating to his operation. With this information, he can identify trends before they become serious problems by taking positive, timely action. The District Director of Transportation should have current, concise information in a more summarized form which will accurately portray the state of maintenance and construction safety within his sphere of responsibility. The Deputy Director for Operations should have the same information in a more summarized form by which he can evaluate statewide maintenance and construction safety. Many Headquarters functional administrators and units need different portions of this information on which to base management and program decisions. Each of these levels has a different, yet related, need for this information. It should be available in a single computerized system with retrieval capability at any of these levels.

If management information is only a statistical report that supervisors and managers gather to fill headquarters reporting requirements, it is a waste of time and money. The truly viable system should be a working tool that all levels of management can use to meet their responsibilities in making their units safer places to work.

RECOMMENDATIONS

4.20.1 Development of Safety Management Information System - A CALTRANS safety management information system should be developed to provide meaningful safety information to all levels and units throughout the department. To meet current and safety program information needs, it should:

a. Alert management to developing problems.

b. Provide monitoring against safety goals.

c. Provide sufficient flexibility to allow retrieval of data which will make testing of hypotheses possible.

d. Provide sufficient flexibility to allow tracking of special projects or situations which arise.

The system should also provide compatibility with:

a. Requirements of the State Administrative Manual.

b. Meet insurance requirements of the State Compensation Insurance Fund and Motor Vehicle insurance carriers.

c. Departmental policy.

d. California Occupational and Safety Health Act.

The Headquarters Safety Coordinator should initiate development of the system prior to October 1, 1974. The system should be tested by July 1, 1975 and fully operational by January 1, 1976. See Annexes D and E for development sequence and a contents outline of the system.

5.0 CONCLUSIONS

In the relatively short period of time available, this study focused upon those areas that reflect the highest degree of hazard based on concern expressed by the steering committee, available accident records, and the input of employees who actually perform the work. While there are many safe, effective operations under way throughout the state, there are also areas where additional steps could be taken. The following general comments are in regard to the safety of maintenance and construction personnel in their relationship to passing traffic:

During the study of maintenance and construction safety and its relationship to passing traffic, it became apparent that the safety of employees and workers has been included in planning, conducting, and evaluating maintenance and construction operations throughout the state. The department could not have attained the status it has today without making concerted efforts toward improving employee and worker safety and keeping traffic moving. However, if the organization wants to move forward, it must continually work to increase effectiveness. Therefore, we must continue to improve our safety efforts.

During the task force inquiries, it was found that safety is a vital concern in many operations. In others, however, it plays a less conspicuous role.

Early in this special study, it became apparent that meaningful, in-depth information was not readily available throughout the department to properly identify current and potential problems and the results of efforts to correct them. There is a need to develop a Safety Management Information System that will provide for the selective retrieval of information related to maintenance and construction safety by individual managers at any level in the department. This should not be a massive array of statistics and fine detail, rather a method of indicating developing problems and evaluating results of specific safety efforts. Presently, there is no easy way to correlate information from the several information systems that are available within CALTRANS. Hand tallying is the only way to obtain some key information. A safety management information system could coordinate these resources and provide meaningful data. This is one of the most pressing needs for improvement in the management safety program.

Of major importance to a maintenance and construction safety program is the degree of support and acceptance of responsibility given by all levels of management and supervision. Safety is something that cannot be delegated. Administrators may have safety coordinators to assist them, but in the final analysis the line administrator must accept and fully support his unit's safety program. As safety plays such a visible and important role in managing this department, administrators

should include specific objectives and goals related to safety in their management plans. Each employee's periodic evaluation should specifically include an indication of his performance in the area of safety. This includes evaluating the Director on the safety of the entire department; Deputy Directors on their spheres of responsibility; each District Director of Transportation for his District; the superintendent for his maintenance territory; the resident engineer for his project; the foreman for his crew; as well as the individual worker for those procedures and responsibilities that are under his control. There appears to be a need within the department for an increased commitment to and evaluation of safety efforts when measuring managers' and individuals' true effectiveness. This does involve risk, but nothing will be gained without it.

An important consideration relative to maintenance and construction activity is uniformity in the eyes of the motorist. The study reveals that there are differences in our equipment, procedures, and warning devices that could be inconsistent with the motorist's expectations. There is a need for some flexibility in order to meet local needs; however, the best ideas could be combined and used statewide to increase uniformity in the eyes of the public.

Such a stress upon uniformity in maintenance and construction procedures would not be intended to develop a rigid inflexibility with a commensurate deadening effect. However,

headquarters functional units can effectively serve as catalysts for ideas and developments that originate in the field so that they can be shared statewide. By taking the best ideas and using them as a basis to establish uniform procedures and equipment design, the department can receive the benefit of statewide thinking and development. Also, time and effort can be saved and the possibility of redeveloping something that another district already has can be eliminated.

When analyzing those conditions contributing to accidents, the focus is frequently on the more mechanical aspects of the incident such as equipment; signs; weather; design of the structure and location where the individual is working. Often, recommendations to correct the condition include more or better equipment. While these are positive contributions, they are not the most important factors. The attitude and safety consciousness of the individuals involved is probably the most single important factor affecting the success or failure of any safety program.

This applies not only to the individual worker but to his supervisors and administrators as well. Their attitudes also have an effect on his safety. Frequently, a poor safety record or an unusual accident or incident pattern is a symptom of underlying problems. To make meaningful improvements in the safety of an organization, managers must broaden their focus to include the entire work situation.

Throughout this study, the role of training was frequently identified. Not only is it important at the employee level but also for management and supervision. Providing employees with a sound foundation of how to perform a particular job in the most effective and safe manner is a major responsibility of every manager and supervisor. However, training and procedures should not be so firmly structured that creativity and experimentation to develop a better and safer way of performing a particular job are blocked. Under the hazardous conditions that are present on the highway, an employee or worker may not get a second chance if he is expected to learn by trial and error.

Every leadman; foreman; supervisor; manager and administrator should be familiar with the basic techniques of teaching. This should be acquired when an individual is first moved into a supervisory position. Training of the formal structured classroom type, however, while important, is not the most critical training factor that relates to safety. It is the day-to-day guidance that a supervisor provides to his subordinates. This should include the following: a one-to-one coach-pupil method of instruction explaining the how's and why's of a job, a demonstration on how to do the job, and the employee's performance of the job under observation with the supervisor providing guidance if necessary. Basic teaching techniques of going from simple to complex or following a logical sequence of operation provide for an easy basic

structure for instructional procedure. If a unit or individual is experiencing work-related accidents or near accidents, an examination of his training may reveal the underlying cause. Throughout the analysis section of this report there are many references to training as a means of increasing safety. Training is an integral part of any safety program.

Public information activities relating to maintenance and construction safety are receiving increased attention. Television spot announcements, brochures and news releases are increasingly being utilized. These are the beginning of an effort that can make a meaningful contribution to improving safety in this important area. This resource needs to be more fully developed to raise the level of awareness of the driver passing through maintenance and construction zones. Driver education classes in the high schools and references to maintenance and construction safety in the study material for California drivers' license examinations should be an integral part of the program. This is another key area that plays an important part in making the highway worker's job safer.

6.0 RECOMMENDATIONS

One hundred and one separate recommendations have been developed by this Special Study on Maintenance and Construction Safety as it relates to passing traffic. These recommendations range from reinforcement of existing procedures or actions to major adjustments and new undertakings. Collectively, these recommendations should substantially improve the safety of California's highway maintenance and construction workers.

To aid in their implementation, these recommendations include: the specific action to be taken; the unit or organization responsible for implementing or developing the recommendation; and a specific time frame in which to start, develop and implement the task.

Without such designations, these recommendations would be open-ended. It would be all too easy to take this report and place it on a shelf to activate "sometime".

Each separate recommendation names a specific unit or organization responsible for its development and implementation. While this unit or organization is responsible, it is not intended that it do all of the developmental work alone. Ideally, it should function as a catalyst and coordinator of ideas from an entire cross section of the department. If the best sources available for each of the recommendations can be tapped, their validity and usefulness will be markedly

increased. Implementation should not be just a downward flow of new directions and procedures from headquarters. It should be a composite of the best thinking available from the entire department.

With the large number of recommendations included in this report, it is important to provide follow-up evaluations on a systematic basis. This should take place annually for the next five years to determine:

a. How many of the recommendations were implemented?

b. How many were not, and why?

c. What benefits have been realized?

d. What detriments have developed?

e. Has maintenance and construction employee and worker safety actually improved?

f. What changes or adjustments should be made to the program?

Some of the recommendations involve an increase in fiscal expenditures and manpower allocations. It is important that the responsible organizational units evaluate each recommendation for budgetary adjustments that may be necessary.

The following is a list of recommendations indicating the subject; the unit or organization responsible; and implementation and completion dates. The full text of each recommendation is included in the analysis section. Reference numbers are included for ease of location.

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.1.1	Sweeping - Hours of Work	District Maintenance Branches	November 1, 1974	Continuing
4.1.2	Sweeping - Advance Signs	Headquarters Maintenance Branch	November 1, 1974	Continuing
4.1.3	Sweeping - Signs on Shadow Trucks	Headquarters Maintenance Branch	October 1, 1974 (Each District January 1, 1975)	Continuing
4.1.4	Sweeping - Short Sight Distances	Headquarters Maintenance Branch	November 1, 1974 (Each District January 1, 1975)	Continuing
4.1.5	Sweeping - Signs and Warning Flags	Headquarters Equipment Branch	January 1, 1975	Continuing
4.1.6	Sweeping - Chevron Stripes on Vehicles	Headquarters Equipment Branch	October 1, 1974	Continuing
4.1.7	Sweeping - Levels of Service	Headquarters Maintenance Branch	October 1, 1974	Continuing
4.1.8	Sweeping - Standardized Equipment	Headquarters Equipment Branch	January 1, 1975	January 1, 1977
4.1.9	Sweeping - Energy Attenuators on Vehicles	Headquarters Equipment Branch	July 1, 1975	July 1, 1977
4.1.10	Sweepers - Radio Equipped	Headquarters Maintenance Branch	July 1, 1975	July 1, 1978

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.2.1.1	Raised Markers - Installation	Headquarters Construction and Maintenance Branches	January 1, 1975	Continuing
4.2.1.2	Raised Markers - Combined Scheduling	All Levels of Maintenance Supervision	Immediately	Continuing
4.2.1.3	Raised Markers Installation - Scheduling	District Maintenance Branches	Immediately	Continuing
4.2.1.4	Raised Markers - Uniformity of Signs and Devices on Equipment	Headquarters Equipment Branch	January 1, 1975	January 1, 1977
4.2.1.5	Raised Markers Installation - Pilot Vehicles	Headquarters Maintenance Branch	January 1, 1975	Continuing
4.2.1.6	Marker Replacement - Level of Service	Headquarters Maintenance Branch	January 1, 1975	Continuing
4.2.1.7	Development of Marker Installation Equipment	Headquarters Equipment Branch	July 1, 1976	Continuing
4.2.2.1	Statewide Striping Criteria	Headquarters Maintenance Branch	January 1, 1975	July 1, 1975
4.2.2.2	Statewide Signing and Warning Device Criteria - Striping	Headquarters Maintenance Branch	April 1, 1975	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.2.2.3	Uniform Placement of Lighting and Equipment on Vehicles Used in Striping	Headquarters Equipment Branch	July 1, 1975	July 1, 1977
4.2.2.4	Hot Striping Equipment	Headquarters Equipment Branch	As soon as possible	Continuing
4.3.1	Litter Pickup - Parking Vehicles	Headquarters Maintenance Branch	October 1, 1974	Continuing
4.3.2	Litter Pickup - Advance Warning Signs	Headquarters Maintenance Branch	October 1, 1974	Continuing
4.3.3	Litter Pickup - Safe Working Techniques	Headquarters Maintenance Branch	October 1, 1974	Continuing
4.4.1	Patching - Cone Placement	Headquarters Maintenance Branch	October 1, 1974	Continuing
4.4.2	Patching - Improved Cone Placement	Headquarters Traffic Branch	April 1, 1975	Continuing
4.4.3	Patching - Coordination With CHP	Each District and Maintenance Station	Immediately	Continuing
4.4.4	Patching - Shadow Vehicles	Headquarters Maintenance Branch	April 1, 1975	Continuing
4.4.5	Patching - Shadow Vehicle Use Training	Headquarters Maintenance Branch	July 1, 1975	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.4.6	Patching - Safer Work Practices	Headquarters Maintenance Branch	October 1, 1974	January 1, 1975
4.4.7	Patching - Chevron Stripes on Equipment	Headquarters Equipment Branch	January 1, 1975	January 1, 1977
4.5.1.	Snow Removal - Equipment Design	Headquarters Equipment Branch	October 1, 1974	Continuing
4.5.2	Snow Removal - Radios on Equipment	Headquarters Maintenance Branch	November 1, 1974	Continuing
4.5.3	Snow Removal - Uniform Warning Devices	Headquarters Equipment Branch	January 1, 1975	January 1, 1976
4.5.4	Snow Removal - Bare Pavement Policy	Headquarters Maintenance Branch	November 1, 1974	Continuing
4.5.5	Sanding - Reduction of Levels	Headquarters Maintenance Branch	November 1, 1974	Continuing
4.5.6	Inclement Weather - Public Information	Headquarters Public Information Branch	Immediately	Continuing
4.5.7	Drivers' Handbook - Winter Driving Information	Headquarters Office of Environmental and Community Affairs	October 1, 1974	Continuing
4.5.8	Snow Removal - Driver Education Classes	Headquarters Office of Environmental and Community Affairs	January 1, 1975	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.6.1	Median Barriers - Concrete	Headquarters Traffic Branch	January 1, 1975	Continuing
4.6.2	Median Barriers - Reduced Use of Chain-Link Mesh	Headquarters Traffic Branch	October 1, 1974	Continuing
4.6.3	Median Barriers - Metal Beam Barriers	Headquarters Maintenance Branch	October 1, 1974	Continuing
4.6.4	Reduction of Median Screen Planting	Headquarters Landscape Architecture Branch	October 1, 1974	Continuing
4.6.5	Safe Medians - Safer Sprinkler Controls	Headquarters Landscape Architecture Branch	September 1, 1974	Continuing
4.7.1	Work Scheduling - Nights	Headquarters Maintenance Branch	April 1, 1975	July 1, 1975
4.7.2	Work Scheduling - Coordination	Headquarters Maintenance Branch (also each District)	January 1, 1975 April 1, 1975	Continuing Continuing
4.8.1.1	Complete Facility Closure	Headquarters Traffic Branch	January 1, 1975	January 1, 1976
4.8.2.1	Lane Closure Training	First Line Supervisors	Immediately	Continuing
4.8.2.2	Evaluation of Accidents in Lane Closures	First Line Supervisors	Immediately	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.8.2.3	Coordination of Lane Closures with CHP/ Police	Maintenance Superintendents and Foremen	Immediately	Continuing
4.8.2.4	Multiple Activities in Single Closure	District Maintenance Branches	Immediately	Continuing
4.8.2.5	Use of Shoulders for Traffic Lanes	Headquarters Traffic Branch	July 1, 1975	Continuing
4.9.1	Flagmen - Evaluation of Use	Headquarters Traffic Branch	April 1, 1975	Continuing
4.9.2	Flagmen - Uniformity of Equipment	Headquarters Traffic Branch	January 1, 1975	Continuing
4.9.3	Flagmen - Training	Headquarters Traffic Branch	January 1, 1975	July 1, 1975 Continuing
4.10.1	Criteria for Use	Headquarters Maintenance Branch	January 1, 1975	Continuing
4.10.2	Slow Moving Vehicles - Uniformity of Equipment	Headquarters Equipment Branch	January 1, 1975	January 1, 1977 Continuing
4.11.1	Fixed Protection - Uniform Set-up and Take-down	Headquarters Maintenance and Construction Branches	January 1, 1975	July 1, 1975

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.11.2	Increasing Safety by Job Restructuring	Headquarters Maintenance and Construction Branches	October 1, 1974	July 1, 1975
4.11.3	Uniform Specifications and Use of Cones	Headquarters Traffic Branch	October 1, 1974	October 1, 1975
4.11.4	Increasing Use of Flashing Sequential Signs	Headquarters Traffic Branch	January 1, 1975	June 30, 1975
4.11.5	Uniform Use of Shadow Vehicles	Headquarters Traffic Branch	January 1, 1975	December 31, 1975
4.11.6	Use of "End Roadwork" Signs	Headquarters Traffic Branch	January 1, 1975	Continuing
4.11.7	Improvement of Sign Colors	Headquarters Traffic Branch	Immediately	January 1, 1976
4.11.8	Sign Placement	Headquarters Traffic Branch	Immediately	July 1, 1975
4.11.9	Changeable Message Signs	Headquarters Traffic Branch	January 1, 1975 (Field - January 1, 1976)	January 1, 1976 Continuing
4.11.10	Vehicle and Equipment Colors	Headquarters Equipment Branch	Immediately (Field - July 1, 1975)	January 1, 1976 Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.12.1	Falsework Clearance Specifications	Headquarters Project Development Branch	January 1, 1975	Continuing
4.12.2	Construction Structures and Worker Safety	Headquarters Office of Structures	January 1, 1975	Continuing
4.13.1	Safety Training for Employees and Workers	Headquarters Construction Branch	Immediately	Continuing
4.13.2	Planned Work Sequences for Increased Safety	Headquarters Construction Branch	January 1, 1975	Continuing
4.13.3	Use of Safety and Traffic Experts During Construction	Headquarters Project Development Branch	January 1, 1975	Continuing
4.13.4	Traffic Direction Training (See Recommendation 4.9.3)			
4.13.5	Safety Considerations in Design Stage	Headquarters Project Development Branch	January 1, 1975	Continuing
4.14.1	Assignment of Traffic Safety Coordinators on Construction Projects	Headquarters Traffic Branch	April 1, 1975 (Operational July 1, 1975)	Continuing
4.14.2	Uniformity of Signs and Devices on Equipment	Headquarters Equipment Branch	January 1, 1975	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.14.3	Increasing Drivers' Alertness	Headquarters Traffic Branch	October 1, 1974	Continuing
4.14.4	Changeable Message Signs	Headquarters Traffic Branch	January 1, 1975	Continuing
4.14.5	Contracts to Include Items for Traffic and Safety	Headquarters Construction Branch	January 1, 1975	Continuing
4.14.6	Reevaluation of Traffic Control Devices	Headquarters Traffic Branch	October 1, 1974	April 1, 1975
4.15.1	Policy Regarding Worker Safety During Design	Headquarters Project Development Branch	October 1, 1974	Continuing
4.15.2	Safety Review During Designs	Headquarters Project Development Branch	January 1, 1975	Continuing
4.15.3	Increased Emphasis on Safety in Design Publications	Headquarters Project Development Branch	January 1, 1975	January 1, 1976
4.16.1	Legislation Changes Regarding Detour Signs	Headquarters Traffic Branch	January 1, 1975	Continuing
4.16.2	Improved Standards for Display of Signs	Headquarters Traffic Branch	January 1, 1975 (Operational April 1, 1975)	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.16.3	Increased Uniformity of Lane Closure Signs and Devices	Headquarters Traffic Branch	January 1, 1975 (Operational April 1, 1975)	Continuing
4.17.1	Support of Legislation for CHP to Use Radar	Assistant Director for Legislative Affairs	January 1, 1975	Continuing
4.17.2	Increased Flexibility of Speed Limit Signs	Headquarters Traffic Branch	July 1, 1975	Continuing
4.17.3	Increased Coordination with CHP	Headquarters Office of System Operations and District Traffic Branches, Resident Engineers, and Maintenance Superintendents	Immediately (Operational November 1, 1974)	Continuing
4.17.4	Construction Zones Signing for Radar Enforcement	Headquarters Traffic Branch	If Legislation Authorized	Continuing
4.18.1	Construction and Maintenance Information in DMV Drivers' Handbook	Headquarters Traffic Branch	October 1, 1974	Continuing

	Recommendations	Responsible Unit or Organization	Implementation Date	Completion Date
4.18.2	Public Information Activities Relating to Construction and Maintenance	Headquarters Office of Environmental and Community Affairs	Immediately	Continuing
4.18.3	District Public Information Activities	District Public Information Offices	Immediately	Continuing
4.19.1	Increased Safety Instructions to Employees	Departmental Safety Coordinator (All Levels of Supervisors and Management)	October 1, 1974	Continuing
4.19.2	Positive Corrective Actions Related to Safety	Departmental Safety Coordinator	January 1, 1974	Continuing
4.19.3	Safety Management Information System	See 4.20		
4.19.4	Increased Support to District Safety Programs	Headquarters Safety Coordinator	September 1, 1974 (Operational January 1, 1975)	Continuing
4.19.5	Evaluation of District Safety Programs	Office of Deputy Director for Operations	January 1, 1975	Continuing
4.19.6	Safety Program Management Manual	Departmental Safety Coordinator	July 1, 1975	Continuing
4.20.1	Development of Safety Management System	Headquarters Safety Coordinator	Prior to October 1, 1974	January 1, 1976

7.0 BIBLIOGRAPHY

Highway Research News, Number 54, "Crash Cushion Trailer Protects Workers, Doubles Production Thru Added Security", Spring 1974.

Hulbert, Slade. Traffic Engineering, Chapter 3, 4th edition, 1974.

Minnesota Department of Highways. Instructions to Flagmen.

Minnesota Mining and Manufacturing Company, Traffic Control Products Division. More Danger Than Meets The Eye. St. Paul, Minnesota.

Morimoto, Thomas T. "Rehabilitating Chicago's Expressways", Civil Engineering - ASCE. December 1972.

National Cooperative Highway Research Program. "Traffic Control for Freeway Maintenance". 1969.

Rural and Urban Roads. "Crash Pads Protect Maintenance Trucks". May 1974.

State of California. Construction Safety Order 1509 and 1510. 1965.

_____. Form 637 - Individual Development Plan and Performance Appraisal Summary. April 1970.

State of California, Department of Motor Vehicles. California's Driver's Handbook. January 1974.

_____. Vehicle Code. 1973

State of California, Department of Public Works. Guide to Formal Punitive Actions and Other Employer Actions, 1971.*

_____. Standard Specifications, 1973.*

State of California, Department of Transportation. Statutes Relating to the California Department of Transportation, 1974.

State of California, Division of Highways. Bridge Planning and Design Manual, Volume III, Chapter 10. June 1971.*

_____. Circular Letter 70-93, Safety Reviews. October 22, 1970.*

_____. Construction Manual.*

_____. Equipment Manual of Instruction.*

_____. Highway Design Manual, 7-204-7, October 30, 1970.*

_____. Maintenance Manual.*

State of California, Department of Transportation. Manual of Warning Signs, Lights, and Devices for Use in Performance of Work Upon Highways. 1973.*

State of California, Division of Highways. Report of Study - Improvement of Traffic Safety in Relation to Workmen and The Traveling Public. May 1, 1972.*

_____. Traffic Manual.*

State of California, Division of Highways, District 04. Circular Letter 71-15.*

State of California, Division of Highways. District 07 - Design Procedures Manual. Section IV-21.0.*

State of California, Division of Highways, District 07. An Example of Increasing Capacity and Reducing Demand Past a Lane Closure. 1969.*

_____. A Field Procedure for Determining Effects of Lane Closure. 1969.*

State of Oregon, State Highway Department, Personnel Division, Safety Section. Safety Code. April 1966.

State of Washington, Washington State Highway Commission, Department of Highways, Flagman's Manual. 1973

United States Government, Department of Transportation. Manual of Uniform Traffic Control Devices for Streets and Highways. 1973.

Wierer, Jonathan and Fonda, Roy D. "Corridor Traffic Patterns During Eisenhower Expressway Resurfacing and Repairs". November 1968. (typewritten)

*The California Department of Public Works which includes the Division of Highways became the California Department of Transportation on July 1, 1973. Publications prior to that time have prior Departmental and Division designations.

SAFETY OF MAINTENANCE

AND CONSTRUCTION PERSONNEL

IN WORK ZONES

STEERING COMMITTEE MEMBERSHIP

CALTRANS HEADQUARTERS

Mr. J. F. Maloney, Deputy Director for Operations

Mr. L. R. Gillis, Deputy State Highway Engineer

Mr. G. L. Russell, Office of System Operations

Mr. J. R. Cropper, Construction Branch

Mr. A. C. Estep, Traffic Branch

Mr. W. Altus, Maintenance Branch

Mr. F. Boucher, Traffic Branch

Mr. R. Inman, Chief, Industrial Engineering Group

Mrs. H. Jones, Public Information Office

Mr. R. L. Negri, Safety Coordinator

Mr. D. Theobald, Highway Systems Planning

Inspector R. M. Hartman, CHP Representative at CALTRANS

DISTRICT REPRESENTATIVES

Mr. Gene Hardin, Deputy District Director for System Operations, District 04

OTHER STATE DEPARTMENTS

Capt. R. Gilbert, California Highway Patrol Headquarters

Mr. C. Pfaff, Safety Engineer, Division of Industrial Safety

CONSULTANT

Dr. Slade F. Hulbert, Ph.D., UCLA, School of Engineering

EMPLOYEE ORGANIZATION

Mr. W. Denny, Employee Relations Representative, CSEA

SAFETY OF MAINTENANCE

AND CONSTRUCTION PERSONNEL

IN WORK ZONES

TASK FORCE MEMBERSHIP

R. M. Hartman - Chairman - CHP Representative at Caltrans

Subcommittee I - Problem Identification

R. Negri - Chairman - Departmental Safety Coordinator
Headquarters Safety Section

W. Altus - Assistant Maintenance Engineer
Headquarters Maintenance Branch

F. Boucher - Associate Highway Engineer
Headquarters Traffic Branch

B. Denny - Employee Relations Representative Mechanical & Construction Trades
California State Employees Association

L. Ferguson - Assistant Construction Engineer
Headquarters Construction Branch

H. Jones - Information Officers
Headquarters Public Information Office

Subcommittee II - Procedures Evaluation

D. Crane - Chairman - Assistant Maintenance Engineer
Headquarters Maintenance Branch

F. Boucher - Associate Highway Engineer
Headquarters Traffic Branch

L. Ferguson - Assistant Construction Engineer
Headquarters Construction Branch

H. Jones - Information Officer
Headquarters Public Information Office

P. Meador - Assistant Highway Superintendent
Modesto Maintenance Territory, District 10

R. Negri - Departmental Safety Coordinator
Headquarters Safety Section

B. Simpson - General Superintendent
Headquarters Equipment Branch

Subcommittee III - Maintenance and Construction Safety Practices

R. Inman - Chairman - Chief Industrial Engineer
Headquarters Equipment Branch

F. Boucher - Associate Highway Engineer
Headquarters Traffic Branch

A. Dildine - Maintenance Operations Engineer
Headquarters Maintenance Branch

L. Ferguson - Assistant Construction Engineer
Headquarters Construction Branch

J. Hunter - Resident Engineer
Construction, District 03

C. Jackson - Senior Highway Engineer
Headquarters Construction Surveys

H. Jones - Information Officer
Headquarters Public Information Office

P. Littlejohn - Highway Maintenance Statewide Action Group
California State Employees Association
MTC Department, District 10

R. Negri - Departmental Safety Coordinator
Headquarters Safety Section

J. Ongaro - Highway Superintendent
Bay Toll Crossings

L. Pearson - Traffic Engineer
Prof. Engineers in California Government

J. H. Russell - Consultant
Division of Industrial Safety

B. St. John - Highway MTC Supervisor
MTC Department, District 02

E. Tensher - Senior Highway Superintendent
MTC Department, District 04

Subcommittee IV - Traffic Flow

L. Newman - Chairman - Chief
Highway Operations Branch, District 04

R. Chaney - Assistant Maintenance Engineer
Headquarters Maintenance Branch

L. Ferguson - Assistant Construction Engineer
Headquarters Construction Branch

F. Johnson - Bridge Manager SFOBB
Toll Bridge Administration

K. Moskowitz - Assistant Traffic Engineer
Headquarters Traffic Branch

R. Murphy - Senior Engineer
Freeway Operations Branch, District 07

C. Wynn - Captain, CHP Area Commander
Redwood City Area, California Highway Patrol

Subcommittee V - Driver Behavior

J. Bell - Chairman - Chief
Freeway Operations Branch, District 07

W. Berry - Captain, CHP Area Commander
Westminster Area, California Highway Patrol

F. Boucher - Associate Highway Engineer
Headquarters Traffic Branch

J. Farr - Highway Landscape Maintenance Worker II
Florence Landscape Maintenance Station
California State Employees Association

L. Ferguson - Assistant Construction Engineer
Headquarters Construction Branch

R. Gerald - Resident Engineer
Construction Branch, District 07

Dr. S. Hulbert
Institution of Transportation & Traffic Engineering, UCLA

H. Jones - Information Office
Headquarters Public Information Office

W. Myyra - Senior Maintenance Engineer
District 07

R. Negri - Departmental Safety Coordinator
Headquarters Safety Section

M. Puentes - Traffic Engineer
Southern California Automobile Club

Mechanical and Construction Trades Council

1108 "O" STREET SACRAMENTO, CA. 95814

Printing Trades Advisory Subgroup, Civil Maintenance Advisory Subgroup, Maintenance and Trades Managers' Assn.
Trades and Crafts Advisory Subgroup, Highway Maintenance Statewide Action Group (HMSAG)

CALIFORNIA STATE EMPLOYEES' ASSOCIATION

You Can Help Improve Your Working Conditions

CSEA is helping the Department of Transportation (CalTrans) gather data on the hazardous aspects of your working conditions.

D.O.T. (CalTrans) has established a Maintenance and Construction Safety Task Force to identify, study and formulate changes of employees' hazardous working conditions when they are working on or near the highways.

The study's goal is "to reduce accidents and injuries in maintenance operations and construction zones that involve passing traffic."

HMSAG and the Maintenance and Trades Managers' Association will have representatives on the subgroups, studying various problem areas. Your help is needed in identifying and acquiring details of those aspects of your work which are hazardous. All information you supply will be held in CONFIDENCE.

Please answer the following questions and give the completed questionnaire in the envelope provided, to your yard rep by December 28, 1973. The yard rep will then send your comments to CSEA Headquarters, attention Bill Denny, 1108 "O" Street, Sacramento, 95814.

For assistance in answering the questions, attachment #1 contains a listing of major work activities and general work locations descriptions.

1. General Information About Yourself

   (a) Classification (b) Age

   (c) Years of state service (d) Years of service at current work place

2. Have you ever been operating a piece of maintenance equipment on or near the traveled way when you, the equipment, or one of your fellow workers were almost struck or injured by a passing vehicle?

Please give details of the incident(s) and how you think it could have been avoided.

WORK ACTIVITY _____

_____

PROGRAM METHOD NUMBER* _____

_____

INCIDENT _____

_____

_____

_____

APPROXIMATE DATE _____

WORK LOCATION _____

_____

COMMENTS _____

_____

_____

_____

_____

3. Have you ever been working on or near the traveled way when you or one of your fellow workers were almost struck by a passing vehicle?

Please give details of the incident and how you think it could have been avoided.

WORK ACTIVITY & PROGRAM METHOD NO. _____

_____

INCIDENT _____

_____

APPROXIMATE DATE _____

WORK LOCATION _____

*Program method number - use attachment #1 and Maintenance Management system numbers.

COMMENTS _____

_____

_____

_____

_____

4. Are there any maintenance procedures or work activities which you think are hazardous?

   Please list in order of most hazardous to least hazardous and state what you think can or should be done to reduce the hazard.

PROCEDURE OR WORK ACTIVITY _____

_____

HAZARDOUS CONDITION _____

_____

_____

_____

_____

COMMENTS _____

_____

_____

_____

_____

5. Have you ever received any comments or complaints from a motorist regarding maintenance activities or procedures as they relate to employee or motorist safety?

   Please describe below:

WORK ACTIVITY OR PROCEDURE _____

_____

COMMENTS OR COMPLAINTS _____

_____

_____

_____

APPROXIMATE DATE _____

YOUR REACTION _____

_____

_____

_____

_____

If you need additional space, please attach additional sheets.

You can help yourself by sending us details of your experience.

Bill Denny

Bill Denny
Employee Relations Representative
Mechanical & Construction Trades

ls

Issue date: 12/17/73

MAINTENANCE PROGRAMS

ATTACHMENT #1

MAJOR WORK ACTIVITY LISTING

01-000	ROADBED, FLEXIBLE	11-000	PUBLIC SERVICE FACILITIES
02-000	ROADBED, RIGID	12-000	LANDSCAPE MAINTENANCE
03-000	ROADSIDE MAINTENANCE	13-000	BRIDGE & PUMP MAINTENANCE
04-000	ROADWAY LITTER & DEBRIS	14-000	TUBE, TUNNEL & FERRY MAINTENANCE
05-000	VEGETATION CONTROL	15-000	PERMIT
06-000	PAVEMENT DELINEATION	16-000	OPERATIONS
07-000	SIGNS	17-000	ADMINISTRATION & AUXILIARY SERVICES
08-000	ELECTRICAL	18-000	MAJOR DAMAGE & DISASTER MAINTENANCE
09-000	TRAFFIC SAFETY DEVICES	19-000	WORK FOR OTHERS
10-000	SNOW REMOVAL & ICE CONTROL		

GENERAL WORK LOCATION DESCRIPTION

1. FREEWAY (URBAN)
2. FREEWAY (RURAL)
3. CONVENTIONAL HIGHWAY (2 LANE URBAN)
4. CONVENTIONAL HIGHWAY (2 LANE RURAL)
5. EXPRESSWAY (4 OR MORE LANES - URBAN)
6. EXPRESSWAY (4 OR MORE LANES - RURAL)
7. ON OR OFF RAMP
8. FRONTAGE ROAD

*Program method number - use attachment #1 and Maintenance Management System Numbers.

SAFETY MANAGEMENT INFORMATION SYSTEM

DEVELOPMENT SEQUENCE

1. Departments and other involved parties formalize requests for data they wish to receive from the system. (Headquarters Safety to coordinate efforts.)
2. Contact Computer Systems. Alert them to need for revision of system or possibility of new program being needed.
3. Review of existing programs, i.e., CHP's and our own existing system which could be utilized as either a data base or capable or receiving input for analysis - purposes, i.e., Maintenance Management System. Permis I & II.
4. Compile list of all other computer programs which supply data to the Safety Office. Example: Equipment Department mileage report.
5. Interim modifications to existing data collection procedures. Changing of accident data flow to computer.
6. Results of Study Committee to Safety with recommendations. Ties results of task force effort of M.I.S. (Committee) into development.
7. Correlation of needs versus existing system.
8. Develop program(s) to fill needs not presently satisfied. Computer Systems.
9. Implement and test system. Safety.

ANNEX D

SAFETY MANAGEMENT INFORMATION SYSTEM - CONTENTS

As discussed in Section 4.20, available safety management information system should be organized and programmed to contain at least the following categories of information:

I. Two Broad Categories

A. Motor Vehicle & Personal Injury

B. Cross reference system between Motor Vehicle & Personal Injury

II. Personal Injury Computations

A. Tabulation; Basic

1. Cost Center
2. Name
3. Position Code
4. Date
5. Hour
6. Age
7. Specific work activity of injury based on a management system
8. Cause of injury
9. Nature of injury
10. Days lost

B. Injury (location on body versus activity)

C. Activity (work codes) at time of injury vs. cause of injury

III. Motor Vehicle

A. Tabulation, basic

1. Cost Center
2. SS #
3. Name
4. Recordable

5. Date/Accident
6. Time
7. Vehicle make
8. Vehicle model
9. Driving experience
10. Accident type
11. Road type (if enroute to or from work zone)
12. Work activity
13. Road surfaces

IV. Cross reference system

A. Type of motor vehicle accident vs. type of injury

B. Type of accident vs. activity, weather, lighting

C. Type of accident vs. total accidents, recordability, Dept. injuries, other injuries, Dept. vehicle injury, other vehicle damage.

D. Type of motor vehicle accident vs. work activity

E. Dept. vehicle movement prior to collision vs. other vehicle's movement preceding collision

F. Type of accident vs. vehicle

G. Type of accident vs. recordability